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CONTROL FOR AN ELEVATOR CLOSURE

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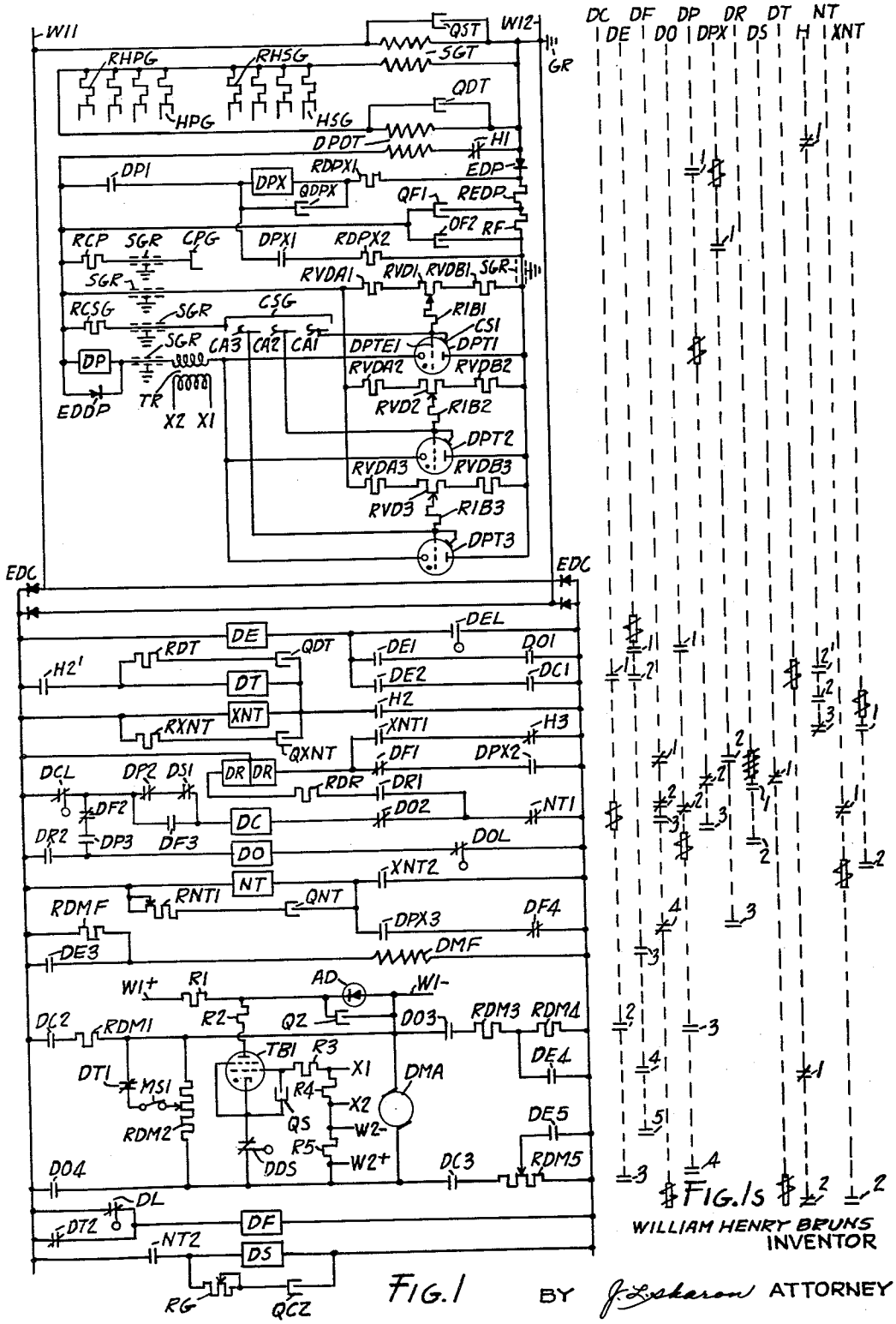


FIG. 1

FIG. 1a

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CONTROL FOR AN ELEVATOR CLOSURE

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This invention relates to door control mechanism, especially for sliding doors equipped with protective mechanism such as are used in elevator installations.

It is common practice in present day elevator installations to effect closing of the elevator car and hoistway doors automatically. In many such installations, especially those operated without attendants, safety devices or protective mechanisms have been provided that are responsive to the presence of a person in the closing path of the doors to stop their closing movement thereby minimizing the possibility of injuring the person. It is not uncommon in such unattended installations not only to stop the doors in closing upon detection of a person in their path, but to reopen them either fully or partially to allow the person to enter or leave the car unimpeded. Frequently if intending passengers arrive at spaced intervals, this stopping and reopening to allow passenger transfer occurs repeatedly and requires the elevator to stand at the landing for a considerable time.

