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Diamond

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[54] **SELF-ADJUSTING PROXIMITY DETECTING APPARATUS**

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[52] **U.S. Cl.** ..... **187/29 R**

[51] **Int. Cl.** **B66b 13/26**

[58] **Field of Search** 182/29, 48

[56] **References Cited**

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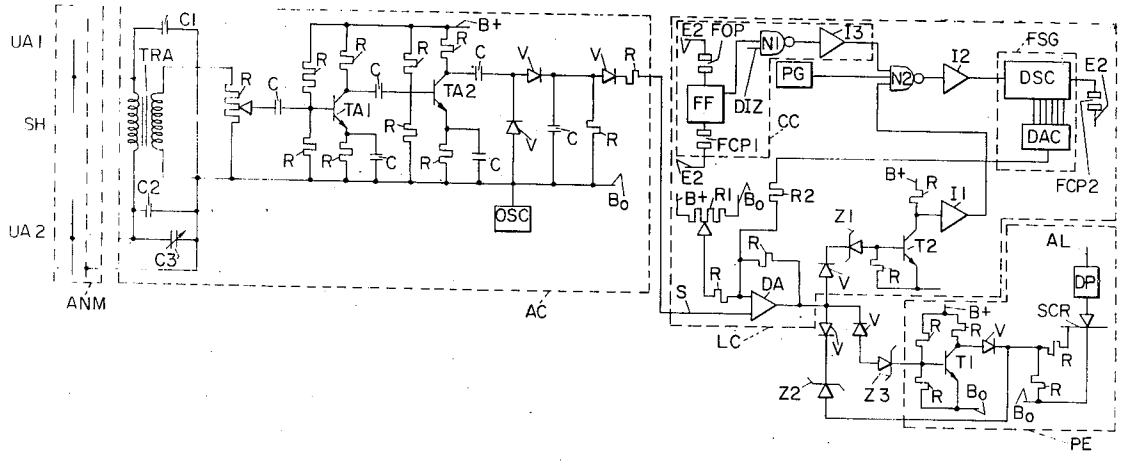
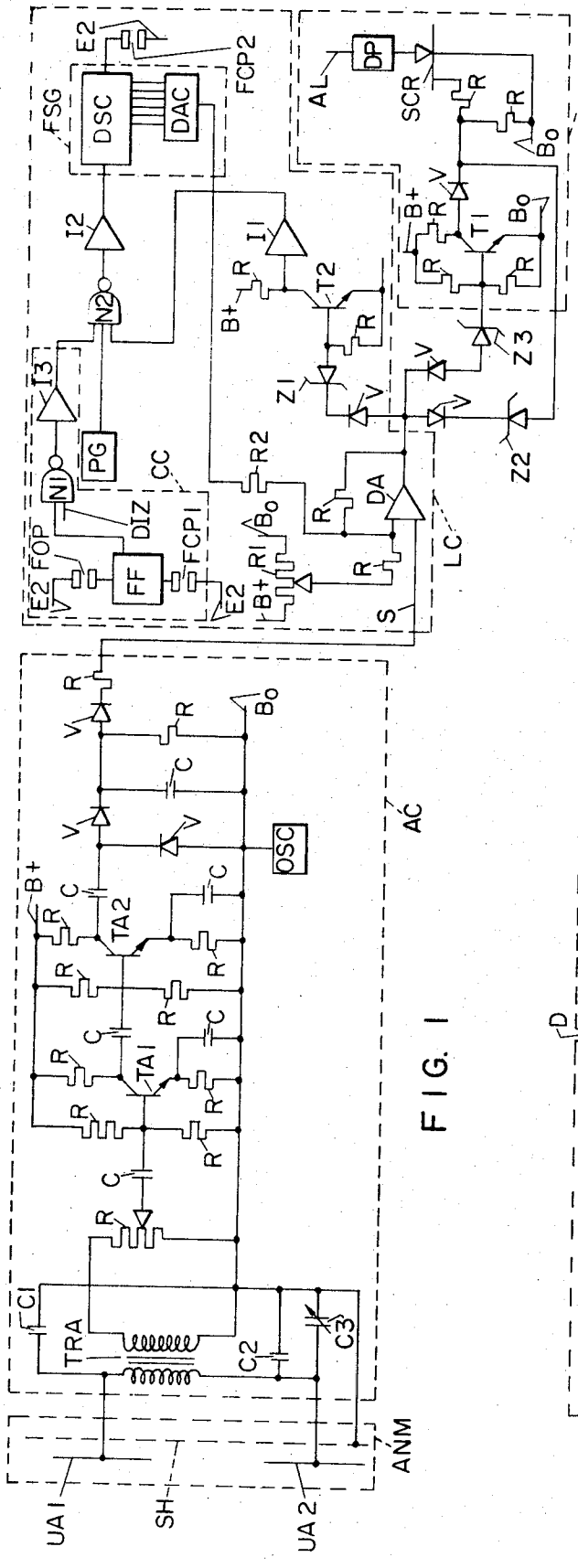
[57] **ABSTRACT**

The effects of undesirable circuits to ground on the operation of elevator door protective apparatus of the proximity detection type are reduced by an arrangement which responds to such undesirable circuits, if any, during the opening of the door and prevents them from effecting the operation of the protective apparatus during closing movement.

