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DOOR PROTECTIVE EDGE

Filed Sept. 25, 1958 7 Sheets-Sheet 1

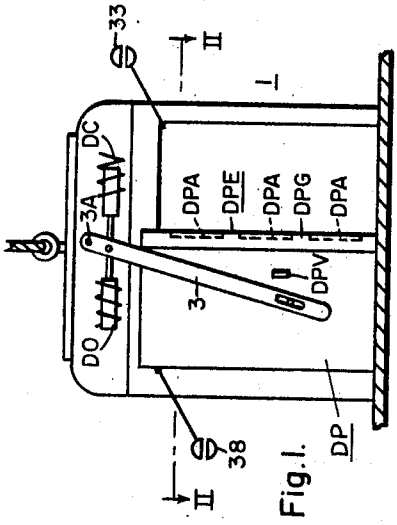


Fig. 1.

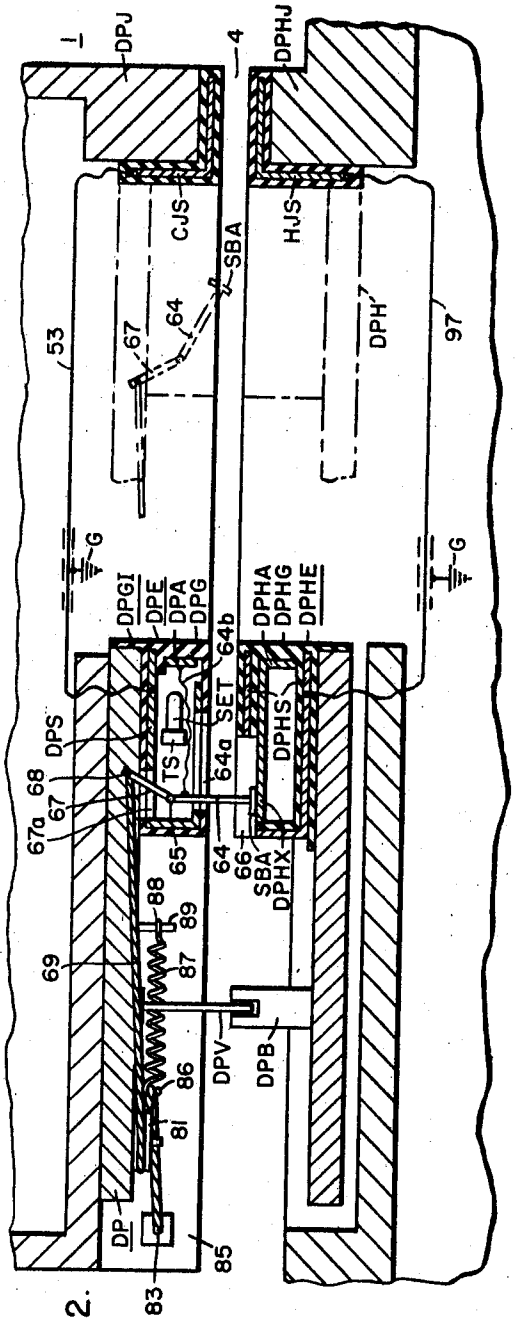


Fig. 2.

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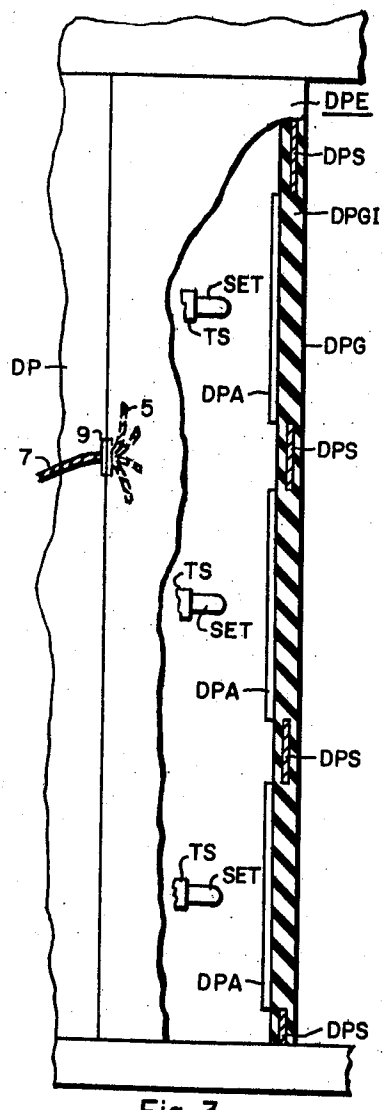


Fig. 3.

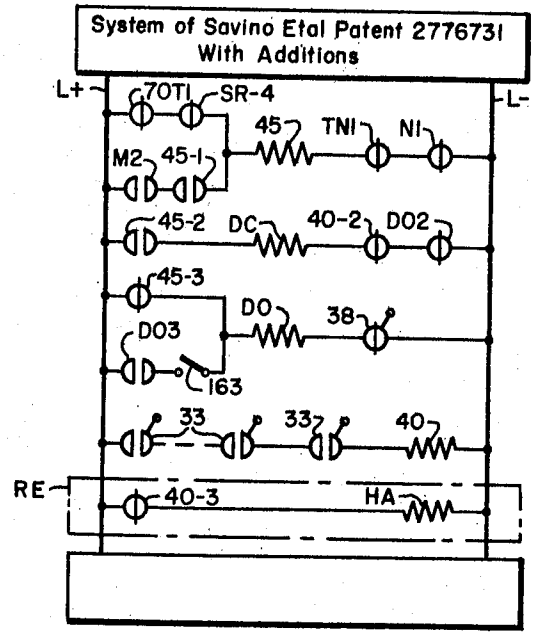


Fig. 9.

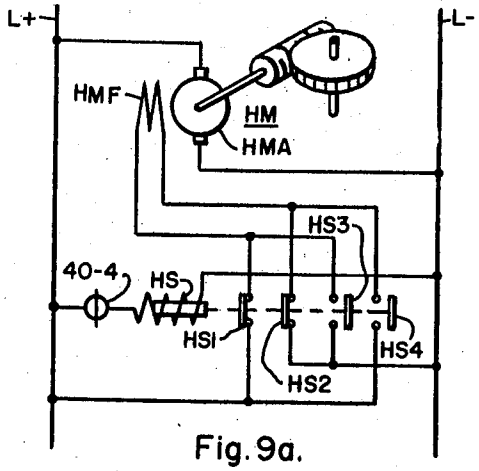


Fig. 9a.