Although it is desirable to stop the closing movement of the doors as soon as detection occurs, in these prior art door control mechanisms, the doors usually continue to move in the closing direction for a distance which has come to be known at the "slide." This slide is due to the time required to actuate relays controlling the door stopping mechanism and also to the time required by the stopping mechanism once it is actuated to overcome the kinetic energy of the closing doors. The magnitude of the slide distance controls the nearness with which the closing doors can be permitted to approach an obstruction before it is necessary to stop their closing movement to prevent striking the obstruction. The smaller this distance the fewer times it will be necessary to stop or reverse the closing doors, and, the less time will be wasted by the car standing at the landing.

The invention contemplates improving the operation of the doors, in response to actuation of protective mechanism.

It is an object of the invention to improve elevator operating efficiency by providing improved elevator door control mechanism.

Another object of the invention is to safeguard transferring passengers while minimizing unnecessary door movement.

It is still another object of the invention to minimize the time and distance required to stop closing doors, as the door protective mechanism detects an object in the closing path of the doors.

A further object of the invention is to provide a control for elevator doors which minimizes unnecessary door movement and yet does not hinder passenger transfer.

A still further object of the invention is to provide a control for elevator doors wherein the protective mechanism is rendered ineffective to reopen closing doors upon the happening of a predetermined condition, but which remains effective to stop the doors instantaneously, but only momentarily, upon detection of a person in their path.

Another object of the invention is to provide a door control including protective mechanism which is rendered inoperative to reopen closing doors when the doors reach a predetermined point in their closing movement but yet remain effective to stop the doors instantaneously, but only momentarily, upon detection of a person in their closing path.

The invention will be described by reference to one preferred embodiment in which a car door and hoistway door of the power operated, side opening type and door protective mechanism similar to that shown and described in W. H. Bruns et al., Patent No. 2,601,250, issued June 24, 1952 are utilized. Such door protective mechanism detects the presence of a person within a predetermined range in advance of the leading edge of the elevator doors. In this preferred embodiment the closing doors are caused to stop and reverse only if and to the extent required to allow the unimpeded passage of a transferring passenger. Persons entering or leaving the car, if not within the range of the detector, do not interfere with the closing of the doors. If, as the doors continue closing, a transferring passenger is brought within range of the detector the doors stop their closing movement practically instantaneously. The doors then reverse to the opening direction only until the passenger is again just out of range of the detector. At that point, the doors stop opening and after an adjustable predetermined time interval resume their closing movement. Thus, the door control mechanism allows sufficient time for the passenger to pass through the entranceway without reopening the doors a greater distance than is required. If the detection reoccurs, the doors again "back off."

In another aspect of the invention, if detection of a passenger occurs at a time when the doors are a predetermined distance from their fully closed position, where reopening the doors is impractical, the protective mechanism is prevented from initiating the door reopening operation, but instead causes the doors to stop instantaneously, but only momentarily, and then continue closing.

In still another aspect of the invention, at the expiration of a predetermined time interval, regardless of the position of the doors, the door protective mechanism is rendered inoperative to cause reopening of the closing doors and the doors are moved closed at a greatly reduced speed to expedite departure of the car while the protective mechanism remains effective to detect a person in the closing path and stop the doors instantaneously, but only momentarily.

Features and advantages of the system will be seen from the above and from the following description of operation of one preferred embodiment when considered in conjunction with the drawings in which:

FIGURE 1 is a simplified schematic wiring diagram embodying the invention, as applied to that portion of an elevator power and control system which relates to the control of the elevator doors, including circuits for a door protective mechanism; and

FIGURE 1s is a key sheet for FIGURE 1, showing the electromagnetic switches in spindle form.

The circuits are shown in "across-the-line" form, the relationship of the coils and contacts being seen from

FIGURE 1s where the coils and contacts are in horizontal alignment with the corresponding coils and contacts in the wiring diagram. Inasmuch as the invention involves only a portion of the elevator control system a complete control system has not been shown.

The following designations are used for the coils of electromagnetic switches and relays:

DC—Door close switch
DE—Door speed switch
DF—Door position switch
DO—Door open switch
DP—Door protective relay
DS—Door stop switch
DPX—Auxiliary door protective relay
DR—Door control switch
DT—Door time switch
H—Field and brake switch
NT—Hall time switch
XNT—Auxiliary hall time relay

Electromagnetic switch and relay contacts are designated corresponding to their activating coils, number suffixes being added to distinguish between sets of contacts on the same relay or switch. All such switches and relays are shown in their de-energized condition. Door control switch (DR) is of the latching type having two coils DR, the coil shown on the right being its operate coil and the coil on the left being its release coil and is shown for its unlatched condition.

Mechanical switches activated by door movement have contacts which are shown for closed door position and which are designated as follows:

DCL—Door close limit switch
DDS—Door direction switch
DEL—Door speed limit switch
DL—Door reopen limit switch
DOL—Door open limit switch
MS1 designates contacts of a manually operated switch.