16 Claims, 2 Drawing Figures

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B+
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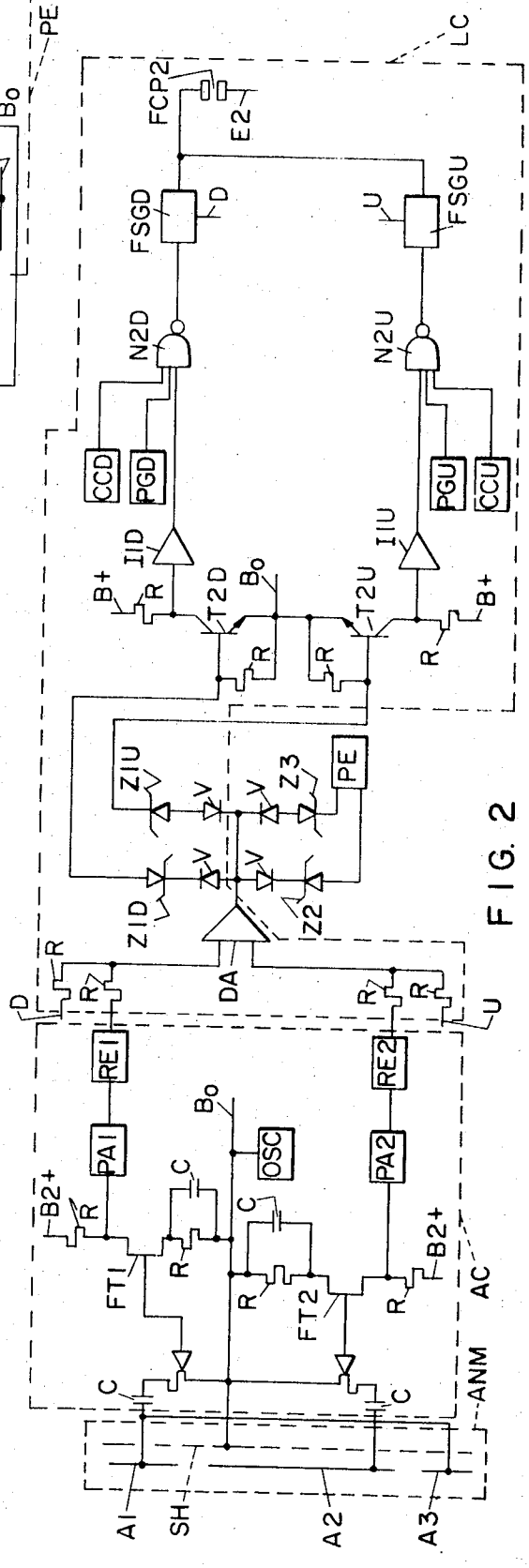
FIG. 1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T2U
B+
Bo
R
Z1U
Z3
PE
Z1D
Z2
DA
RE1
RE2
PA1
PA2
OSC
B2+
FT1
FT2
AC
ANM
A1
SH
A2
A3

FIG. 2

SELF-ADJUSTING PROXIMITY DETECTING APPARATUS

This invention relates to elevator car door protective apparatus of the proximity detection type. More particularly it relates to proximity detection apparatus which adjusts itself to the effects of undesirable circuits to ground and maintains its detection capabilities notwithstanding the presence of such circuits.

Proximity detection apparatus for an elevator car typically includes antennae mounted in that edge of the car door which leads it when moving in the closing direction. These antennae are arranged in one or more electrical circuits and establish an electrostatic field around not only the leading edge of the car door but that of the hoistway door, as well, of any landing at which the car stops. Any object with a sufficient capacity to ground which becomes located in such a field produces a signal which causes the apparatus to operate to prevent the doors from closing.

Moisture and dust on the leading edge of either the car or the hoistway door exhibit a capacity to ground effect and relatively large accumulations of either can cause unwanted operations of proximity detection apparatus. A warped car or hoistway door, or a car or hoistway door the plane of which is not plumb when that of the other is, similarly can cause undesirable operations of proximity detection apparatus.

A number of arrangements have been proposed in an attempt to eliminate entirely, or at least to reduce, such unwanted operations. Among these is an arrangement in which the antennae are connected in one or more capacitive bridge circuits which are unbalanced by objects proximate the antennae. In this arrangement one end of a motor driven elongated bar is proposed to be moved into or out of proximity with an antenna, as required, to maintain the bridge circuitry balanced in the presence of undesirable circuits to ground. Although theoretically operable, this arrangement is impractical for application in a commercial installation.