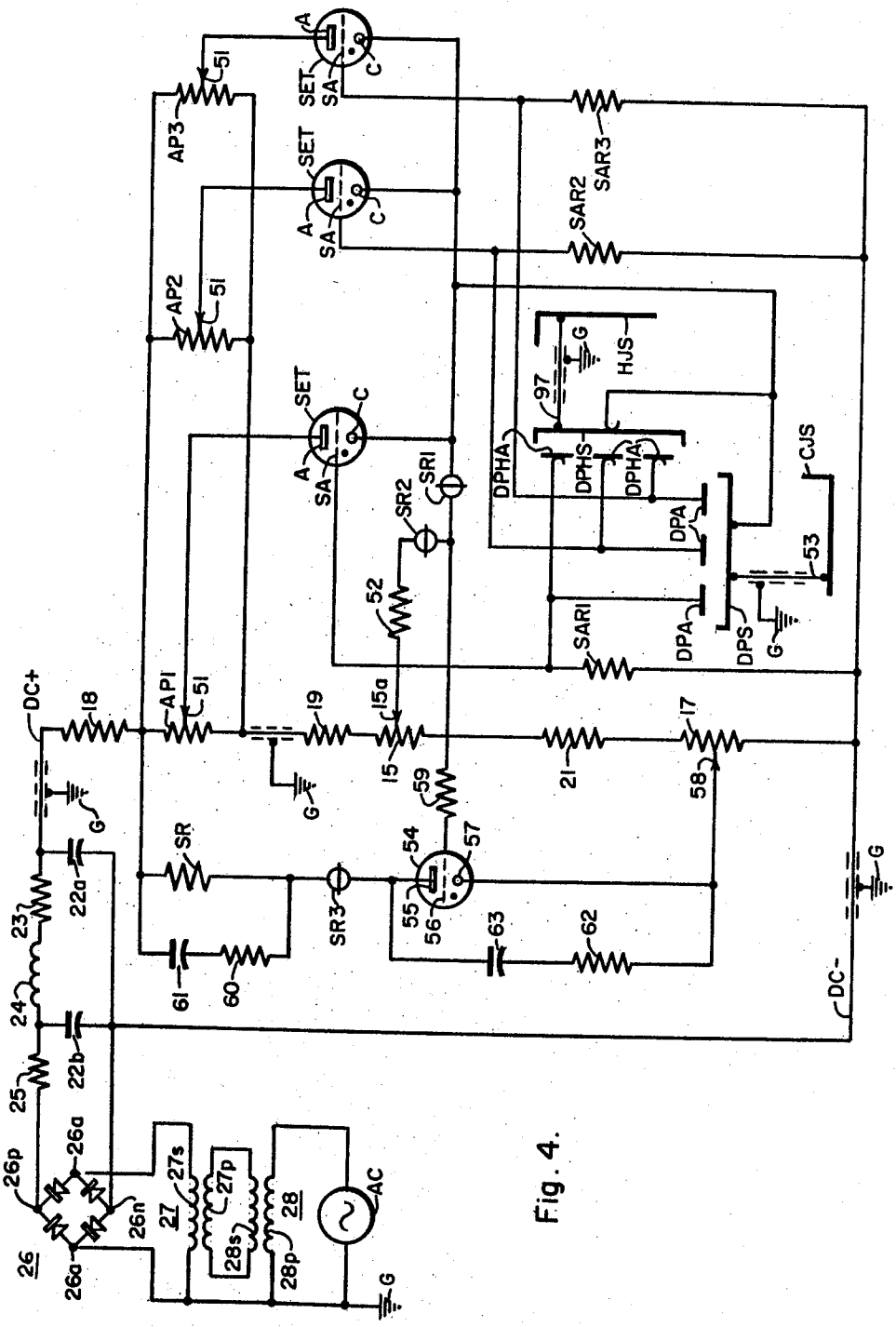

A
SET
SA
C
51
AP3
SAR3
SAR2
AP2
G
HJS
97
DPHA
DPHS
DPA
CJS
53
SRI
SR2
52
SARI
DPS
DC+
18
API
19
15a
15
21
17
59
58
SR
54
57
SR3
55
56
63
62
61
60
22a
23
24
22b
25
26p
26a
26n
26
27
27s
27p
28
28s
28p
AC
DC-

Fig. 4.

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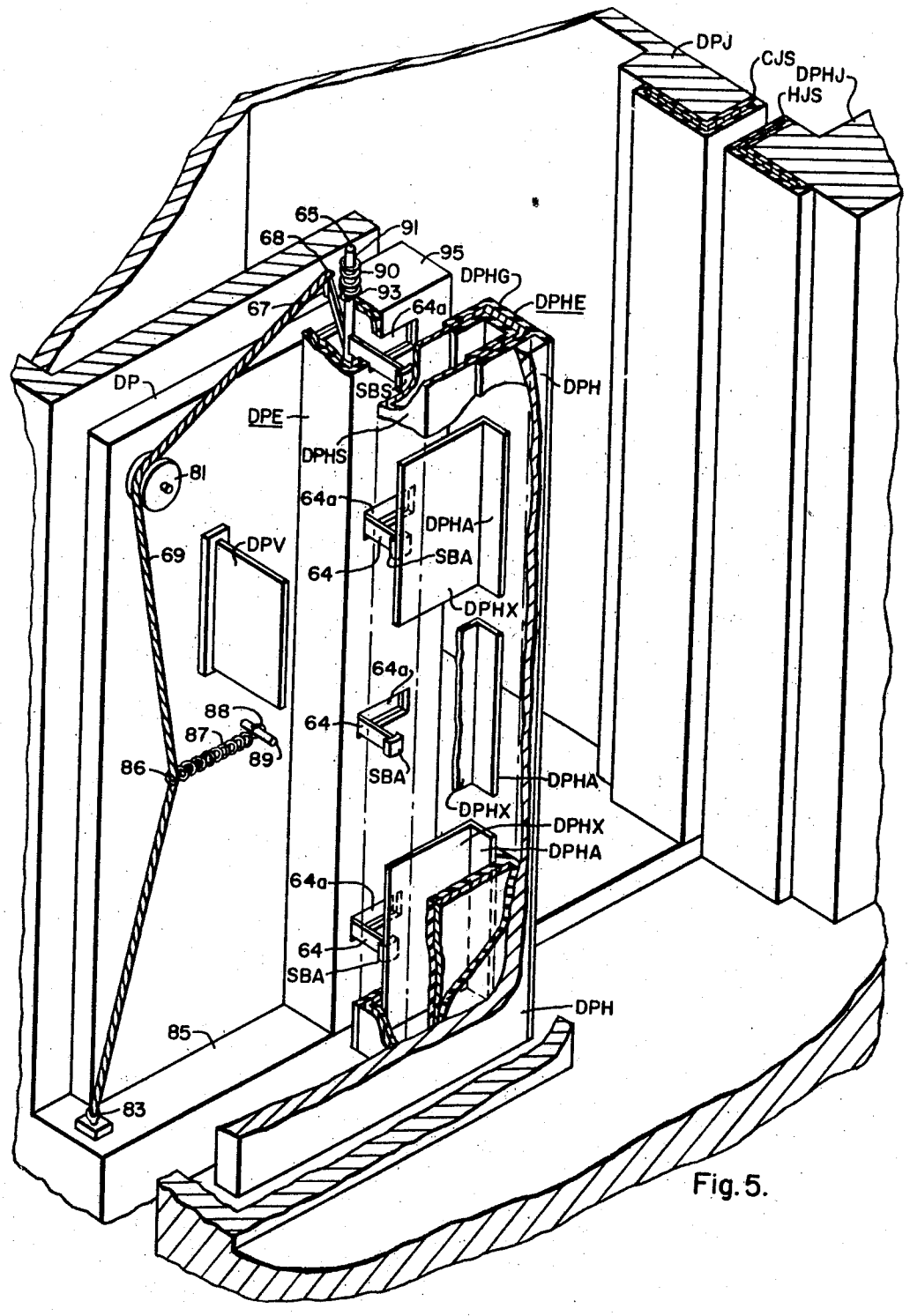


Fig. 5.

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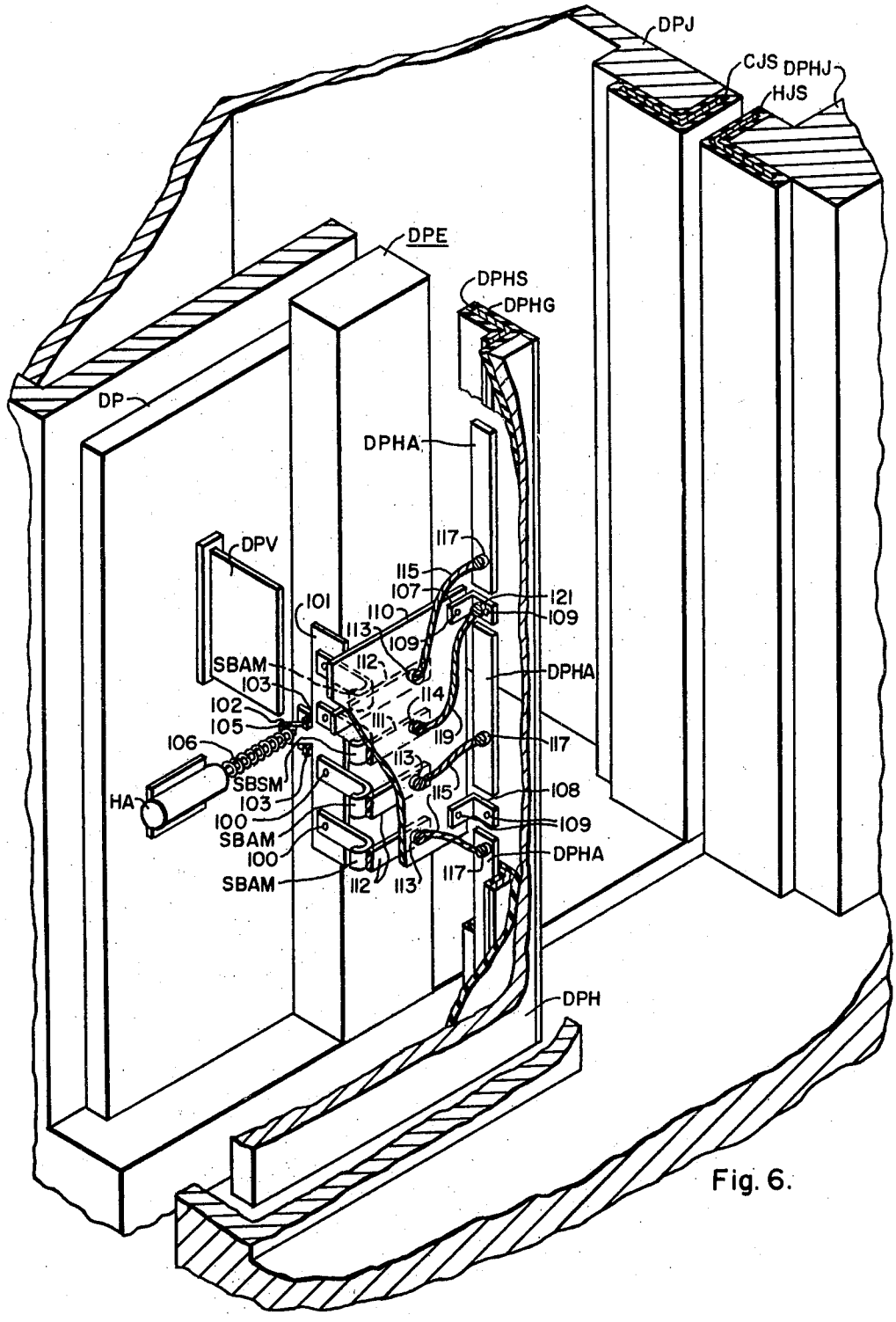


Fig. 6.