The circuits of FIGURE 1, above rectifying device EDC, comprise door protective circuits and are connected to a source of single phase alternating current over wires W11 and W12. SGT and DPDT are constant voltage transformers for providing the desired values of alternating current voltage. Condensers QST and QDT are surge protecting condensers. The circuits for three door protective tubes DPT, such as the RCA1C21, cold cathode, gas type, are illustrated. The door protective tubes and their respective associated apparatus are differentiated from each other by the appended numerals 1, 2 and 3. An adjustable point on voltage divider resistor RVD for each tube is connected by way of resistor RIB, which in one tested embodiment was found may suitably be about 40 megohms, to the control electrode DPTE and conductive spot CS of the tube. Three antennas CA, one for each tube, are positioned vertically along the leading edge of the car door to cover a space sufficient to scan a person of average height. Each antenna CA is connected to the control electrode DPTE and conductive spot CS of its corresponding tube. Direct voltage is provided through rectifier EDP for the anode-cathode circuits of the tubes, approximately 150 volts being obtained with 120 R.M.S. volts from the transformer secondary winding which is insufficient in itself to cause breakdown of the tubes. A filter network is provided by condensers QF1 and QF2 and resistor RF. Resistors REDP, RDPX1 and RDPX2 are current limiting resistors. To prevent any undesirable effect on the tubes by action of stray fields, shielded conductors are employed with the shields connected to ground as indicated at the points SGR.

A car door sight guard CSG and a car door strike jamb post guard CPG are connected to the ungrounded side of the secondary winding of transformer DPDT, thus shielding the tubes from unwanted operation due to ground potential. The hoistway door sight guards HSG and the hoistway door strike jamb post guards HPG are connected to the ungrounded side of the secondary winding of transformer SGT, thus shielding the doors against unwanted operation as they near closed positions. The voltages applied to sight guards HSG and CSG and to post guards HPG and CPG are substantially in phase. For simplicity, the hoistway door post guards HPG and sight guards HSG are shown for only one floor of the building. Resistors RHPG, RHSG, RCP, RCSG associated with these guards are current limiting resistors. The physical construction of the protective mechanism is more fully illustrated and described in the aforementioned Bruns Patent No. 2,601,-250.

The door operating circuits are provided with direct current derived through rectifier EDC. The anode-cathode circuit of tube TB1 is supplied with a unidirectional voltage of approximately 300 volts over supply lines W1+ and W1— from any suitable source which is isolated from source W11—W12. Tube TB1 may be a thyratron, such as type RCA2050, having control grid, anode and suppressor grid electrodes, the latter two being connected together. For simplicity, the tube filament circuit has not been shown. The control grid electrode is connected to the cathode electrode through shunting condenser QS of about .001 microfarad. The anode electrode is connected to supply line W1+ through current limiting resistors R2 and R1 of 15 ohms and 75 ohms, respectively. Door motor armature DMA is connected in the cathode circuit of tube TB1. A parallel circuit, comprising an avalanche or zener diode AD having a rated voltage drop of approximately 150 volts and a condenser QZ of 6,400 microfarads, is connected in the anode-cathode circuit of tube TB1 in series with armature DMA. Diode AD functions as a voltage regulator, permitting condenser QZ to charge quickly to 150 volts from a 300 volt source. Grid resistors R3, R4 and R5 are connected in series between the grid and cathode electrodes of tube TB1. A negative grid bias of approximately 20 volts is applied over lines W2— and W2+ across grid resistor R5. Resistor R3 has a value of 1 megohm. Lines designated X1 and X2 connect the output of transformer TR, which is connected in the common anode circuit of tubes DPT, across grid resistor R4 of 100,000 ohms.

The manner in which the doors are controlled may vary considerably. In the particular circuits illustrated, the doors open automatically as a stop is made at a landing and close automatically upon the expiration of a given time interval. Coil XNT of the auxiliary hall time relay and coil NT of the hall time switch are both connected to the supply lines during the running of the car. As the car arrives at the landing at which the stop is to be made, brake switch H (not shown) releases, separating contacts H2 and H2' to disconnect coil XNT of the auxiliary hall time relay and coil DT of the door time switch from the supply lines. The de-energization of these coils, XNT and DT, is delayed by the discharge of condensers QXNT and GDT, respectively. Brake switch H also engages contacts H3 to complete a circuit by way of contacts XNT1 for the operate coil DR of the door control switch. This switch latches itself in its operated condition. Its contacts DR2 complete a circuit for the coil DO of the door open switch by way of contacts DOL of the door open limit switch. The door open switch (DO) engages its contacts DO3 and DO4, establishing a circuit for the armature DMA of the door operating motor through resistors RDM3 and RDM4 to cause operation of the door operating mechanism to open car and the hoistway doors at the floor at which the stop is being made. As the doors begin their opening movement, contacts DDS of the door direction switch open disconnecting the cathode electrode of tube TB1 from the door motor circuits. As the doors move a certain distance, contacts DEL of the door speed limit switch close to complete a circuit for the coil DE of the door speed switch. The switch engages contacts DE3 to short circuit resistance RDMF in

series with door motor field winding DMF and engages contacts DE4 to short circuit resistance RDM4 in series with armature DMA to increase the opening speed of the doors. As the doors in their opening movement reach a point approximately ten inches from their fully closed position, contacts DL of the door reopen limit switch open to disconnect coil DF of the door position switch from the supply lines, without effect at this time. As the doors near open position, contacts DEL of the door speed limit switch open, without effect at this time. As the doors reach full open position, contacts DOL of the door open limit switch open, de-energizing coil DO of the door open switch to break the circuit for armature DMA to de-energize the door motor and stop the door. The door open switch (DO) also de-energize coil DE of the door speed switch in preparation for the door closing operation. Contacts DCL of the door close limit switch also close and remain closed until the doors again reach their fully closed position, for purposes to be explained later.