In another arrangement in which the antennae are also connected in one or more capacitive bridge circuits, diodes whose capacitances vary with the voltage applied to them are proposed to be employed in the bridge circuit. These diodes have applied to them, through a delay circuit, voltages proportional to unbalances which occur in the bridge. Thus, if a disturbance causes the bridge to tend to become unbalanced at a slow rate as in the normal case with moisture and dust accumulation, the bridge is restored to balance by varying the capacitance of one or the other of the diodes thereby preventing the moisture and dust accumulation from interfering with proper door operation. Similarly if an unbalance is caused by the plane of the hoistway door at a particular landing not being in parallel with the plane of the car door, such as in the case of the warping of one or the other, this unbalance exists long enough during door opening and the normal door hold open time to enable the bridge to be returned to a balanced condition by varying the capacitance of one or the other of the diodes before the detection apparatus is required to perform its protective function during the door closing operation.

On the other hand, if a sudden unbalance is experienced during the door closing operation, as by the location of a person in the electrostatic field, the delay circuit prevents the restoration to the balanced condition

for a predetermined period thereby enabling the detection apparatus to cause an interruption in the closing movement.

In yet a third arrangement in which antennae are connected in a capacitive bridge circuit, a differential amplifier is proposed to be employed to receive the output of the bridge circuit at one input channel through a delay circuit and at the other input channel directly without a time delay. This arrangement operates in the same manner as the previously described rate responsive arrangement to respond only to rapidly occurring unbalances which arise during door closing operation and to be unresponsive both to slowly occurring unbalances and to rapidly occuring ones which arise during door opening or while the doors are being maintained open.

Each of these rate responsive arrangements is deficient in that a person can come into contact with the electrostatic field around the leading edge of a door while the door is fully opened with a sufficient amount of its normal door open time remaining to permit the arrangement to operate to compensate for the unbalance in the respective bridge circuit that the person produced. As a result, the detection equipment would then remain insensitive to that person for the rest of that cycle of operation including the door's movement in its closing direction as long as he remained in contact with the field in relatively the same manner. Thus, passengers can easily interfere with the protective apparatus to an extent to which they could render the door operation unsafe.

It is an object of this invention to provide improved elevator car door protective apparatus of the proximity detection type.

It is a further object of this invention to provide elevator car door protective apparatus of the proximity detection type which operates to compensate for undesirable ground circuits only during the initial door opening movement in any particular cycle of door operation.

In carrying out the invention in a preferred embodiment, there is provided in an elevator installation an elevator car with a slidable door for opening and closing a doorway in the car. A door operating mechanism moves the door in the opening and closing directions through cycles of operation from the closed position to the opened position and back to the closed. Antenna means and associated circuitry is mounted in that edge of the door which leads it when moving in the closing direction. This antenna means and associated circuitry operates from a balanced to an unbalanced condition in response to the presence of objects proximate said antenna means. The degree of unbalance varies directly with the capacitance to ground of such objects and their proximity to the antenna means. Protective equipment is provided which is operable in response to a predetermined degree of unbalance during movement of the door in the closing direction to cause the door operating mechanism to interrupt the closing movement. Limiting circuitry operates in response to a particular degree of unbalance during the initial opening movement of the door in any cycle of operation and limits the operation of the protective equipment in causing the door operating mechanism to interrupt movement of the door in the closing direction during that cycle of operation to operation in response to change in the unbalanced condition from the particular

degree of unbalance equal in magnitude to the difference between the predetermined degree of unbalance and the balanced condition.

Other objects, features and advantages of the invention will be apparent from the foregoing and from the following description when considered in conjunction with the appended claims and the accompanying drawing.

FIG. 1 of the drawing is a simplified schematic illustration of a preferred embodiment of the invention; and

FIG. 2 is a simplified schematic illustration of another embodiment of the invention.

In the drawing condensers are designated C, resistor elements R and rectifiers V. The reference characters used to identify other elements shown in the drawing will be introduced later in association with their respective elements. Suffix letters and/or numerals are appended to the reference characters associated with various of the elements to facilitate the differentiation of similar elements from one another.

Referring to FIG. 1, as is typical with one arrangement of door protective apparatus of the proximity detection type, two antennae UA1 and UA2 are suitably mounted in that edge of their associated elevator car door (not shown) which leads it in closing. As will be discussed, these are connected in a capacity bridge circuit. Shield SH is provided for the antennae to prevent them from being influenced by spurious signals. This shield is connected to a voltage source (not shown) through line BO. These two pairs of antennae and their shield comprise antenna means ANM.