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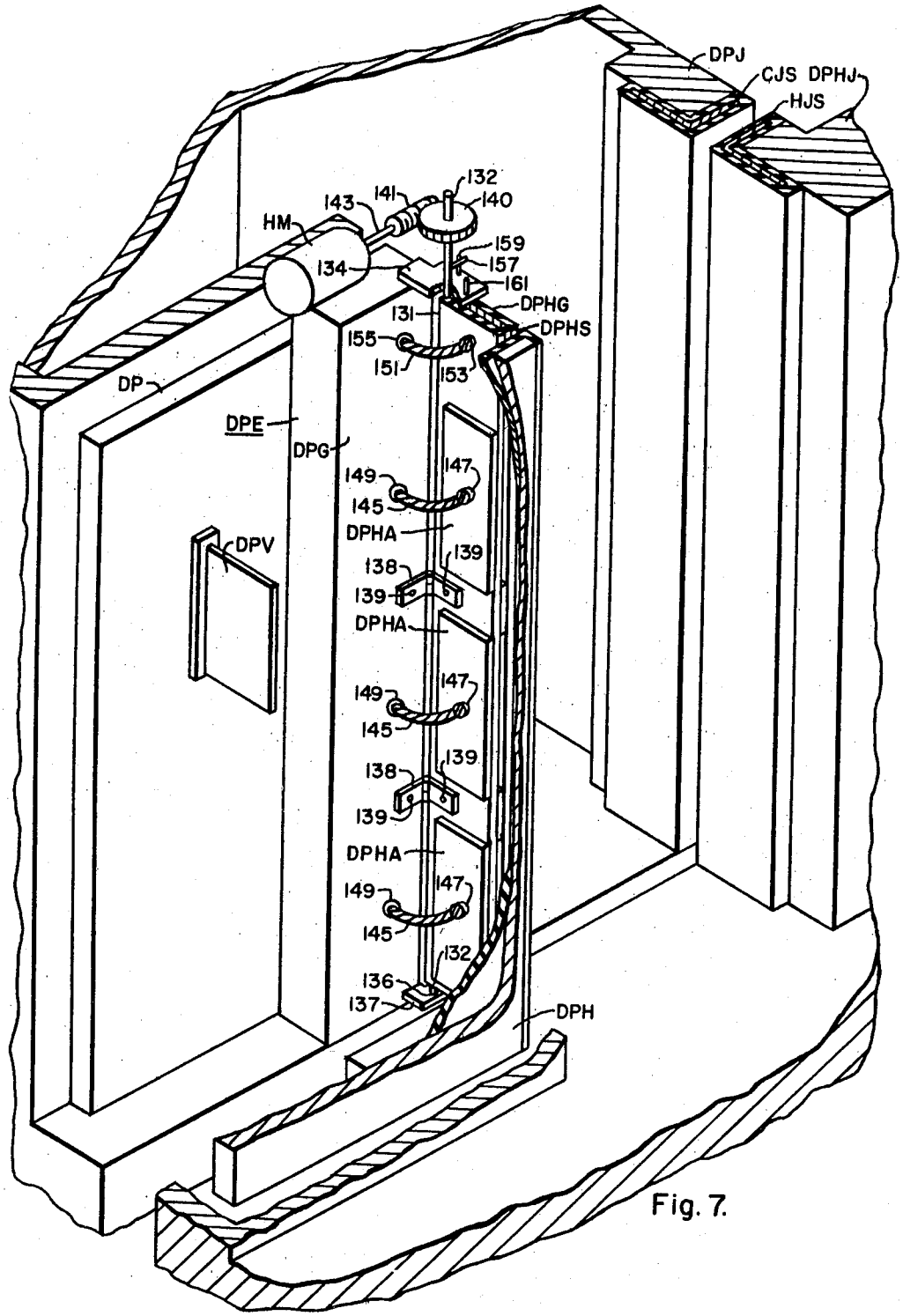


Fig. 7.

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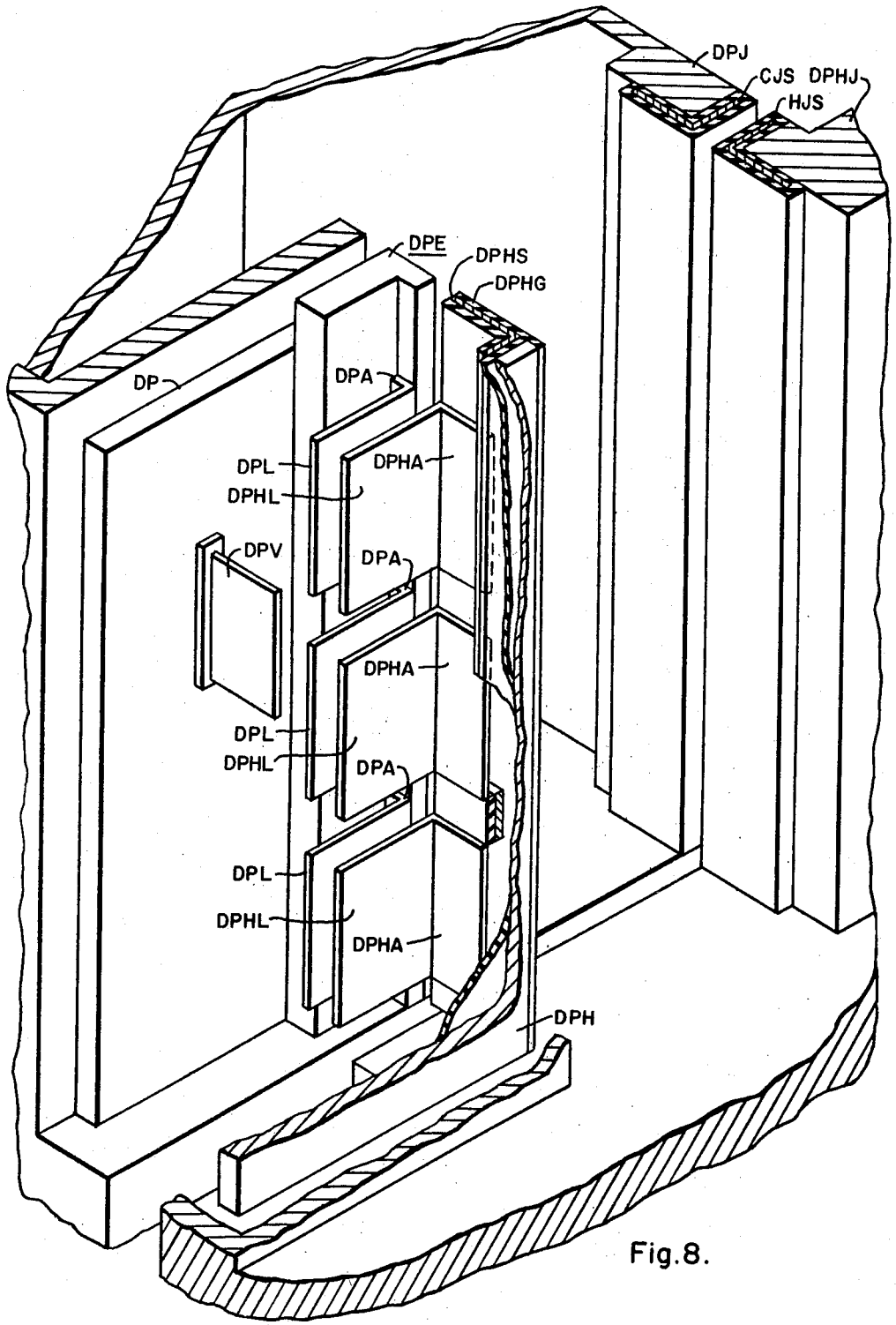


Fig.8.

United States Patent Office 3,017,957
Patented Jan. 23, 1962

3,017,957

DOOR PROTECTIVE EDGE

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Filed Sept. 25, 1958, Ser. No. 763,354
10 Claims. (Cl. 187—48)

This invention relates to load transporting devices and more particularly to safety mechanism for doors of elevators suitable for conveying passengers.

Load transporting devices may be provided with one or more cars for transporting load from one position or landing to another position or landing. The cars are provided with entranceways for load at the landings and a closure may be furnished for each entranceway. An example of such a device is an elevator car serving a plurality of vertically-spaced landing or floors in a hoistway. In addition to a car closure or door, a separate hoistway door is generally provided for each of the landings or floors served by the elevator car.

An elevator car door may be provided with a capacity-operated safety edge which comprises circuitry including one or more electronic tubes, preferably of the cold cathode gas type, carried by the elevator car, each tube being provided with an antenna carried in the leading edge of the associated car door, the antenna having capacitance to ground. When a person or object is positioned in the closing path of movement of the door, the antenna-to-ground capacitance is increased, and one or more of the tubes breaks down, thereby actuating switching means to stop, reopen or reduce the speed of movement of the door.

In accordance with the invention, each hoistway door may be furnished with antennae having capacitance to ground. Means are provided for coupling the hoistway door antennae to energizing equipment carried by the elevator car. Such an arrangement provides improved hoistway door protection without requiring the duplication of tubes and associated circuitry for each hoistway door.