Upon the expiration of the time interval, as determined by the discharge of condenser QXNT, coil XNT of the auxiliary hall time relay de-energizes, separating its contacts XNT2 to disconnect the coil NT of the hall time switch from the supply lines. After an interval determined by the discharge of the condenser QNT, coil NT of the hall time switch de-energizes engaging its contacts NT1 to establish a circuit by way of contacts DR1 of the door control switch for the release coil DR of the door control switch which is restored to its unlatched condition. Contacts NT2 also open disconnecting coil DS of the door stop switch from the supply lines. After a relatively short time interval determined by the discharge of condenser QCZ, coil DS de-energizes engaging its contacts DS1 to complete a circuit for the coil DC of the door close switch by way of contacts DCL, DP2, DO2 and NT1 to initiate the door closing operation. Thus, a time interval which includes the delay interval of coil XNT, say four and a half seconds, plus the delay interval of coil NT, say one half second, and the delay interval of coil DS, say one second, or a total of six seconds, is provided from the time that the stop is made until the closing of the doors is initiated by the door close switch (DC). The door close switch upon operation engages its contacts DC2 and DC3 to complete a circuit for armature DMA of the door operating mechanism to close the car and hoistway doors. As the doors begin their closing movement, contacts DDS of the door direction switch again close connecting the cathode of tube TB1 to the door motor armature DMA, for purposes to be explained later. Contacts DOL of the door open limit switch also reclose, without effect at this time. During the closing operation, contacts DEL of the door speed limit switch again close, energizing coil DE of the door speed switch which engages its contacts DE3 to short circuit motor field resistance RDMF and in addition engages its contacts DE5 to short circuit a portion of resistor RDM5 to increase the closing speed of the doors. As the doors reach a point approximately ten inches from their fully closed position, contacts DL of the door reopen limit switch close energizing coil DF of the door position switch, without effect at this time. As the doors reach their closed position, contacts DCL of the door close limit switch open, breaking the circuit for the coil DC of the door close switch. This switch separates its contacts DC2 and DC3 in the circuit of the door motor armature DMA to de-energize the door motor. It also separates contacts DC1 to open the circuit for coil DE of the door speed switch preparatory to the next opening operation.

The manner in which the protective mechanism operates will now be explained with reference to the circuits for tube DPT1; it being understood that the effect of tubes DPT2 and DPT3 and their associated circuits on the operation of the protective mechanism is substantially identical in all respects to that of tube DPT1. As the car comes to a stop and the brake is applied contacts H1 close to supply power, both alternating and rectified, to the protective mechanism circuits. Rectified voltage is supplied through unidirectional device EDP to apply unidirectional potential across the voltage divider comprising RVDB1, RVD1 and RVDA1. The connection of RVD1 of this divider to conductive spot CS1 and control electrode DPTE1 through resistor RIB1 supplies unidirectional bias voltage to these elements, the magnitude of which is adjusted to a value slightly less than required to cause the tube to conduct current in the presence of the alternating voltage signal that exists during non-detection periods.

Alternating voltage is also supplied to the protective device and is distributed in an alternating voltage divider circuit comprising ground antenna CA1, resistor RIB1 and that portion of the unidirectional voltage divider including RVD1 and RVDA1, a branch of this circuit also including resistor RCSG and the car sight guard CSG. Antenna CA1 has normal impedance couplings to ground and to sight guard CSG, the values of which are quite high as compared to the value of resistor RIB1 and its associated resistors in the cathode-control electrode circuit forming the alternating voltage divider. Under ordinary circumstances the major portion of the alternating signal appears across the antenna to ground impedance portion of the alternating voltage divider but, when a person, who has a relatively large capacity to ground coupling, approaches antenna CA1 sufficiently close to increase the capacity coupling of that antenna to ground, the impedance of that portion of the alternating voltage divider reduces materially. Correspondingly, the proportionate part of the alternating signal that appears across resistor RIB1 during such period is greatly increased and is sufficient to cause tube DPT1 momentarily to conduct current between its control electrode and cathode. In typical fashion, this current conduction is transferred to the higher potential anode-cathode circuit to send a current pulse through the primary winding of transformer TR and energize coil DP of the door protection switch.