The primary of transformer TRA is connected across the diagonal of the bridge circuit formed by antennae UA1 and UA2 and condensers C1, C2 and C3. The secondary of transformer TRA is connected across a resistor element whose movable tap is connected through a condenser to the base of transistor TA1. The collector of transistor TA1 is connected through a resistor to line B1+ and is also coupled through an RC circuit to the base of transistor TA2. The collector of transistor TA2 is also connected to line B1+ through a suitable resistor. In addition, it is connected through a rectifying circuit and an output resistor to line S. Each of the transistors of this amplifying circuitry, TA1 and TA2, has its emitter connected through an RC biasing circuit to line BO. Also connected to this line is an oscillating circuit OSC shown in block diagram form. The oscillator described in U.S. Pat. No. 3,194,975 granted to Lew H. Diamond performs satisfactorily in this circuitry. The amplifying circuits in conjunction with transformer TRA and capacitances C1, C2 and C3 together with oscillating circuit OSC comprise associated circuitry AC for antenna means ANM.

Line S is connected to one input of a differential amplifier DA. The other input of this amplifier is connected to a variable tap on resistor R1 and through a resistor R2 to the output of a feedback signal generator FSG. This generator includes a digital to analog signal converter DAC connected to the output of a digital signal generator DSG. Any suitable commercially available binary counter capable of maintaining its output at whatever number it has counted to until it is reset to zero is satisfactory as digital signal generator DSG. Converter DAC may be any compatible circuit capable of receiving binary signals signifying particular numbers and converting them in accordance with a predetermined scale to corresponding voltages.

One input of digital signal generator DSG is connected to line E2 through contacts FCP2. These contacts and contacts FCP1 (to be discussed later in connection with other circuitry) engage when the door with which they are associated reaches its fully closed position. The other input to digital signal generator DSG is connected to logic circuitry including NAND gates N1 and N2, inverters I2 and I3, pulse generator PG and bistable multivibrator, or flip flop, FF.

The two inputs of flip flop FF are each connected to line E2, one through previously mentioned contacts FCP 1 and the other through contacts FOP. These latter contacts engage when the door with which they are associated reaches its fully opened position. The output of flip flop FF is connected to one input of NAND gate N1. The other input of this gate is connected through line DIZ to circuitry (not shown) which produces a binary one signal along line DIZ when the leading edge of the door with which this circuitry is associated is in a zone which extends a predetermined distance on either side of the mid point of the door's travel from its fully closed to its fully opened position. The output of NAND gate N1 is connected through inverter I3 to one of the three inputs of NAND gate N2. Flip flop FF in conjunction with contacts FCP1 and FOP together with NAND gate N1 and inverter I3 comprise control circuitry CC.

A second input of NAND gate N2 is connected to pulse generator PG. This generator may take any suitable form and satisfactorily applies binary one signals to its respective input of NAND gate N2 at a rate of 1,000 pulses a second. The third input of NAND gate N2 is connected through inverter I1 to the collector of transistor T2. The base of this transistor is connected through zener diode Z1 and a rectifier V to the output of differential amplifier DA. This circuitry is arranged to produce a binary one signal at its associated input of NAND gate N2 whenever the output signal from differential amplifier DA is sufficiently positive in magnitude to cause zener diode Z1 to break down. In this embodiment, zener diode Z1 conducts current from amplifier DA whenever any positive signal having a magnitude greater than two volts is applied therefrom. The foregoing circuitry, including differential amplifier DA and its input circuits, feedback signal generator FSG, control circuitry CC, pulse generator PG, NAND gate N2, inverter I2, and the circuitry from the output of differential amplifier DA to the input of NAND gate N2, comprise limiting circuitry LC.

The output of differential amplifier DA is also connected through a rectifier V and zener diode Z2 to the gate of silicon controlled rectifier SCR. Zener diode Z2, in this embodiment, conducts current from amplifier DA whenever a positive seven volt signal is applied to the diode from the amplifier. The cathode of rectifier SCR is connected to line B0, and its anode is connected through coil DP of a door protective relay to a suitable alternating current source applied along line AL.

A third circuit from the output of differential amplifier DA is connected through rectifier V and zener diode Z3 to the base of transistor T1. Zener diode Z3, in this embodiment, conducts whenever the negative seven volt signal is applied to it from amplifier DA. The output of transistor T1 is connected through a rectifier V to the gate circuit of transistor SCR. Thus a signal is applied to the gate of silicon controlled rectifier SCR

sufficient to cause that rectifier to conduct whenever the output signal of differential amplifier DA equals or exceeds the predetermined 7 volt magnitude in either polarity. The door protective relay and its associated coil DP together with silicon controlled rectifier SCR and its associated gate circuitry comprise protective equipment PE.

Antenna means ANM and its associated circuitry AC in general operate the same as the comparable apparatus of the previously mentioned Lew H. Diamond patent. The major difference is that the amplifying circuits including transistors TA1 and TA2 and their associated components are capable of producing outputs of greater potential magnitude than the corresponding equipment of the Lew H. Diamond patent.