The hoistway doors also are provided with electric shields to shield the tubes carried by the elevator car and thus to prevent unwanted breakdowns of the safety edge tubes due to the proximity of the hoistway door antennae to grounded parts of the elevator installation. When the car is stopped at a landing, the associated hoistway door shield may be energized from the car, eliminating the need for the hoistway wires and the hoistway door shield potential adjustments heretofore required.

While the invention is applicable to either side or center-opening doors, for the purpose of illustration the elevator cars and the hoistway landings are provided with side-opening doors. For center-opening doors, each car door and hoistway door section respectively is furnished with apparatus duplicating that described herein.

It is, therefore, an object of the invention to provide improved circuitry and design for safety edges for closures of load transporting devices and more particularly for capacity-operated safety edges for elevator car and hoistway doors.

It is also an object of the invention to provide a safety edge as defined in the preceding paragraph wherein the hoistway doors are provided with antenna means having capacitance to ground and with electric shield means and in which coupling means are provided for energizing such antenna and shield means from equipment carried by the associated elevator car.

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

FIGURE 1 is a view in elevation with parts broken away of an elevator car in which the invention may be incorporated;

FIG. 2 is an enlarged view in section with parts broken away and parts omitted of the elevator car shown in FIG. 1, taken along the lines II—II of FIG. 1, with an associated hoistway and a hoistway door added and embodying one aspect of the invention;

FIG. 3 is a detail view in elevation with parts broken away and parts omitted of the leading edge of the door of the car of FIG. 1;

FIG. 4 is a schematic view of an electronic circuit embodying the invention;

FIG. 5 is an enlarged detail view in perspective with parts broken away of the elevator car, hoistway and hoistway door shown in FIG. 2;

FIG. 6 is an enlarged detail view in perspective with parts broken away depicting a modification of the aspect of the invention shown in FIG. 5;

FIG. 7 is an enlarged detail view in perspective with parts broken away depicting another modification of the aspect of the invention shown in FIG. 5;

FIG. 8 is an enlarged detail view in perspective with parts broken away depicting still another modification of the aspect of the invention shown in FIG. 5;

FIG. 9 is a schematic view in straight line form with parts broken away showing a control circuit suitable for use with the elevator car of FIG. 1; and

FIG. 9*a* is a schematic view in straight line form of an alternate control circuit for a portion of the control circuit of FIG. 9.

Referring to the drawings, FIG. 1 shows an elevator car 1 provided with a door DP, illustrated in open position, which is mounted to slide across a passage through which passengers enter and leave the elevator car. A suitable door operator may be employed for opening and closing the door DP. In the embodiment of FIG. 1, the door operator includes a lever 3 which is pivotally mounted on the car by means of a pivot 3A. The lever 3 is moved in a counterclockwise direction about the pivot 3A by means of a door-close solenoid DC for the purpose of closing the passage and is moved in a clockwise direction about the pivot 3A to open the door by means of a door-open solenoid DO.

The elevator car 1 travels in a hoistway 4 to serve various floors of the structure with which it is associated. A separate hoistway door DPH, illustrated in FIG. 2, is provided for each of the floors served by the elevator car. The coupling of the two doors may be effected in a conventional manner, as by a vane DPV which is secured to the door DP for reception in the slot of a slotted block DPB which is mounted on the hoistway door DPH. The hoistway door DPH is moved to close and to expose a hoistway passage through which load enters and leaves the elevator car. An edge DPE of the car door DP and edge DPHE of the hoistway door DPH, which are the leading edges during a door-closing movement, are safety edges of the capacity-operated type. As explained above, such capacity-operated safety edges may be responsive to the presence of a person or an electroconductive body in the closing path of movement of the doors while still a substantial distance therefrom for modifying a closing movement of the doors.

FIG. 3 shows the edge DPE of the car door DP in somewhat greater detail, while FIG. 4 shows circuitry employed with the edge. The leading edge of the car door DP is provided with a car door sight guard DPG, of a type well known in the art, which includes a shield DPS of electroconductive material insulated from the door DP and from contact with any object in the path of movement of the door by insulating material DPGI, as is clearly shown in FIGS. 2 and 3. A plurality of antennae DPA in the form of electrically conductive plates

is mounted by suitable means along the inside face of the sight guard DPG, the shield DPS being cut away in front of each antenna. Three such antennae are sufficient to provide adequate door edge coverage. Behind and associated with each antenna is an electronic tube SET, preferably of the cold cathode gas type. A tube such as the RCA 1C21 has been found satisfactory and is illustrated. This tube has an anode A, a control or starter anode SA and a cathode C. Each tube is mounted in a tube socket TS of a conventional type within the safety edge. Connecting wires **5** to the tubes SET and associated circuitry are arranged in a shielded cable **7** fastened to a cable connector **9** extending into the sight guard DPG.

Referring now to FIG. 4, the circuitry shown therein will be described in detail. The voltages required for the various tube electrodes are derived from a plurality of components comprising voltage dividers AP, **15** and **17** and fixed resistors **18**, **19** and **21**. The resistance elements of the voltage dividers AP are connected in parallel with one another, this parallel combination being connected in series with the remaining aforementioned voltage dividers and fixed resistors. The series-connected components are in turn connected across direct current voltage buses D.C.+ and D.C.—. The buses D.C.+ and D.C.— are connected to the output terminals of a conventional filter network comprising capacitors **22***a* and **22***b*, a fixed resistor **23**, an inductor **24** and a fixed resistor **25**. The input terminals of the filter network are connected to direct current voltage terminals **26***n* (negative) and **26***p* (positive) of a full-wave rectifier **26**. Conveniently, the rectifier **26** may be of a semiconductor type such as selenium. Alternating current voltage terminals **26***a* of the rectifier **26** are connected to a secondary winding **27***s* of a transformer **27**, whose primary winding **27***p* is connected to a secondary winding **28***s* of a transformer **28**. A primary winding **28***p* of the transformer **28** is connected to a suitable alternating current voltage source AC, one side of which is connected to ground G. It will be observed that one of the rectifier terminals **26***a* and one end of the transformer winding **27***s* are also connected to ground G.

In the description of circuit operation which follows, it is to be understood that the magnitudes and the polarities of the control SA and the anode A direct current voltages for each of the tubes SET are with respect to their associated cathode.

Positive voltage of a value above sustaining voltage of each tube SET, but insufficient to cause breakdown of the tube, is applied to each anode A through its connection to a movable contact **51** of an associated one of the voltage dividers AP.

The control SA of each tube SET is connected to the antenna DPA associated with that tube. Each control is also connected to the bus D.C.— through a fixed resistor SAR. The cathodes C of the tubes SET are connected together, their common lead being connected through a series circuit comprising break contacts SR1 and SR2 of a door protective relay SR and a fixed resistor **52** to a movable contact **15***a* of the voltage divider **15**. There is thus applied to each control SA negative voltage of a value insufficient to cause breakdown of its associated tube SET. This mode of operation of a cold cathode gas tube, wherein there is applied to the control a negative direct current voltage with respect to the cathode, is known as second-quadrant operation, in contrast to first-quadrant operation, wherein the control direct current voltage is positive with respect to the cathode. In second-quadrant operation the control electron flow, before tube breakdown, is from the control to the cathode, while in first-quadrant operation such electron flow is from the cathode to the control.

Operation of that portion of the protective edge circuitry of FIG. 4 comprising the tubes SET may be explained as follows. There is capacitance directly between each antenna DPA and ground and between each antenna and the shield DPS, the latter capacitance thus being connected between its associated control SA and cathode C and, for the purpose of this analysis, being connected directly in series with the former capacitance. When an antenna approaches an object such as a person's body, the aforementioned antenna-to-ground capacitance is thereby paralleled with an external capacitance, i.e., the antenna-to-ground capacitance is effectively increased. The affect of said object upon circuit operation depends upon its impedance to ground, an object which is directly grounded having greater affect upon circuit operation than one whose impedance path to ground is relatively high.

If an external capacitance parallels a direct antenna-to-ground capacitance, more electrons are able to flow, through these paralleled paths, into the associated antenna-to-shield capacitance, when the grounded side of the alternating current voltage source A.C. is negative with respect to the ungrounded side of that source. This greater electron flow causes an increase in the votage drop across the associated antenna-to-shield capacitance which will, in turn, if the external capacitance is of sufficient magnitude, cause an electron discharge from the associated control SA to the associated cathode C of magnitude sufficient to effect a transfer of electron flow to the associated anode A, i.e., breakdown of one of the tubes SET will occur. Subsequent to such breakdown, changes in control voltage with respect to cathode will have no influence on tube electron flow, as is well known in the case of cold cathode gas tubes. Extinguishment of the tubes is accomplished by means hereinafter explained. Each resistor SAR is of a value which effectively isolates the aforementioned alternating current voltage applied between its associated control SA and its associated cathode C from the direct current voltage applied therebetween.