The voltage pulse appearing in the secondary of transformer TR is applied as a positive pulse over leads X1—X2 across resistor R4 in the control grid—cathode circuit of tube TB1 to stop the closing doors. This voltage pulse opposes sufficiently the negative bias existing across resistor R5 to cause TB1 to conduct. Condenser QZ now discharges practically instantaneously through R2, TB1, DDS and DMA, the current flowing through the armature in a direction to reverse its closing rotation. Condenser QZ stores sufficient energy to cause the doors to stop instantaneously and reverse to their opening movement when it is discharged through armature DMA.

At substantially the same time operation of the door protective relay (DP) separates its contacts DP2 opening the circuit for coil DC of the door close switch to separate contacts DC2 and DC3 in the door motor armature circuit. The door protective relay (DP) also engages contacts DP3 to complete a circuit for coil DO of the door open switch to reopen the doors. As the doors move in the opening direction, contacts DDS of the door direction switch reopen removing armature DMA from the anode-cathode circuit of tube TB1, thereby allowing condenser QZ to recharge quickly to the breakdown voltage of Zener diode AD in preparation for any subsequent detection by the protective mechanism. The door protective relay (DP) also engages contacts DP1 to complete the circuit for coil DPX of the auxiliary door protective relay. This relay, upon operation, engages its contacts DPX2 which complete a circuit for the operate coil DR of the door control switch. The auxiliary door protective relay (DPX) also engages its contacts DPX3 causing delayed-release coil NT of the hall time switch to energize and engage its contacts NT2 energizing delay-release coil DS of the door stop switch. The hall time time switch (NT) also opens contacts NT1, without effect at this time. The auxiliary door protective relay (DPX) also engages contacts DPX1 to shunt voltage

dropping resistor RDPX2 across the anode-cathode circuit of tube DPT1 to extinguish the tube. As current conduction ceases, coil DP of the door protective relay de-energizes. This relay is delayed slightly in releasing by the discharge of its coil through rectifier EDDP to insure that its contacts DP3 remain closed for a sufficient time to operate the door open switch (DO), as previously stated. Coil DO of the door open switch is maintained energized through contacts DR2 of the door control switch after contacts DP3 separate. When the door protective relay (DP) releases, it separates contacts DP1 to open the circuit for coil DPX of the auxiliary door protective relay. This relay is delayed in releasing by the discharge of condenser QDPX to allow sufficient time for tube DPT1 to de-ionize. The auxiliary door protective relay (DPX), upon releasing, separates contacts DPX3 to open the circuit for coil NT of the hall time switch. This switch is delayed in releasing for one half second to allow the door protective relay (DP) to operate again, if the doors have not moved out of range of the obstruction in their path, thereby re-energizing coil DPX and in turn coil NT to continue the movement of the doors in an opening direction. The hall time relay (NT), upon releasing, engages contacts NT1 to establish a circuit by way of contacts DR1 for the release coil DR of the door control switch which is thus restored to unlatched condition. The door control switch (DR) separates its contacts DR2 de-energizing coil DO of the door open switch which opens the circuit for door motor armature DMA bringing the door to a stop. The hall time switch (NT) also separates contacts NT2 to open the circuit for the coil DS of the door stop switch. This switch is delayed in releasing for one second by the discharge of condenser QCZ and upon releasing engages contacts DS1 energizing coil DC of the door close switch to close the door.

It may be noted that the door stop switch (DS) introduces a time delay, which is effective, after the doors have "backed off" to a position where the person in their closing path is out of range of the detector and the doors stop opening, to delay the reclosing movement of the doors and allow that person and other passengers freedom to enter or leave the car. This delay also minimizes shock to the door operating equipment as the direction of movement of the doors is reversed.

As the doors resume their closing movement, contacts DDS of the door direction switch close, again inserting armature DMA in the anode-cathode circuit of tube TB1. If the closing path of the doors is again obstructed by a passenger, the detector initiates a reopening operation, as has been previously described, by instantaneously discharging condenser QZ through armature DMA and by energizing coil DP of the door protective relay. In such a case the doors again "back off" until the detector is out of range of the obstruction and then stop to allow the passenger to enter or leave the car. After the time interval introduced by the discharge of condenser QCZ, the door stop switch (DS) releases the door again resumes closing. As often as a person is detected in the closing path of the doors, this sequence of detection, door opening movement, and after a time delay during which the doors remain immobile, door closing movement is repeated in a "hovering" type of operation which reopens the doors only as much as is required and keeps them open only long enough to allow passenger transfer.

If, upon detection of a person in the closing path of the doors, it is desired to provide a larger opening through which passengers may pass, the doors may be made to reopen for a distance greater than the range of the detector by moving the adjustable tap on resistor RNT1 in a direction to increase the resistance in series with condenser QNT thereby decreasing the discharge rate of condenser QNT and thus increase the time required for switch NT to release, and unlatch the door control switch (DR). Thus the doors will reopen further before the door control switch (DR) separates its contacts DR2 to de-energize coil DO of the door open switch to stop the opening movement of the doors, as has been previously described. In this manner the closing doors upon detection reverse direction and continue moving in the opening direction a predetemined time interval after detection ceases, then stop and remain stationary for a certain time interval before they resume their closing movement.