Assume the elevator car is stopped at a landing with the car door (not shown) and the landing door (not shown) open and that the capacitive bridge circuit is balanced such that the amplifying circuits produce no more than an insignificant signal voltage along line S and that whatever this signal is the effect it might tend to have on differential amplifier DA is neutralized by the signal applied thereto through resistor R1 from line B+. As a result, amplifier DA is producing no output signal.

Assume now that the door operating mechanism (not shown) is closing the doors and that a person comes into contact with the zone of influence of the detection apparatus. This zone typically extends about 3 inches from the leading edge of the car door. As a result of the person contacting the zone, the capacitance to ground of one of the antennae is increased, increasing the capacitance in the corresponding leg of the bridge circuit. As a result of this unbalance, the signal applied along line BO by oscillator OSC causes an alternating current signal flow through the secondary of transformer TRA. This signal is amplified by transistors TA1 and TA2 and results in a positive potential detection signal being applied along line S which, in turn, causes differential amplifier DA to produce a positive potential operating signal. In the disclosed preferred embodiment, with the particular components chosen for use therein, the operating signal produced by amplifier DA preferably has a magnitude of 7 volts when a person is within 3 inches of the leading edge of the car door and increases the closer he gets.

This 7 volt operating signal passes a current through 2 volt zener diode Z1 causing transistor T2 to conduct. As a result, a binary one signal is applied by inverter I1 to its respective input of NAND gate N2. This is without effect at this time, however, because inverter I3 is applying a binary zero signal to its respective input of the NAND gate. The seven volt operating signal also passes a current through seven volt zener diode Z2 to the gate of silicon controlled rectifier SCR causing it to conduct on positive half waves of the alternating current signal applied along line AL. As a result of the current conducted by the silicon controlled rectifier, coil DP of the door protective relay is energized sufficiently to cause the actuation of its respective relay. In typical fashion, this causes the door operating mechanism to interrupt the closing of the doors in any well known manner such as by stopping and reversing them.

Assume now that the elevator car has just arrived at a landing and is in the process of opening the doors. Also assume that a capacitance circuit to ground is established with respect to one of the antennae which would be sufficient to cause differential amplifier DA to produce a positive 10 volt operating signal at its output. Such a capacitance to ground circuit would be established by the accumulation of a sufficient amount of moisture on the leading edge of either the hoistway door or the car door or as the result of the plane of one of these doors not being parallel with the plane of the other.

Since the doors have last been in their fully closed position, contacts FCP1 were engaged more recently than contacts FOP and so flip flop FF is conditioned to apply a binary one signal at its respective input of NAND gate N1. When the doors reach the predetermined zone which extends on both sides of the mid point of their travel (say one foot therefrom on either side) a binary one signal is also applied to the other input of NAND gate N1 along line DIZ. This results in a binary zero signal being applied to inverter I3 and a binary one signal being applied at its respective input of NAND gate N2. At the same time pulse generator PG is applying alternating binary one and binary zero signals along its respective input to NAND gate N2 at the rate of 1,000 of each a second.

When the assumed circuit to ground unbalances the bridge circuit such as to cause the positive 10 volt operating signal to be produced at the output of differential amplifier DA, 2 volt zener diode Z1 conducts. As explained earlier, this causes transistor T2 to conduct and inverter I1 transmits a binary one signal to NAND gate N2. Thus all inputs to NAND gate N2 are in the binary one condition for some period during every thousandth of a second. As a result, binary one signals are applied to digital signal generator DSG at that rate. This causes the counter which comprises the generator to produce an output signal which increases from zero in digital increments of one for each pulse it receives. This output signal of increasing numerical value is applied to converter DAC which consequently applies analog signals of correspondingly increasing magnitudes through resistor R2 to the respective input of differential amplifier DA. This increasing feedback signal offsets the effect the detection signal along line S has on amplifier DA and ultimately results in the output of the amplifier decreasing below 2 volts thereby preventing it from passing a current through 2 volt zener diode Z1. This causes transistor T2 to cease conduction and removes the binary one signal from that input of NAND gate N2 which is connected to inverter I1. Binary one signals cease to be applied to digital signal generator DSG but for the remainder of the cycle of door operation generator DSG maintains its output and consequently that of converter DAC at those values which caused the output of differential amplifier DA to decrease below 2 volts.

In this way the particular degree of unbalance resulting from the circuit to ground produced by the accumulation of moisture or by the non-parallel condition of the doors is prevented from thereafter affecting the closing of the doors throughout that cycle of door operation. If a person, however, enters the zone of influence of the antennae during the door closing operation, the apparatus is still operable to interrupt that closing operation if that person produces a change in the unbalanced condition from that particular degree of unbalance an amount equal to the difference between the balanced condition and that predetermined degree of unbalance sufficient to interrupt the closing of the

doors if the circuitry was balanced when such closing commenced. Such a person provides a capacitive circuit to ground for at least one of the antennae in the same fashion as previously described. This can cause one of two things. It can result in the further unbalancing of the bridge circuit and an increase in the detection signal along line S by an additional voltage which in and of itself would be sufficient to cause amplifier DA to produce a positive 7 volt operating signal in the previously explained manner. Or, on the other hand, it can result in a capacitance to ground tending to balance the previously unbalanced bridge. This would result in a decrease in the detection signal along line S such that the feedback signal applied to the input of amplifier DA through resistor R2 would be greater than the detection signal.

