

[54] AUTOMATIC DOOR CONTROL UNIT

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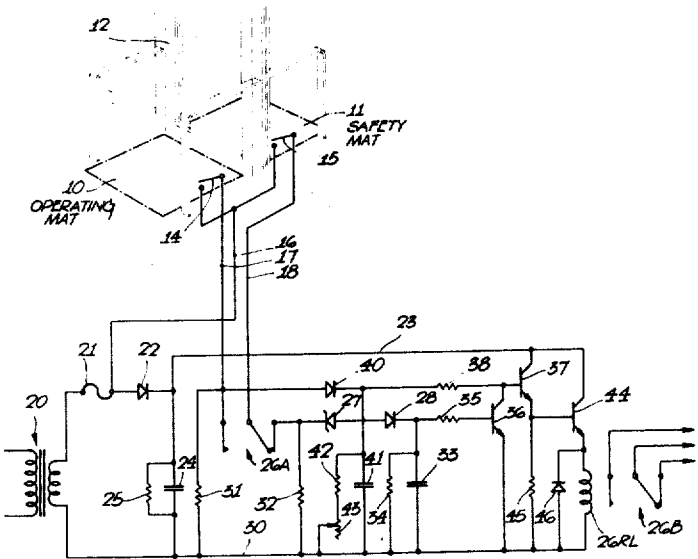
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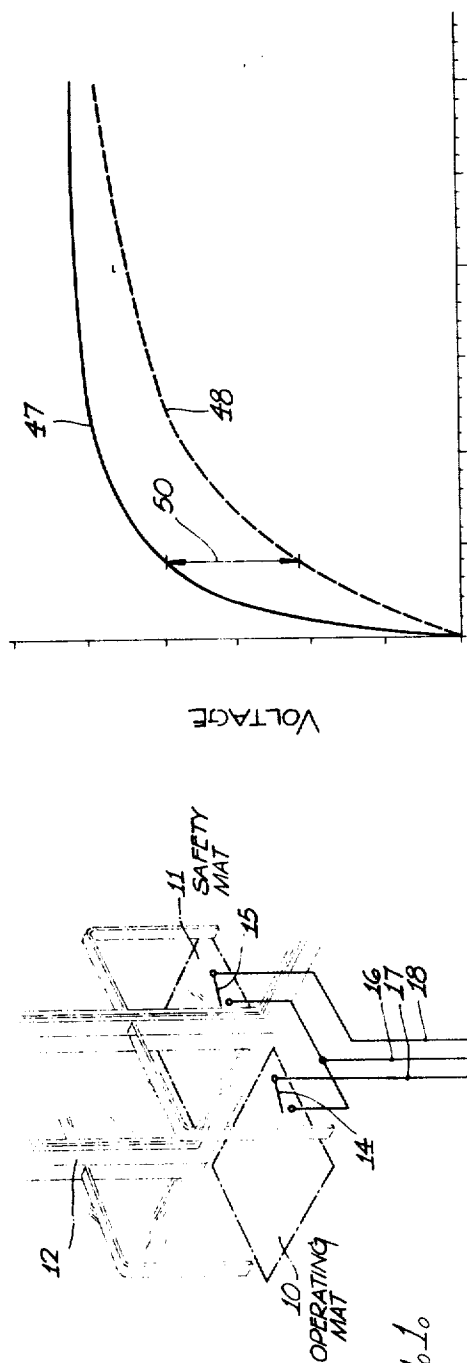
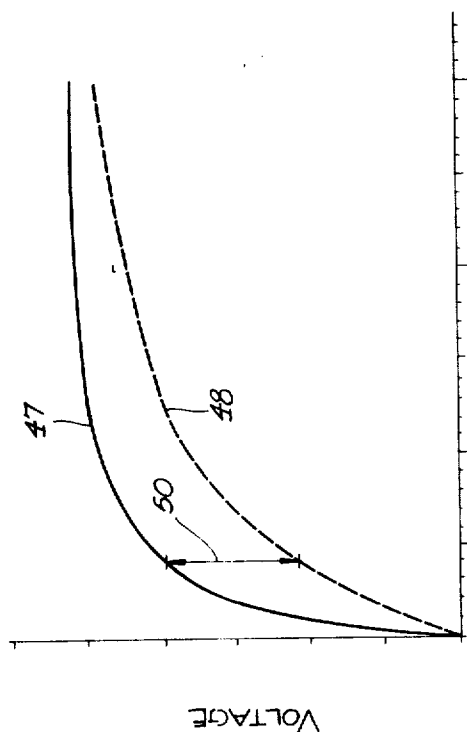
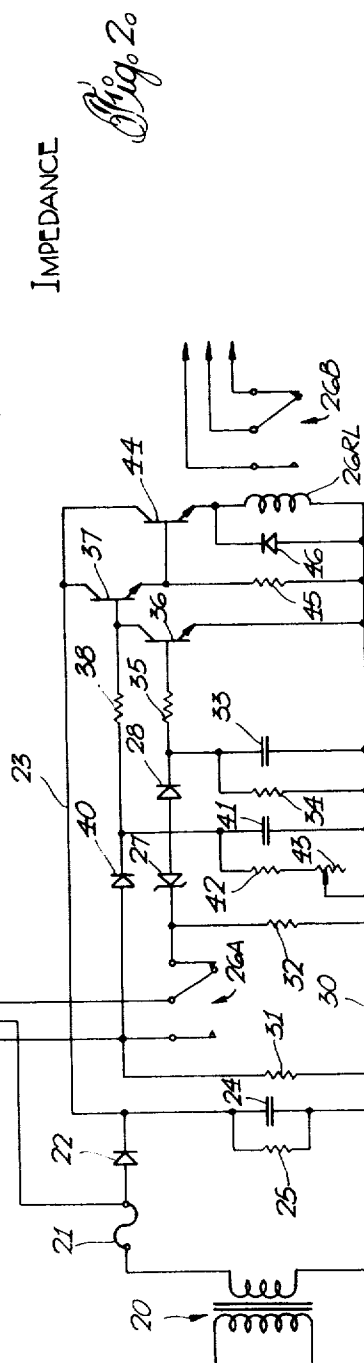
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[57] ABSTRACT