As the doors in closing arrive at a predetermined distance from their fully closed position at which point it is deemed impractical to reopen the doors upon detection of a person in their closing path and which distance for purposes of this embodiment may suitably be ten inches, contacts DL of the door reopen limit switch close, energizing coil DP of the door position switch. This switch opens contacts DF1, DF2 and DF4 and closes contacts DF3 disabling the protective mechanism from reopening the closing doors. However, the protective mechanism remain effective to stop the doors instanteously, but only momentarily, as a person is detected in the closing path of the doors. In such a case, as tube DPT1 conducts, a pulse of positive polarity is applied to grid resistor R4 over lines X1 and X2 causing tube TB1 to conduct. As tube TB1 conducts, condenser QZ discharges through armature DMA to stop the doors instanteously, but only momentarily, thereby enabling the person to move out of the path of the doors and minimizing the possibility of striking that person.

It is to be noted, that in case of congestion when the passenger transfer cannot be effected quickly, the doors may fail to close sufficiently to actuate the door reopen limit switch (DL) to expedite departure of the car. If the doors fail to close after a certain period, say fifteen seconds, the door protective mechanism is rendered ineffective to reopen the doors and the doors are forced to their closed position at a speed slower than normal closing speed, enabling the car to answer the next call. The door time switch (DT) is utilized for this purpose. When a stop is made at a landing, contacts H2 and H2' of the brake switch separate to disconnect the coil DT of the door time switch from the supply lines. This switch is delayed in releasing for a prescribed period, say fifteen seconds, by the discharge of condenser QDT and upon releasing, engages its contacts DT2 energizing coil DF of the door position switch to render the protective mechanism circuits inoperative to reopen the doors while maintaining them effective to stop the doors instantaneously, but only momentarily, by means of instantaneously discharging condenser QZ through armature DMA, as has been previously described. The door time switch (DT) also engages contacts DT1 to short circuit a portion of resistance RDM2 causing the door closing operation to take place at a speed slower than normal closing speed. This arrangement makes possible the forced closing of the doors at reduced speed while minimizing the possibility of striking a transferring passenger.

In view of the protection given to transferring passengers by the ability of the protective mechanism to stop the doors instantaneously, but only momentarily, by means of discharging condenser QZ through armature DMA, if it is desirable, when the door time switch DT releases at the expiration of fifteen seconds, the doors may be forced to close at normal closing speed instead of at a reduced speed to expedite further the departure of the car. This may be accomplished by opening contacts MS1 of the manual switch, which contacts are in series with contacts DT1.

It may also be desirable in some installations to expedite the departure of the car while still safeguarding transferring passengers by positioning the mechanically actuated door reopen limit switch (DL) so that it is actuated by the doors when they reach their fully opened position instead of when they are ten inches from their

fully closed position, as described in the preferred embodiment. In such a case, the protective mechanism is disabled from reopening the doors during the entire closing movement of the doors and is only effective to stop the closing doors momentarily, by means of condenser QZ, in the manner previously described.

It may be noted that in lieu of connecting tube TB1 and condenser QZ across armature DMA, as shown in the drawings, to obtain instantaneous, but only momentary stopping of the closing doors when detection occurs, a circuit comprising tube TB1 and contacts DDS of the door direction switch may be connected across contacts DO3 and a similar circuit comprising say tube TB2 and contacts DDS1 may be connected across contacts DO4 to obtain the same operation. Each of these tubes TB1 and TB2 connected across contacts DO3 and DO4, respectively, are caused to conduct when detection occurs and a voltage pulse of positive polarity is applied across their respective grid resistors R4 over lines X1—X2 overcoming the negative grid bias applied to their grid resistors R5, as previously explained. As these tubes TB1 and TB2 conduct, a current is sent through armature DMA in a direction to stop its closing rotation, stopping the closing doors instantaneously, but only momentarily since, as the doors momentarily reverse their direction of movement, contacts DDS of the door direction switch separate disconnecting tubes TB1 and TB2 from the armature circuit and extinguishing them. Such a modification of the circuits of FIGURE 1 eliminates the necessity of utilizing a second power source such as the one supplying lines W1+ and W1— and eliminates the Zener diode AD and condenser QZ.

Although the invention has been described in connection with the protective mechanism shown and described in the aforementioned Bruns Patent No. 2,601,250, it is also applicable to other forms of protective mechanism including protective mechanism which may or may not require actual contact with the obstruction.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an elevator system in which a car serves several floors of a building, a control for a sliding type elevator door comprising, door operating means for opening and closing said door, switching means for controlling the energization of said door operating means, first initiating means for actuating said switching means to cause a door-opening operation of said door operating means incident to the car stopping at a floor, second initiating means effective following the opening of said door to fully open position for actuating said switching means to cause a door-closing operation of said door operating means, detecting means responsive to the presence of an object in the closing path of said door within a predetermined distance in advance of the leading edge of said door, said detecting means being effective upon detection of an object within said distance during the closing movement of said door to actuate said switching means to cause said door operating means to propel said door in an opening direction only as long as said detection persists, and delay means operatively responsive to said detecting means for maintaining said switching means in unactuated condition for a predetermined time interval after detection ceases before causing said door operating means to resume said door-closing operation.