If the former is the case, amplifier DA produces an additional 7 volt operating signal which causes transistor T2 to conduct but is ineffective to operate feedback signal generator FSG because the last input to flip flop FF had been through closed contacts FOP. This occurred when the doors were fully opened. As a result, a binary zero signal is being applied to the respective input of NAND gate N1 thereby removing the binary one signal to the input of NAND gate N2 connected to inverter I3. The increased signal from amplifier DA, however, does pass through the seven volt zener diode Z2 to cause the actuation of the door protective relay in the previously described manner.

If instead the entrance of the person into the zone of influence of the antenna means tends to cause the balancing of the previously unbalanced bridge, the operating signal from differential amplifier DA changes to at least a negative 7 volt operating signal. The inputs to amplifier DA are the signal applied through resistor R2 capable of causing the amplifier to produce a negative 10 volt signal and the changed detection signal applied along line S capable of causing the amplifier to produce at most a positive 3 volt signal. This negative 7 volt operating signal passes a current through 7 volt zener diode Z3 which causes transistor T1 to cease conduction. As a result, a sufficiently positive signal is applied to the gate of silicon controlled rectifier SCR to cause it to conduct on positive half cycles of the alternating current signal applied along AL. This, as previously explained, operates the door protective relay to interrupt the closing movement of the door.

From the foregoing it can be seen that an arrangement has been provided by which undesirable circuits to ground are prevented from affecting the operation of the proximity detection apparatus. This is accomplished by enabling such undesirable circuits to cause the production of a feedback signal during the initial opening movement of a door in each cycle of door operation. This feedback signal balances out the effect such undesirable circuits to ground produce. The ability of the equipment to produce feedback signals is limited to a portion of the initial door opening movement so as to make it as difficult as possible for passengers to interfere with the protective function of the apparatus.

Since an undesirable circuit to ground might be produced by a phenomenon which is individual to a particular landing, the equipment is arranged such that the feedback signal generator FSG is reset to produce a zero output signal at the completion of each door closing. This is accomplished through the engagement of contacts FCP2 and the consequent application of the signal along line E2 to digital signal generator DSG in any suitable manner.

FIG. 2 discloses another embodiment of the invention similar to the arrangement shown in FIG. 1 but which doesn't have its antennae connected in a capacitive bridge circuit. In this embodiment the antenna means ANM comprises three antennae disposed in the leading edge of the car door in the manner disclosed in U.S. Pat. to Galanty No. 2,720,284 wherein the two relatively short compensating antennae, A1 and A3, are mounted near the top and bottom of the door above and below the large signal antenna A2. Both of the compensating antennae are connected through a resistance capacitance coupling to the gate of field effect transistor FT1. The large signal antenna is connected through a resistance capacitance coupling to the gate of field effect transistor FT2. The drain of each of these transistors is connected through a resistor to line B2+ while the source of each is connected through an associated RC biasing circuit to line BO. Oscillator OSC is connected to apply pulses on line BO in this embodiment as in the embodiment of FIG. 1.

The drain of each of transistors FT1 and FT2 is also connected to amplifying circuitry PA1, PA2 and a rectifying circuit RE1, RE2 which may suitably comprise the corresponding circuitry described in connection with FIG. 1. Each of rectifying circuits RE1, RE2 is connected through an output resistor to a separate input of differential amplifier DA. The compensating antennae circuits are connected to the inverting input of the amplifier while the circuits of the signal antenna A2 are connected to the non-inverting input. As in the other embodiment, the output of amplifier DA in this embodiment is connected to protective equipment PE and to circuitry which produces feedback offsetting signals. In this embodiment, however, since amplifier DA can produce positive or negative polarity operating signals during the door opening movement, depending on which of its input signals is greater, two feedback signal generators FSGD and FSGU are employed. Each of these operates like that of the FIG. 1 embodiment FSG. In this arrangement the output of generator FSGU is connected through line U to the non-inverting input of amplifier DA. The output of generator FSGD is connected through line D to the inverting input of the amplifier.

In operation should a particular unbalanced condition occur during the initial opening movement of the associated doors such that the output signal of the amplifying circuits connected to the signal antenna A2 or to the compensating antennae A1 and A3 exceeds the output signal of the other, either a positive or negative polarity operating signal is produced by amplifier DA. This causes its associated feedback signal generator FSGD or FSGU to produce a signal which offsets the excess of the input signal to amplifier DA.