An automatic door control unit for connection to an operating mat and a safety mat to actuate the unit. The unit includes an amplifier connected to the operating mat to provide a signal actuating a door operating relay, and the amplifier includes an input impedance forming a network decreasing sensitivity to operating mat degradation of resistance. A transistor circuit is connected across the amplifier unit and controlled by the safety mat to prevent operation of the amplifier. The safety mat actuates the transistor circuit when the door is closed and there is traffic on the safety mat. The transistor circuit includes an impedance forming a network decreasing sensitivity to safety mat degradation of resistance and further includes a Zener diode at the input thereof to provide a barrier to voltage resulting from open circuit safety mat resistance degradation. There is a separate time delay associated with the operating mat and with the safety mat.

3 Claims, 2 Drawing Figures





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AUTOMATIC DOOR CONTROL UNIT

This invention relates to apparatus for automatically opening and closing doors in response to traffic using the doorway, and in particular it relates to improved circuitry and controls for an automatic door control unit.

The automatic door control unit of this invention is intended to be connected to mats containing a switch mechanism or similar actuation devices. The mats are placed in the doorway and serve to actuate a door control unit which opens and closes the door. Traffic passing over the mats changes the mat resistance, or more properly the resistance provided by the switch mechanism arrangement within the mats, from an open circuit to a substantially zero resistance under ideal conditions. This change in resistance is used to actuate the automatic door control unit.

The mats or similar devices referred to above are well known in the art. With continued use the contact resistance in such mats may deteriorate and increase from a very low resistance up to perhaps 100 or 200 ohms, and the open circuit resistance may decrease to perhaps several hundred ohms. A door control unit having circuitry sensitive to degradation of mat resistance, that is to undesired changes in mat resistance from the ideal open circuit and short circuit conditions, will require frequency replacement of the mat or mats. The circuitry of the present invention is relatively insensitive to undesired changes in mat resistance, and permits mats to be used for a longer period of time.

In addition in certain prior art door control units operating with a control mat in front of the door and a safety mat after the door to hold the door open, there is no separate delay associated with the safety mat. It is, of course, necessary to have a delay associated with the control mat, but it is also desirable to have a delay associated with the safety mat so that control of the door is not passed to the control mat immediately after traffic moves through the door and off the safety mat. When there is no delay associated with the safety mat, children are able to "fool" a door control unit by jumping up and down on the safety so that control may pass back to the control mat, the door may close and then open while the children are on the safety mat.

It is the object of the invention to provide an automatic door control unit that is relatively independent of resistance degradation of actuating devices connected to it.

It is another object of the invention to provide an automatic door control unit for actuation by mats or the like where the unit is relatively insensitive to degradation of the electrical characteristics of the mats.

It is another object of the invention to provide for independent time delay functions associated with each one of a pair of actuating devices.

It is yet another object of the invention to provide in a door control unit a time delay associated with the safety mat.