2. A control for a sliding type elevator door comprising, proximity detecting means responsive to the presence of an object in the closing path of said door within a predetermined range in advance of the leading edge of said door, switching means actuatable from a first condition to a second condition when said proximity detecting means responds to an object within said range and being actuated to an intermediate condition when said object ceases to be within said range, door operating means for opening and closing said door, said door operating means being operatively responsive to the condition of said switching means for moving said door in a closing direction when said switching means are in said first condition, for moving said door in an opening direction when said switching means are in said second condition and for holding said door stationary upon actuation of said switching means to said intermediate condition, delay means responsive to said detecting means for actuating said switching means from said intermediate condition to said first condition at the expiration of a certain time after detection ceases to cause said door operating means to move said door in a closing direction, and expediting means operable when said door reaches a predetermined distance from its fully closed position in its closing movement, said expediting means rendering said detecting means inoperative to actuate said switching means thereby forcing said door to its fully closed position.

3. A control for a sliding type elevator door comprising, detecting means responsive to the presence of an object in the closing path of said door within a predetermined range in advance of the leading edge of said door, switching means actuatable from a first condition to a second condition when said detecting means responds to an object within said range and being actuated to an intermediate condition when said object ceases to be within said range, door operating means for opening and closing said door, said door operating means being operatively responsive to the condition of said switching means for moving said door in a closing direction when said switching means are in said first condition, for moving said door in an opening direction when said switching means are in said second condition for holding said door stationary when said switching means are in said intermediate condition, delay means responsive to said detecting means for actuating said switching means to said first condition at the expiration of a certain time after detection ceases, first expediting means operable when said door reaches a predetermined distance from fully closed position in its closing movement, said first expediting means maintaining said switching means in said first condition forcing said door to close, speed-reducing means to reduce the closing speed of the door below normal closing speed, and second expediting means operable at the expiration of a predetermined time after the initial opening of the door to disable said detecting means from actuating said switching means and to return said switching means to said first condition and to actuate said speed-reducing means forcing the door to close at a slower than normal closing speed.

4. In an elevator system in which a car serves several floor landings of a building, a control for a sliding type elevator door comprising, detecting means responsive to the presence of an object in the closing path of said door within a predetermined range in advance of the leading edge of said door, door operating means for opening and closing said door, said door operating means including a reversible direct current door motor having an armature, first initiating means for initiating a door-opening operation of said door operating means as a car stops at a floor landing, second initiating means effective following the opening of said door to fully open position for initiating a door-closing operation of said door operating means, and instant-stop means operatively responsive to operation of said proximity detecting means, said instant-stop means being effective upon detection of an object within said range during closing movement of said door to apply momentarily an electric stopping force to said direct current door motor of sufficient magnitude to stop momentarily said closing movement.

5. A control as claimed in claim 4 wherein the instant-stop means comprises means for instantaneously applying a pulse of unidirectional current through said reversible door motor armature in a door-opening direc-

tion, said pulse being of a magnitude sufficient to stop the closing movement of said door instantaneously, but only momentarily.

6. A control as claimed in claim 5 wherein the means for instantaneously applying a pulse of unidirectional current through said reversible door motor armature in a door-opening direction and of a magnitude sufficient to stop the closing movement of said door instantaneously, but only momentarily comprises a thyratron tube having control grid, anode and cathode electrodes, circuit interrupting means actuated by movement of said door for connecting said reversible door motor armature in series with said cathode electrode only during closing movement of said door, a condenser connected across the anode-cathode circuit of said tube from said anode electrode to the cathode return, said condenser being connected in series with said armature, a source of unidirectional voltage connected across said condenser, said source being of a value above the breakdown voltage of said tube, means for applying a negative grid bias to said tube of sufficient value to maintain said tube in non-conducting condition and tube firing means operatively responsive to operation of said detecing means for causing said tube to conduct upon detection of a person within said range, thereby causing said condenser to discharge through said door motor armature connected in the cathode circuit of said tube for instantaneously stopping the closing movement of said door momentarily.