In operation if the apparatus is in a balanced condition such that the output signal of the amplifying circuits connected to the signal antenna A2 is substantially equal to the output signal of the amplifying circuits connected to the compensating antennae A1 and A3, amplifier DA produces no significant operating signal. Should this balanced condition prevail when the doors commence to close, then the introduction of a sufficient circuit to ground within the specified proximity of any of the antennae, say a person within three

inches thereof, produces a predetermined unbalance which operates the protective equipment causing the door operating mechanism to interrupt the closing movement.

Should a particular unbalanced condition arise during the initial opening movement of the doors such as by the doors being non-parallel, the output signal of the signal antenna circuitry or the compensating antenna circuitry exceeds the output signal of the other. Depending upon which of these is greater in magnitude, amplifier DA either produces a positive or negative polarity operating signal, respectively. This causes the associated feedback signal generator FSGD or FSGU to produce a signal which offsets the excess of the input signal to amplifier DA representing the unbalanced condition. Thereafter in that cycle of door operation, protective equipment PE is limited to operation in response to changes from the particular prevailing degree of unbalance which are equal in magnitude to the difference between the balanced condition and the forementioned predetermined degree of unbalance.

Although disclosed in connection with an elevator door, those skilled in the art will realize that these arrangements are also suitable for use in connection with the doors of other vehicles as well.

As changes can be made in the above described embodiments and many apparently different constructions of the invention can be made without departing from the scope thereof, it is intended that the foregoing be considered illustrative only and not limiting in any sense.

What is claimed is:

1. In a system for a vehicle having a door for opening and closing a doorway in said vehicle, a door operating mechanism for moving said door in the opening and closing directions through cycles of operation from the closed position to the opened position and back to the closed, antenna means and associated circuitry mounted in that edge of the door which leads it when moving in the closing direction, said antenna means and associated circuitry operating from a balanced to an unbalanced condition in response to the presence of objects proximate said antenna means, the degree of said unbalance varying directly with the capacitance of said objects to ground and the proximity of said objects to said antenna means, protective equipment operable in response to a predetermined degree of unbalance during movement of said door in the closing direction to cause said door operating mechanism to interrupt said movement, the improvement comprising limiting circuitry operating in response to a particular degree of unbalance during the initial opening movement of said door in any cycle of operation and limiting the operation of said protective equipment in causing said door operating mechanism to interrupt movement of said door in the closing direction during that cycle of operation to operation in response to changes in the unbalanced condition from said particular degree of unbalance equal in magnitude to the difference between said predetermined degree of unbalance and said balanced condition.

2. In a vehicle system according to claim **1**, wherein said antenna means and associated circuitry include a bridge circuit and amplifying circuits producing detection signals whose magnitudes directly signify the degrees of said unbalances, wherein said limiting circuitry receives said detection signals from said amplifying circuits and in response thereto produces operating signals which are applied to said protective equipment, and wherein said protective equipment operates to cause said door operating mechanism to interrupt movement of said door in response to an applied operating signal exceeding a predetermined magnitude during closing movement of said door.

3. In a vehicle system according to claim **2**, wherein said limiting circuitry includes a feedback signal generator operating during the initial movement of the door in the opening direction in each cycle of door operation in response to the reception by said limiting circuitry of a detection signal in excess of a particular magnitude from said amplifying circuits and producing a respective feedback signal which offsets the effect of said excess signal on said limiting circuitry and prevents said circuitry from producing in response to said excess signal a signal for application to said protective equipment during movement of said door in the closing direction in that cycle of door operation.

4. In a vehicle system according to claim **3**, wherein said limiting circuitry includes resetting means operating in response to each return of said door to the closed position to cease production of the offsetting feedback signal then being produced by said feedback signal generator.

5. In a vehicle system according to claim **4**, wherein said protective equipment is operable in response to an input signal exceeding a predetermined magnitude during closing movement of said door to cause said operating mechanism to reverse the movement of said door and wherein said limiting circuitry includes control circuitry which operates in response to said door reaching the opened position and prevents said feedback signal generator from producing an increased offsetting feedback signal in response to detection signals from said amplifying circuits during closing movement and during reversals notwithstanding the magnitudes of the detection signals produced during closing movement and during reversals exceed that of the detection signal produced during the original opening movement portion of the door operating cycle during which said closing movement and said reversals occur.

6. In a vehicle system according to claim **5**, wherein said feedback signal generator includes a digital signal generator operating in response to excess signals and generating signals which signify in digital form the magnitude of the offsetting feedback signal to be produced and wherein said feedback signal generator also includes a digital to analog signal converter operating in response to said digital signals and producing said offsetting feedback signals.

7. In a vehicle system according to claim **6**, wherein said digital signal generator is a binary counter which increases the magnitude of its generated signal in increments until the offsetting feedback signal produced during any cycle of door operation prevents the excess signal produced during that cycle from producing a signal for application to said protective equipment.