The characteristics of cold cathode gas tubes of the same tube type vary with respect to one another by relatively large amounts. The voltages applied to the electrodes of each tube SET, therefore, must be adjusted for optimum tube operation. In the past, the anode voltage was maintained at a constant value while the control voltage was varied until the optimum operating point for the tube was determined. In second-quadrant operation, for a given anode voltage the total variation of control voltage required among tubes of the same time for optimum safety edge operation is too great for practical application; and a relatively small increment in the anode voltage of a tube alters the optimum control voltage for that tube by a relatively large amount. The variation in control voltage for a given anode voltage from three inches minimum sensitivity of the safety edge, for example, to that control voltage wherein a tube breaks down without the aid of external capacitance is approximately four times as great in second-quadrant operation as in first-quadrant operation. Thus, the more critical voltage is not the control voltage but the anode voltage. Since this is also the case in first-quadrant operation, the variations due to changes in tube characteristics, the values of circuit components and applied voltages that a tube will tolerate and still not break down without the aid of external capacitance is three to four times greater in second-quadrant operation than in first-quadrant operation. The sensitivity obtained from second-quadrant operation is approximately 25% greater than that which may be obtained from first-quadrant operation.

Inasmuch as a relatively small change in anode voltage changes the control voltage required for optimum tube operation by a relatively large amount, only 25% of the variation previously needed is required if the control voltage is held constant and the anode voltage is varied to set the point of optimum tube operation. This procedure makes is possible for all tubes of a suitable type to be used in the safety edge, while approximately only 25%

of such tubes may be used in the circuit when the anode voltage is held constant and the control voltage is varied.

Referring again to FIG. 4, it will be seen that the anode voltage of each of the tubes SET may be varied independently by means of its associated voltage divider AP. The individual anode circuit voltage dividers are provided in order to enable adjustment of all of the tubes SET in the edge to the same sensitivity while the common control voltage of the tubes is held constant. There is a control voltage which provides maximum sensitivity but above which the tubes SET will break down without the aid of external capacitance. At some lower control voltage the sensitivity becomes impracticably low. After the anode voltages have been adjusted by means of the voltage dividers AP, the common control voltage of the tubes SET is then adjusted by means of the voltage divider **15** to provide the desired safety edge sensitivity.

As heretofore mentioned, operation of the cold cathode gas tubes in the second quadrant is much more stable and sensitive than in the first quadrant. The sensitivity of the edge with respect to its proximity to the body to be protected is not affected by changes in ambient temperature or light intensity in second-quadrant operation. Variations in humidity also affect the sensitivity of the edge to a much lesser extent than in first-quadrant operation.

Because the hoistway door DPH and the car door DP are normally grounded, it is necesary to shield the safety edge DPE from the doors to prevent unwanted breakdown of the tubes SET due to the proximity of the antennae DPA to these grounded parts. As pointed out above, the car door sight guard DPG includes the car door shield DPS. The shield DPS is provided with a shielding potential by connecting the shield to the common cathode circuit of the tubes SET, as is shown in FIG. 4. The connection from the common cathode circuit to the shield DPS may be made in a conventional manner as by a terminal suitably secured to the shield and a wire running from the terminal to the common cathode circuit.

Referring to FIG. 2, the elevator car **1** is provided with a car door strike jamb DPJ for the car door DP, the strike jamb normally being grounded. To prevent unwanted firing of the tubes SET as the door DP and thereby the antennae DPA approach the car door strike jamb DPJ during a closing movement of the car door, a shield CJS of a type similar in construction to that of the shield DPS is provided for the strike jamb DPJ. Shielding potential for the shield CJS is provided by means of a flexible shielded cable **53**, running from the car door shield DPS to the strike jamb shield CJS, as is clearly shown in FIGS. 2 and 4. Each end of the cable **53** is connected to its associated shield by means of a suitable terminal.

Referring again to FIG. 4, it will be observed that the voltage divider **17**, the fixed resistor **21**, a portion of the voltage divider **15**, the fixed resistor **52**, a portion of one of the voltage dividers AP and the resistor **18** are connected in series with one of the tubes SET when it breaks down. The magnitude of electron flow from the cathode C to the anode A when such breakdown occurs is, therefore limited by this series resistance. By virtue of this current limitation, the tubes SET, upon breakdown thereof, are unable to furnish the power required to effect pickup of the door protective relay, whose operation is hereinafter explained in detail. In a preferred embodiment of the invention, an additional cold cathode gas tube **54** is used to advantage here. A tube such as the RCA 5823 has been found suitable for this purpose.

The tube **54** has an anode **55**, a starter anode or control **56** and a cathode **57**. Positive voltage of a value above sustaining voltage of the tube **54** but insufficient to cause breakdown of the tube is applied to the anode **55** with respect to the cathode **57** through a series circuit comprising break contacts SR3 and the coil of the door protective relay SR, one end of the coil being connected to the junction of the fixed resistor **18** and the voltage dividers AP. The cathode **57** is connected to a movable contact **58** of the voltage divider **17**. The control **56** is connected through a fixed resistor **59** to the junction of the break contacts SR1 and SR2. Thus a positive direct current voltage of a value insufficient to cause breakdown of the tube **54** is applied to the control **56** with respect to the cathode **57**, this voltage being adjusted for optimum sensitivity of the tube **54** by means of the voltage divider **17**. When one or more of the tubes SET breaks down, the resulting voltage drop across the resistor **52** in the common cathode circuit of the tubes SET causes the voltage applied to the control **56** with respect to the cathode **57** to increase by an amount sufficient to cause breakdown of the tube **54**. The magnitude of electron flow from the cathode **57** to the anode **55** upon such breakdown is limited only by a relatively low resistance connected in series with the tube **54**. This resistance comprises a portion of the voltage divider **17**, the resistance of the coil of the relay SR and the fixed resistor **18**. Thus, by use of the tube **54**, that power required to effect pickup of the relay SR is furnished to the coil thereof.

Pickup of the relay SR causes its contacts SR1 and SR2 in the common cathode circuit of the tubes SET and its contacts SR3 in the anode circuit of the tube **54** to break. Any conducting tubes are thereby extinguished.

A series circuit comprising a resistor **60** and a capacitor **61** connected in parallel with the coil of the relay SR provides the relay with a deenergization or dropout delay when the tube **54** is extinguished. A series circuit comprising a resistor **62** and a capacitor **63** connected in parallel with the cathode-anode circuit of the tube **54** provides a low impedance shunt around the tube **54** to prevent unwanted breakdown of the tube due to anode-to-cathode transient voltage of relatively high magnitude which may appear.

Conveniently, the components contained in the direct current voltage power supply for the safety edge DPE may be mounted either atop the car **1** or atop the car door DP in a conventional manner. The items **18**, **54**, **59**, **60**, **61**, **62**, **63**, SR, and AP are preferably mounted adjacent the end of the car door DP directly above the car door sight guard DPG. These components may be contained within a suitable enclosure which may constitute an extension of the sight guard DPG and which may have an easily removable front cover (not shown). Conveniently, the voltage dividers AP may be mounted within the enclosure and the voltage dividers **15** and **17** may be mounted within the sight guard DPG in a manner such that one man may easily adjust for optimum safety edge operation. The tube **54** and the relay SR are placed within the enclosure so that their operation may be easily checked while the anode voltages for the tubes SET are being adjusted. To prevent undesirable effects on the tubes SET by action of stray fields on conducting wires running from outside of the sight guard DPG to the components within the sight guard and from the car door shield DPS to the car door strike jamb shield CJS, such conducting wires have shields which are connected to ground, as indicated by the points G in FIGS. 2 and 4.

In addition to improved car door protection, the invention provides improved hoistway door protection. As is shown in FIGS. 2 and 4, the hoistway door DPH is provided with a plurality of antennae DPHA corresponding in number to the antennae provided for the car door DP. FIGS. 5 through 8 shown various means for coupling the hoistway door antennae to the car door antennae. Such coupling means enable the hoistway door to be furnished with the protection required without necessitating the carrying by each hoistway door of tubes and associated circuitry duplicating those carried by the elevator car. Each hoistway door is also provided with a sight guard DPHG and a shield DPHS similar in construction to the sight guard DPG and the shield DPS,

respectively, provided for the car door DP. In the manner heretofore explained for the car door shield DPS, the hoistway door shield DPHS prevents unwanted breakdowns of the tubes SET. As will be described below, a direct connection by suitable coupling means may be made between the car door shield DPS and each hoistway door shield DPHS.

FIGS. 2 and 5 shown one form of coupling means for the car door and hoistway door antennae and shields. Illustrated therein is a mechanical device which couples the antennae and shield of the hoistway door DPH to the corresponding components of the car door DP when the elevator car is stopped at a landing. Each hoistway door antenna DPHA comprises a sheet of electro-conductive material disposed opposite a corresponding one of the car door antennae DPA. Each hoistway door antenna has an extension DPHX of electro-conductive material disposed at substantially a right angle to the antenna proper and, therefore, substantially parallel to the car and hoistway doors.