7. In an elevator system in which a car serves several floor landings of a building, a control for a sliding elevator door comprising, door operating means for opening and closing said door, switching means operable from a first condition to a second condition and to an intermediate condition, said switching means when in said first condition being effective to actuate said door operating means to a door-closing condition and when in said second condition being effective to actuate said door operating means to a door-opening condition and when in said intermediate condition said door operating means are de-energized, initiating means operable incident to said car stopping at a floor landing in response to a call for service to actuate said switching means from said first condition to said second condition for causing a door-opening operation of said door operating means and being effective to return said switching means to said first condition upon expiration of a predetermined time after said door reaches fully opened position to cause a closing operation of said door operating means, proximity detecting means operatively responsive to the presence of an object in the closing path of said door within a predetermined range of the leading edge of said door, said proximity detecting means actuating said switching means to said second condition upon detection of an object in said range to cause door-opening operation of said door operating means and actuating said switching means to said intermediate condition as soon as detection ceases, and delay means operatively responsive to operation of said proximity detecting means for actuating said switching means to said first condition for door-closing operation of said door operating means at the expiration of a predetermined time measured from the cessation of detection.

8. In an elevator system in which a car serves several floor landings of a building, a control for a sliding elevator door comprising, door operating means for opening and closing said door, switching means operable from a first condition to a second condition, said switching means when in said first condition being effective to actuate said door operating means to a door-closing condition and when in said second condition being effective to actuate said door operating means to a door-opening condition, initiating means operable incident to the car stopping at a floor landing in response to a call for service to actuate said switching means from said first condition to said second condition for initiating a door-opening operation of said door operating means and being effective to return said switching means to said first condition upon expiration of a predetermined time after said door reaches fully opened position to initiate a closing operation of said door operating means, proximity detecting means operatively responsive to the presence of an object in the closing path of said door within a predetermined range of the leading edge of said door, said proximity detecting means actuating said switching means to said second condition upon detection of an object in said range to cause door-opening operation of said door operating means and maintaining said switching means in said second condition until said detection ceases, first delay means operatively responsive to operation of said proximity detecting means for maintaining said switching means in said second condition for a certain time after detection ceases, and second delay means operatively responsive to expiration of said certain time for preventing a door-closing operation of said operating means until the expiration of a second certain time measured from the cessation of detection.

9. In an elevator system in which a car serves several floor landings of a building, a control for a sliding elevator door comprising, door operating means for opening and closing said door, said door operating means including a direct current reversible door motor having an armature, switching means operable from a first condition to a second condition, said switching means when in said first condition being effective to actuate said door operating means to a door-closing condition and when in said second condition being effective to actuate said door operating means to a door-opening condition, initiating means operable incident to said car stopping at a floor landing in response to a call for service to actuate said switching means from said first condition to said second condition for initiating a door-opening operation of said door operating means and being effective to return said switching means to said first condition upon expiration of a predetermined time after said door reaches fully opened position to initiate a closing operation of said door operating means, proximity detecting means operatively responsive to the presence of an object in the closing path of said door within a predetermined range of the leading edge of said door, instant-stop means operatively responsive to operation of said detecting means for instantaneously applying a pulse of unidirectional current through said reversible door motor armature in a door-opening direction, said pulse being of a magnitude sufficient to stop the closing movement of said door instantaneously and propel said door in an opening direction momentarily, said proximity detecting means also actuating said switching means to said second condition upon detection of an object in said range to initiate and maintain door-opening operation of said door operating means for so long as detection persists, and delay means operatively responsive to operation of said proximity detecting means for preventing door-closing operation of said door operating means until the expiration of a predetermined time measured from the cessation of detection.

10. In an elevator system in which a car serves several floor landings of a building, a control for a sliding elevator door comprising, door operating means for opening and closing said door, said door operating means including a direct current reversible door motor having an armature, switching means operable from a first condition to a second condition, said switching means when in said first condition being effective to actuate said door operating means to a door-closing condition and when in said second condition being effective to actuate said door operating means to a door-opening condition, initiating means operable incident to said car stopping at a floor landing in response to a call for service to actuate said switching means from said first condition to said second condition for initiating a door-opening operation of said door operating means and being effective to return said switching means to said first condition upon expiration of a predetermined time after said door reaches fully

opened position to initiate a closing operation of said door operating means, proximity detecting means operatively responsive to the presence of an object in the closing path of said door within a predetermined range of the leading edge of said door, instant-stop means operatively responsive to operation of said detecting means for instantaneously applying a pulse of unidirectional current through said reversible door motor armature in a door-opening direction, said pulse being of a magnitude sufficient to stop the closing movement of said door instantaneously, but only momentarily, said proximity detecting means also actuating said switching means to said second condition upon detection of an object within said range to cause door-opening operation of said door operating means until detection ceases, delay means operatively responsive to operation of said proximity detecting means for preventing the door-closing operation of said door operating means until the expiration of a predetermined time measured from the cessation of detection, first expediting means actuated by movement of said

door for maintaining said switching means in said first condition when said door reaches a predetermined distance from fully closed position in its closing movement to force said door to close regardless of operation of said proximity detecting means, speed-reducing means to reduce the closing speed of the door below normal closing speed, and second expediting means operable at the expiration of a predetermined time after the initial opening of said door for disabling said detecting means from actuating said switching means to said second condition and for returning said switching means to said first condition, said second expediting means also actuating said speed-reducing means forcing said door to close at slower than normal closing speed.

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