8. In a vehicle system according to claim **7**, wherein said limiting circuitry includes a differential amplifier which receives both said amplifying circuits signals and said offsetting feedback signals, said differential amplifier operating in response to an excess signal and producing a signal which causes said digital signal generator and said converter to produce an offsetting feedback signal whose magnitude offsets the effect of said

excess signal and prevents said differential amplifier from producing a signal in response to said excess signal.

9. In a vehicle system according to claim **1**, wherein said antenna means includes a main portion and a compensating portion, wherein said associated circuitry includes amplifying circuits for each said portion, said amplifying circuits producing output signals whose magnitudes are substantially equal in the absence of a suitable circuit to ground within said predetermined proximity of said antenna means and producing output signals whose magnitudes are unequal in the presence of such a circuit within said predetermined proximity, wherein said limiting circuitry receives output signals from said amplifying circuits and in response to unequal ones produces operating signals which are applied to said protective equipment, and wherein said protective equipment operates to cause said door operating mechanism to interrupt movement of said door in response to an operating signal in excess of a predetermined magnitude during closing movement of said door.

10. In a vehicle system according to claim **9**, wherein said limiting circuitry includes a feedback signal generator operating during the initial movement of the door in the opening direction in each cycle of door operation in response to an operating signal in excess of a particular magnitude produced in response to a specific inequality in the output signals of said amplifying circuits and producing a respective feedback signal which is applied to said limiting circuitry and reduces the magnitude of said operating signal to said particular magnitude throughout that cycle of door operation provided said specific inequality in the output signals of said amplifying circuits continues to exist.

11. In a vehicle system according to claim **10**, wherein said feedback signal generator maintains the magnitude of the feedback signal it produces in response to a specific inequality during the initial movement of the door in the opening direction in each cycle of door operation at that magnitude throughout that cycle notwithstanding the specific inequality increases during movement of said door in the closing direction during that cycle.

12. In a vehicle system according to claim **11**, wherein the amplifying circuits for each portion of the antenna means includes a field effect transistor whose gate is electrically connected to the associated portion of said antenna means.

13. In a vehicle system according to claim **12**, wherein said limiting circuitry includes a differential amplifier which produces said operating signals in response to the output signals of one of said amplifying circuits which it receives at its inverting input and the output signals of the other of the amplifying circuits at its non-inverting input, whereby said operating signals may be of either polarity and wherein said feedback signal generator operates in response to a positive polarity operating signal to apply a feedback signal to the inverting input of said differential amplifier and operates in response to a negative polarity operating signal to apply a feedback signal to the non-inverting input of said differential amplifier.

14. In a vehicle system having a vehicle with a door for opening and closing a doorway in said vehicle, a door operating mechanism for moving said door in the opening and closing directions, antenna means and associated circuitry mounted in that edge of the door which leads it when moving in the closing direction, said antenna means and associated circuitry being responsive to the capacitance to ground of objects proximate said leading edge to produce output signals whose magnitudes vary directly in relation to the magnitude of said capacitance and the proximity of said objects to said leading edge, protective equipment responsive to input signals in excess of a predetermined magnitude during movement of said door in the closing direction and causing said door operating mechanism to reverse said movement, the improvement comprising limiting circuitry receiving the output signals of said antenna means and associated circuitry and applying input signals to said protective equipment, said limiting circuitry responding during movement of said door in the opening direction to that portion of the output signal of said antenna means and its associated circuitry in excess of a particular magnitude and producing an offsetting signal which is applied to said limiting circuitry and offsets the effect of said excess signal on said limiting circuitry thereby preventing said circuitry during the subsequent movement of said door in the closing direction from producing an output signal in response to said excess signal, said limiting circuitry including control circuits which operate in response to the original movement of said door in the opening direction during each cycle of door operation and prevent said limiting circuitry from increasing its offsetting signal during a particular cycle of door operation after the cessation of the original opening movement during that cycle notwithstanding the magnitude of the output signal produced by said antenna means and associated circuitry later during that cycle may exceed the magnitude of such output signal produced during the original movement in the opening direction in that cycle.

15. In a vehicle system according to claim **14**, wherein said limiting circuitry includes an input circuit and a memory circuit, said input circuit receiving the excessive output signals of said antenna means and associated circuitry and in response thereto applying operating signals to said memory circuit, said memory circuit producing said offsetting signals in response to said operating signals and applying said offsetting signals to said input circuit causing said input circuit to cease to produce said operating signals, said memory circuit maintaining an offsetting signal at the magnitude produced during movement in the opening direction in a particular cycle of door operation throughout the remainder of that particular cycle of door operation notwithstanding said input circuit ceases to produce the operating signal which caused the production of said offsetting signal.

16. In a vehicle system according to claim **15**, wherein said memory circuit includes resetting means responsive to the completion of each cycle of door operation to cease the production of the offsetting signal it is then producing.

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