A shield connector or brush SBS and a plurality of antenna connectors or brushes SBA of suitable electro-conductive material such as steel are provided for coupling the hoistway door shield DPHS and the hoistway door antennae DPHA to the car door shield DPS and the car door antennae DPA, respectively. The brushes SBS and SBA are rigidly secured as by arms **64** of electro-conductive material to a rotatable rod **65** of suitable insulating material such as phenolic resin, which extends vertically through the car door sight guard DPG. The rod **65** is supported at its lower end by a thrust bearing (not shown) which is secured to the bottom cover of the car door sight guard. The car door sight guard DPG is cut away to provide openings **64***a* for the arms **64**, while the hoistway door sight guard DPHG is cut away to provide openings **66** for the brushes SBA. Insulation of the hoistway door sight guard DPHG is cut away to provide a suitable opening in order that the brush SBS may contact the shield DPHS. Flexible conducting wires **64***b* run from the arms **64** to the respective car door safety edge components (the shield DPS and the antennae DPA) associated with the brushes SBS and SBA, as is shown schematically in FIG. 4.

Also secured to the rod **65** is an arm **67** which extends through an opening **67***a* in the hoistway door sight guard DPHG and to which is connected one end **68** of a flexible chain or cable **69** which passes over a roller **81** rotatably secured to the car door DP. The roller **81** has a peripheral groove for reception of the cable **69**. The opposite end **83** of the cable **69** is secured to a car sill **85**. At approximately midway between the end **83** of the cable **69** and the roller **81**, the cable **69** passes through an eyelet formed in an end **86** of a spring **87**. The opposite end **88** of the spring **87** is fastened to a pin **89** which is in turn secured to the car door DP.

The upper end of the rod **65** passes through a coil spring **90**, an end **91** of which is secured to the rod **65**. The opposite end **93** of the spring **90** is secured to an end plate **95** of the enclosure, mentioned above, which constitutes the extension of the car door sight guard DPG. The spring **90** is arranged so as to exert circumferential torque in a clockwise direction on the rod **65** (viewing the rod **65** endwise from above).

When the doors DP and DPH are in closed position (broken lines, FIG. 2), the cable **69** is pulled taut by virtue of the force exerted thereon by the then fully expanded spring **87**. The cable exerts a force on the arm **67** which in turn applies counterclockwise torque to the rod **65** of magnitude sufficient to overcome the clockwise torque exerted on the rod by the spring **90**. Thus, the rod **65** is rotated to a position wherein the brushes SBS and SBA are withdrawn from contact with the hoistway door shield DPHS and the hoistway door antennae extensions DPHX, respectively, as is clearly shown in FIG. 2. As the doors DP and DPH start to open to expose the elevator car entranceway, the cable **69** slackens, the spring **87** shortens to take up the cable slack and thereby causes the force applied by the cable to the arm **67** to be reduced, circumferential torque exerted by the spring **90** on the rod **65** overcomes the reduced torque exerted by the arm on the rod, and the rod thereby is rotated in a clockwise direction, causing the brushes SBS and SBA to be rotated in the same direction. Such action continues until the brushes firmly contact the hoistway door shield DPHS and the antenna extensions DPHX to effect coupling between these parts and the car door shield DPS and antennae DPA, respectively, as is shown by the solid lines in FIG. 2 and in FIG. 5. The foregoing action reverses as the car and hoistway doors move from their open toward their closed positions. Suitable stop means (not shown) may be employed in conjunction with the coupling means to establish rotational limits for accurately positioning the brushes SBS and SBA.

Several advantages accrue as a result of coupling the hoistway door equipment to the car door equipment. First, absolute hoistway door protection is provided. Secondly, there is no need for the hoistway door to carry electronic equipment, including cold cathode gas tubes, of the type heretofore described for the car door. Thirdly, hoistway wires for energizing the hoistway door shields and hoistway door shield potential adjustments are eliminated. In the past, it was necessary to adjust the potential applied to each hoistway door shield for proper relation to the associated car door shield potential. With the coupling between hoistway and car door shields provided by the present invention, the potential applied to the shield of the hoistway door of each landing served by the same elevator car must be the same as its associated car door shield potential.

A hoistway door strike jamb shield HJS of construction similar to that of the car door strike jamb shield CJS is provided for a hoistway door strike jamb DPHJ. The shield HJS is energized by means similar to that provided for energization of the shield CJS, a shielded flexible cable **97** being provided for the purpose of connecting the hoistway door shield DPHS to the shield HJS. Thus the shield HJS is energized when the shield DPHS is energized by operation of the brush SBS.

It will be noted that with the arrangement of FIG. 5 the hoistway door safety edge equipment is coupled to the associated car door equipment shortly after the doors start to open and remains so coupled until the doors are practically closed due to the action of the cable **69**. The short distance in which the hoistway door equipment is deenergized during movement of the doors results in a small hoistway door safety edge "dead zone" of the order of two inches or less. There is no corresponding dead zone for the elevator car safety edge equipment, since this equipment is always energized when the car door DP is away from fully closed position.

Another arrangement for coupling the hoistway door safety edge equipment to the car door safety edge equipment is shown in FIG. 6. Each hoistway door antenna DPHA again comprises a sheet of electro-conductive material and is suitably secured to the inside face of the hoistway door sight guard DPHG. The hoistway door shield DPHS and the sight guard DPHG are of construction similar to that previously described. Coupling brushes SBSM and SBAM, corresponding to the brushes SBS and SBA, respectively, of FIG. 5 are fastened as by screws **100** to a plate **101** of suitable insulating material such as phenolic resin, which has an extension or arm **102** pivotally secured to the car door for rotation about pivots **103**. Secured to the arm **102** is a shaft **105** of a solenoid HA. The shaft **105** passes through a coil spring **106**. Flexible conducting wires run from the brushes SBSM an SBAM through suitable openings in the car door sight guard DPG to the re-

spective car door safety edge components (the shield DPS and the antennae DPA) associated with the brushes, as is shown schematically in FIG. 4. Secured to the hoistway door sight guard DPHG by means of brackets **107** and **108** and screws **109** is a plate **110** of insulating material such as phenolic resin. On the rear of the plate **110**, as viewed in FIG. 6, are mounted a shield brush bar **111** and a plurality of antenna brush bars **112** of electro-conductive material. Each of the brush bars **112** is secured to the plate **110** by a screw **113**; and brush bar **111** is secured to the plate **10** by a screw **14**. The shield brush bar **111** is associated with the brush SBSM and is disposed opposite thereto. Each of the antenna brush bars **12** is associated with a corresponding one of the brushes SBAM and is disposed opposite thereto. To each of the screws **113**, and thus to each of the bars **112**, is connected one end of a shielded conducting wire **115**, the opposite end of each of the wires **115** being connected to a corresponding one of the hoistway door antennae DPHA, as by a screw **117**. To the screw **114**, and thus to the bar **111** is connected one end of a flexible shielded conducting wire **119**, the opposite end of the wire **119** being connected to a screw **121**. The threaded end of the screw **121** engages a matching threaded aperture (not shown) in the hoistway door shield DPHS. The wire **119** is, therefore, connected to the shield DPHS through the screw **121**.

When the solenoid HA is energized, its shaft **105** moves into the solenoid coil, and the spring **106** is in compressed condition. This motion causes the arm **102** and thus the plate **101** and the brushes SBSM and SBAM to rotate about the pivots **103** to the positions shown in FIG. 6, each brush making firm contact with its associated brush bar. Conductive connections are thereby effected between the hoistway door shield DPHS and the car door shield DPS and between the hoistway door antennae, DPHA and the car door antennae DPA. When the solenoid HA is deenergized, the plate **101** and thus the brushes SBSM and SBAM are caused to rotate in a clockwise direction as viewed from above, due to the expansion force of the spring **106**. The brushes are thereby disconnected from their associated brush bars.

With the arrangement of FIG. 6, that portion of the door operating cycle during which the hoistway door safety edge equipment is energized may be accurately controlled. Since it is necessary that the hoistway door safety edge be effective only when the doors are closing, the solenoid HA may be deenergized by suitable control means when the doors are fully closed. Not only does such operation eliminate the dead zone existing for the arrangement of FIG. 5, but it may also result in elimination of sliding contact between the coupling brushes and the hoistway door equipment, since the solenoid HA may be energized by suitable control means only when the elevator car has stopped at a landing. For those installations wherein the doors start to open before the elevator car has come to a complete stop at a landing, provision must be made for sliding contact between the coupling brushes and the hoistway door safety edge equipment shown in FIG. 5.

Further modifications of the hoistway door safety edge equipment and the coupling means therefor are shown in FIG. 7. The hoistway door antennae DPHA are suitably secured as by screws to the hoistway door sight guard DPHG, the sight guard containing a shield DPHS similar in construction to that heretofore described. To an edge **131** of the sight guard DPHG is secured a rod **132**, the upper portion of which passes through an aperture in the broken-away portion of a bracket **134**. The rod **132** is supported at its lower end by a thrust bearing **136** which is secured to a bracket **137**. The brackets **134** and **137** are suitably secured to the car door safety edge DPE. The assembly comprising the hoistway door sight guard DPHG and hoistway door antennae DPHA is secured to the car door safety edge DPE by means of hinges **138** fastened to the assembly and to the car door safety edge as by screws **139**. A worm wheel **140** is secured as by a force fit to the rod **132** near the top end thereof. Engaging the worm wheel **140** is a worm gear **141** which constitutes an extension of a shaft **143** of a motor HM. The motor HM is secured by any suitable means to the top of the car door safety edge DPE.

The hoistway door antennae DPHA are electrically connected to the car door antennae DPA by means of flexible shielded conducting wires **145**, which are secured to the antennae DPHA as by screws **147**. Each of the wires **145** runs from a corresponding one of the screws **147** through a suitable opening **149** in the car door sight guard DPG and thence to a corresponding one of the car door antennae DPA. The hoistway door shield DPHS is connected to the car door shield DPS by means of a flexible shielded conducting wire **151**. The wire **151**, which is connected to the shield DPHS as through a screw **153**, passes through a suitable opening **155** in the car door sight guard DPG to the car door shield DPS.

Depending upon the direction of rotation of the motor shaft **143**, the hinged hoistway door sight guard and antennae assembly is rotatable in either a clockwise or a counterclockwise direction, as viewed from above. By suitable control means, as explained below, the motor HM may be reversibly energized, so that its shaft rotates in a direction which causes the hinged assembly to withdraw to a position substantially parallel to the car door when the doors are closed and when the elevator car is moving in the hoistway and to assume the position shown in FIG. 7 when the car is stopped at a landing to receive and/or to discharge passengers. Thus, when the assembly is in the latter position, the hoistway door DPH is provided with both a sight guard and a capacity-operated safety edge, but neither the sight guard nor the safety edge equipment is mounted on the hoistway door itself.

Conveniently, the motor HM may be a torque motor, which may be operated under continuous stalled condition. In order to restrict rotation of the hoistway door sight guard and antennae assembly to only that angle necessary for the assembly to assume either of two positions mentioned above, appropriate stops must be provided. For this purpose, a pin **157** is secured to the rod **132** and stops **159** and **161** in the form of pins are fastened to the bracket **134**. The pin **157** extends between the stops **159** and **161**, the latter being spaced to restrict rotation of the pin **157** and thus of the rod **132** to substantially a 90° angle. It will be seen, therefore, that, although the motor HM is continuously energized, the hinged assembly may rotate only between the two aforementioned positions.

As is shown in FIG. 8, the hoistway door antennae may be capacitively coupled to the car door antennae. Each hoistway door antenna DPHA has a linkage electrode DPHL constituting an extension of the antenna at substantially a right angle thereto. Disposed opposite and substantially parallel to each hoistway door antenna linkage electrode DPHL is an associated linkage electrode DPL constituting an extension of one of the car door antennae DPA. With this arrangement, each hoistway door antenna is capacitively coupled to its corresponding car door antenna when the car is stopped at a landing, the safety edge system operating in all other respects as heretofore described. Shielding is shown in FIG. 8 and is employed in the same manner and for the same purpose previously discussed. Such shielding is represented, for example, by the hoistway door shield DPHS.

In order to apply the invention to elevator installations having center-opening car and hoistway doors, each of the leading edges of each of the doors in a door closing movement is provided with a capacity-operated safety edge as described above. In such installations there are no door strike jambs, and consequently no strike jamb shields need be provided, since the door sections close upon each other.

The invention is applicable to various forms of elevator control systems. Conveniently, such a system may be of the type described in the Savino et al. Patent 2,776,731. Inasmuch as the invention applies particularly to elevator door control systems and then only to certain parts thereof, it appears unnecessary to described a complete elevator control system in detail. Consequently, the control diagram of FIG. 9 is a reproduction in detail of a portion of FIG. 2 of the Savino et al. patent, with certain parts added in order to apply the present invention thereto. Use is made in FIG. 9 of the same letters and numbers as those used for corresponding parts in the Savino et al. patent

The system includes in part the following apparatus:

40—door relay
45—door-control relay
DC—door-close solenoid
DO—door-open solenoid
HA—hoistway door antennae solenoid
SR—door protective edge relay

The system of FIG. 9 is similar in construction and operation to the system shown in FIGS. 1 to 4 of the aforesaid Savino et al. patent except for the addition of the contacts SR4, means for operating these contacts, the contacts DO2, DO3, 40–3, the switch 163 and the relay HA, and except for the effects of these additions on the operation of the Savino et al. system.

Energy for the various circuits is derived from direct current buses L+ and L—. The circuits in FIG. 9, however, are shown with the buses L+ and L— deenergized. Since the invention is concerned with the functioning of the safety edges DPE and DPHE during a door closing movement, operation of the circuits of FIG. 9 to effect a door closing movement will be described.

The doors for the elevator car are controlled by a door-control relay 45. For this relay to be initially energized, the break contacts N1 and TN1 must be closed to indicate that the elevator car is not being loaded at a terminal floor. In addition, the break contacts 70T1 must be closed to indicate that the non-interference time has expired; and the break contacts SR4 of the door-protective relay SR must be closed to indicate that the door-protective relay is deenergized.

The door-control relay 45 controls the energization of the door-close solenoid DC and the door-open solenoid DO. If the contacts 45–2 of the door-control relay are closed and the break contacts 40–2 and DO2 are closed, the solenoid DC is energized. The contacts 40–2 are closed when the door of the elevator car or an associated hoistway door is away from its closed position, since the door relay 40 is then deenergized, inasmuch as safety devices 33 are then in their open positions. The safety devices 33 may include switches which are open when the door of the elevator car and the associated hoistway door are open and which are closed when the doors are closed to control the door relay 40. The contacts DO2 are closed when the door-open solenoid DO is deenergized.

When the door-protective relay SR (FIG. 4) is energized as heretofore explained, the break contacts SR4 (FIG. 9) open, causing the door control relay 45 to drop out. When the door control relay 45 drops out, the make contacts 45–3 are closed to complete with a switch 38 an energizing circuit for the door-open solenoid DO. The switch 38 is a limit switch which is normally closed and which is opened as the door reaches its fully-open position.

Referring for a moment to FIG. 4, the series circuit comprising the resistor 60 and the capacitor 61 in parallel with the door protective relay SR has a time constant which is great enough to provide the relay SR with a dropout delay, as heretofore mentioned. This dropout delay is sufficient to insure that the door control relay 45 is deenergized by means of the break contacts SR4 before the relay SR itself drops out due to the extinguishment of the safety edge tubes SET and 54 when the break contacts SR1, SR2, and SR3 open. It will be seen that if the dropout delay of the relay SR is relatively short, the relay SR will continue to cycle, due to repeated breakdowns and extinguishments of the cold cathode gas tubes SET and 54, until the distance between the edge of the door and the obstructing body is such that the body is no longer within the range of sensitivity of the protective edge. Conveniently, the relay SR may be a latching relay of a type well known in the art and it may remain in latched condition until the doors have fully reopened; or the values of the resistor 60 and the capacitor 61 may be such that the relay SR has a relatively long dropout delay in order to prevent unnecessary recycling of this relay once the safety edge has been actuated.

The break contacts DO2 in the circuit of the door-close solenoid DC provide a safety interlock to insure that the solenoid DC remains deenergized for as long as the solenoid DO is energized, once the safety edge is actuated by an obstructing body, regardless of what the door-control relay 45 does. The relay 45 may recycle relatively rapidly due to repeated making and breaking of the contacts SR4, which in turn depends upon the time constant of the resistor-capacitor network in parallel with the relay SR, as pointed out above.

The make contacts DO3 are holding contacts for the relay DO when the break contacts 45–3 are open, provided a manually-operated switch 163 is in closed condition. If the switch 163 is in closed condition, the doors must reach their fully open position in order to open the limit switch 38 and thus to effect deenergization of the door-open solenoid DO, at which time the door closing operation may again begin, as described above. If the switch 163 is in open condition, the doors will cease closing when the relay SR is energized and will move toward fully open position until the door control relay 45 is again energized, the distance of withdrawal of the doors depending upon the time constant of the resistor-capacitor network in parallel with the relay SR.

As previously explained, the hoistway door safety edge equipment may be energized by operation of the mechanical means shown in FIG. 5. If, however, the hoistway door safety edge actuating solenoid HA of FIG. 6 is employed, this solenoid may be controlled by the break contacts 40–3, as is shown in FIG. 9. When the doors are in closed position, the door relay 40 is picked up, since the switches 33 are in closed condition, and the contacts 40–3 are open. Consequently, the solenoid HA is deenergized and the hoistway door safety edge equipment of FIG. 6 is disconnected from its corresponding car door safety edge equipment. As soon as the doors start to open, the switches 33 are opened, the relay 40 is thus deenergized, as a result of which the contacts 40–3 make and the solenoid HA is thereby energized. The hoistway door safety edge equipment is then connected through the brushes SBSM and SBAM to its corresponding car door equipment, as is shown in FIG. 6.

The circuits of FIG. 9*a* may be substituted for the circuit enclosed in the broken-line rectangle RE of FIG. 9 if the arrangement of FIG. 7 is used. The armature HMA of the motor HM is connected directly across the buses L+ and L—. The field HMF of the motor HM is reversibly energized through contacts HS1, HS2, HS3 and HS4 of a motor field solenoid HS. The solenoid HS is connected across the buses L+ and L— through break contacts 40–4 of the door relay 40. When the doors are fully closed, the relay 40 picks up, the contacts 40–4 thereby break, and the solenoid HS thus drops out. The field HMF is then energized through the contacts HS1 and HS2, and the shaft of the motor HM rotates in a direction such that the hoistway door safety edge equipment of FIG. 7 is rotated to a position substantially parallel to the car door DP. When the doors start to open, the relay 40 drops out, the contacts 40–4 thereby make, the solenoid HS thus picks up and the field HMF

is energized through the closed contacts HS3 and HS4, contacts HS1 and HS2 then being open. Thus, the polarity of the voltage across the field HMS has been reversed and the shaft of the motor HM rotates in the opposite direction, rotating the hoistway door safety edge equipment to the position shown in FIG. 7.

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

We claim as our invention:

1. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, each of said doors being provided with separate antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, means adjacent said doors for coupling the antenna means provided for the hoistway door to the antenna means provided for the car door substantially during a door closing movement by said door-operating means when the car is in said predetermined position, and means carried by the car responsive to a predetermined change in said property when said car and hoistway door antenna means are so coupled for modifying said door closing movement.

2. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, each of said doors being provided with separate antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, said antenna means of each door comprising a plurality of antennae, each hoistway door antenna being disposed opposite a corresponding one of said car door antennae substantially during a door closing movement by said door-operating means when the car is in said predetermined position, means adjacent said doors for coupling each hoistway door antenna to its corresponding car door antenna substantially during said door closing movement, and circuit means carried by the car responsive to a predetermined change in said property when said car and hoistway door antennae are so coupled for modifying said door closing movement.

3. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, electroconductive parts adjacent the closing paths of said doors, each of said doors being provided with separate antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, said antenna means of each door comprising a plurality of antennae, each hoistway door antenna being disposed opposite a corresponding one of said car door antennae substantially during a door closing movement by said door-operating means when the car is in said predetermined position, means adjacent said doors for coupling each hoistway door antenna to its corresponding car door antenna substantially during said door closing movement, and circuit means carried by the car responsive to a predetermined change in said property when said car and hoistway door antennae are so coupled for modifying said door closing movement, each door being provided with separate shield means for preventing unwanted operation of said circuit means to effect said modification due to the proximity of said antenna to said electroconductive parts, and means adjacent said doors for coupling the shield means of the hoistway door to the shield means of the car door substantially during said door closing movement.

4. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, electroconductive parts adjacent the closing paths of said doors, each of said doors being provided with separate antenna means and separate shield means, each of said antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, said antenna means of each door comprising a plurality of antennae, each hoistway door antenna being disposed opposite a corresponding one of said car door antennae when the car is in said predetermined position, coupling means for electroconductively coupling the hoistway door shield means to the car door shield means and each hoistway door antenna to its corresponding car door antenna substantially during a door closing movement by said door-operating means when the car is in said predetermined position, said coupling means comprising a plurality of electroconductive connectors carried by the car door and movable relative to said antennae and to said shield means, common actuating means for moving said connectors to a first position to effect said coupling and to a second position in which said connectors are spaced from the hoistway door antennae and from the hoistway door shield means when said doors are in closed position, and means for controlling said actuating means, and circuit means carried by the car responsive to a predetermined change in said property when said car and hoistway door shield means and antennae are so coupled for modifying said door closing movement, said shield means preventing unwanted operation of said circuit means to effect said modification due to the proximity of said antennae to said electroconductive parts.

5. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, each of said doors being provided with separate antenna means having a changeable electrical property dependent upon proximity of load to said antenna means, said antenna means of each door comprising a plurality of antennae, each hoistway door antenna being disposed opposite a corresponding one of said car door antennae when the car is in said predetermined position, coupling means capacitively coupling each hoistway door antenna to its corresponding car door antenna when the car is in said predetermined position, said coupling means comprising a linkage electrode constituting an extension of each of said antennae, said electrodes of corresponding hoistway door and car door antennae being disposed opposite, substantially parallel to, and spaced from one another when the car is in said predetermined position, and circuit means carried by the car responsive to a predetermined change in said property when said antennae are so coupled for modifying a closing movement of the doors by said door-operating means.

6. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the land-

ing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, separate antenna means for each of said doors, each of said antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, means mounting the antenna means for the hoistway door on the car door for movement relative to the car door, means responsive to a door opening movement by said door-operating means for moving the antenna means for the hoistway door to a first position immediately adjacent the hoistway door when the car is in said predetermined position to detect load in the closing path of movement of said hoistway door, means responsive to door closure by said door-operating means for retracting the antenna means for the hoistway door from said first position to a second position substantially spaced from the hoistway door, when the car is in said predetermined position, and adjacent the car door and for maintaining the antenna means for the hoistway door in said second position when said doors are in closed position, means electroconductively coupling the antenna means for the hoistway door to the antenna means for the car door, and means carried by the car responsive to a predetermined change in said property when the car is in said predetermined position for modifying a closing movement of the doors by said door operating means.

7. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, separate antenna means for each of said doors, each of said antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, means mounting the antenna means for the hoistway door on the car door for movement relative to the car door, retracting means operable to move the antenna means for the hoistway door to a first position immediately adjacent the hoistway door, when the car is in said predetermined position, to detect load in the closing path of movement of said hoistway door and to retract the antenna means for the hoistway door from said first position to a second position substantially spaced from the hoistway door and adjacent the car door when said doors are in closed position, means for controlling said retracting means, means electroconductively coupling the antenna means for the hoistway door to the antenna means for the car door, and means carried by the car responsive to a predetermined change in said property when the car is in said predetermined position for modifying a closing movement of the doors by said door-operating means.

8. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, electroconductive parts adjacent the closing paths of said doors, separate antenna means and separate shield means for each of said doors, each of said antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, means electroconductively coupling the antenna means for the hoistway door to the antenna means for the car door, means electroconductively coupling the shield means for the hoistway door to the shield means for the car door, means mounting the antenna means and the shield means for the hoistway door on the car door for movement relative to the car door, means responsive to a door opening movement by said door operating means for moving the antenna means and the shield means for the hoistway door to a first position immediately adjacent the hoistway door, when the car is in said predetermined position, to detect load in the closing path of movement of said hoistway door, means responsive to door closure by said door-operating means for retracting the antenna means and the shield means for the hoistway door from said first position to a second position substantially spaced from the hoistway door, when the car is in said predetermined position, and adjacent the car door and for maintaining the antenna means and the shield means for the hoistway door in said second position when said doors are in closed position, and circuit means carried by the car responsive to a predetermined change in said property when the car is in said predetermined position for modifying a closing movement of the doors by said door-operating means, said shield means preventing unwanted operation of said circuit means to effect said modification due to the proximity of said antennae to said electroconductive parts.

9. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for the landing, and an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door-operating means for opening and closing said doors, electroconductive parts adjacent the closing paths of said doors, separate antenna means and separate shield means for each of said doors, each of said antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, means electroconductively coupling the antenna means for the hoistway door to the antenna means for the car door, means electroconductively coupling the shield means for the hoistway door to the shield means for the car door, means mounting the antenna means and the shield means for the hoistway door on the car door for movement relative to the car door, retracting means operable to move the antenna means and the shield means for the hoistway door to a first position immediately adjacent the hoistway door, when the car is in said predetermined position, to detect load in the closing path of movement of said hoistway door and to retract the antenna means and the shield means for the hoistway door from said first position to a second position substantially spaced from the hoistway door and adjacent the car door when said doors are in closed position, means for controlling said retracting means, and circuit means carried by the car responsive to a predetermined change in said property when the car is in said predetermined position for modifying a closing movement of the doors by said door-operating means, said shield means preventing unwanted operation of said circuit means to effect said modification due to the proximity of said antennae to said electroconductive parts.

10. In an elevator system, a structure having a hoistway provided with a landing, a hoistway door for said landing, an elevator car for transporting load, said car having a door, said car being disposed for movement in the hoistway from a position displaced from the landing to a predetermined position adjacent the landing to serve the landing, door operating means for opening and closing said doors, and modifying means for modifying a closing movement of the doors by said door-operating means when the car is in said predetermined position, said modifying means comprising separate antenna means for each door, each of said antenna means having a changeable electrical property dependent upon the proximity of load to said antenna means, means for coupling the antenna means provided for the hoistway door to the antenna means provided for the car door substantially during said door closing movement, and circuit means carried by the car responsive to a predetermined change in said property comprising a first cold cathode gas tube

having a control connected to said car door antenna means, a cathode and an anode, means for applying to the control with respect to the cathode of the first tube negative direct current control voltage of a value insufficient to cause breakdown of the first tube, voltage supply means for applying to the anode with respect to the cathode of the first tube anode direct current voltage, means for adjusting said anode voltage to a value above sustaining voltage of the first tube but insufficient to cause breakdown of the first tube while the control voltage of the first tube is maintained at its said value, means responsive to a predetermined change in said electrical property when said car and hoistway door antenna means are so coupled and when said values of said anode and control voltages are applied to said anode and said control, respectively, of the first tube for effecting breakdown of the first tube, a second cold cathode gas tube having an anode, a cathode and a control, means for applying to the anode with respect to the cathode of the

second tube anode direct current voltage of a value above sustaining voltage of the second tube but insufficient to cause breakdown of the second tube and to the control with respect to the cathode of the second tube control direct current voltage of a value insufficient to cause breakdown of the second tube, means responsive to breakdown of the first tube for effecting breakdown of the second tube, and means responsive to breakdown of the second tube for initiating said modification.

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