The invention accordingly consists of the features of construction, combination of elements, and arrangement of parts which is exemplified in the construction as will hereafter be described and with reference to the drawings, in which

FIG. 1 is a schematic drawings of circuitry according to the invention, and

FIG. 2 is a graph useful in explaining a feature of the invention.

Referring to FIG. 1, there is shown in dashed lines an "operating" or control mat 10 and a "safety" mat 11. The mats contain switch mechanisms and are arranged so that a person or other traffic on the mat causes the mat resistance to become substantially zero. The mat 10 is the first mat, that is, the traffic is intended to pass over mat 10 first. Traffic moving on to mat 10 actuates the door control unit to open the door 12. As the traffic passes on to mat 11 the door control unit is actuated to retain the door in the open position until the traffic is clear. Traffic moving the wrong way onto mat 11 first will not actuate the unit to open the door but rather prevents the door from opening. The mat 11 is thus referred to as the safety mat.

The mats 10 and 11 each have an open and a closed state or condition and are represented in the drawing as switches 14 and 15 respectively. Three conductors 16, 17 and 18 connect the switches 14 and 15 to the circuitry of the door control unit.

Power for the door control unit is provided by a transformer 20 having a primary winding for connection to a suitable power source, such as a 110 volt A.C. source, and a secondary winding connected to the circuitry providing, for example, 12 volts A.C. A protective fuse 21 is connected to one side of the secondary winding and a rectifier 22 is connected to the fuse to provide a D.C. voltage between conductors 23 and 30. Capacitor 24 smooths the rectified voltage provided between conductors 23 and 30 and resistor 25 serves as a leakage path to discharge capacitor 24 quickly in the event of a power failure.

Also connected to fuse 21 is conductor 16. This provides a voltage to one terminal of switch 14 and one terminal of switch 15. Thus, the closing of switch 14 or switch 15 supplies power over conductor 17 or 18 respectively.

Conductor 17 is connected to one contact of a set 26A of relay contacts and conductor 18 is connected to the moving contact as shown. The set of relay contacts 26A is shown in the de-energized or rest position. The other contact is connected through a Zener diode 27 to one side of a diode 28. The outside contacts in the set of contacts 26A are connected to conductor 30 by resistors 31 and 32 (which may in fact be impedances as this part of the circuitry is for alternating current) and which forms part of a network as will be described hereinafter.

The other side of diode 28 is connected to conductor 30 by a parallel arrangement of a capacitor 33 and a resistor 34 which provides a delay function as will hereinafter be described, and is connected by resistor 35 to the base of transistor 36. The collector of transistor 36 is connected to the base of transistor 37 and the emitter of transistor 36 is connected to conductor 30. Thus transistor 36 can provide a substantially open circuit or a substantially short circuit at the base of transistor 37.

The base of transistor 37 is connected by a resistor 38 and diode 40 to the junction of conductor 17 and resistor 31. The junction of resistor 38 and diode 40 is connected to conductor 30 by a parallel circuit comprising capacitor 41 and resistor 42 in series with variable resistor 43. This circuit also provides a delay as will subsequently be described.

Transistor 37 and transistor 44 have their collectors connected to conductor 23 and are arranged in a modified form of a Darlington amplifier circuit. Resistor 45 modifies the operation by insuring a positive switch off for transistor 44. The emitter of transistor 44 is connected to conductor 30 by a parallel circuit comprising a diode 46 and a relay coil 26RL. Relay 26 is the door operating relay. Relay coil 26RL controls the set of contacts 26A previously described and a set of contacts 26B. The contacts 26B provide a normally open and a normally closed switch arrangement for connection to a driving means (not shown) for a power operated door for opening and closing door 12.

The operation of the automatic door control unit may be first considered first with the control unit in the normal or rest condition with the door closed and no traffic. Switches 14 and 15 would therefore be open and the relay contacts 26A and 26B as shown in the drawing. Transistors 37 and 44 are not conducting. When traffic approaches in the normal direction it moves onto mat 10, closes switch 14 and applies power over conductors 16 and 17 to diode 40 and capacitor 41 charges very quickly. Current flows through resistor 38 to the base of transistor 37 causing transistor 44 to conduct heavily. Current flows through coil 26RL changing the contact position in contacts 26A and 26B. The change in position of contacts 26B actuates the driving means to open door 12. The door is held open by the driving means until contacts 26B are returned to their de-energized or rest position.

If for some reason the traffic moves off mat 10 but does not pass on to mat 11, switch 14 opens and capacitor 41 discharges through resistor 42 and 43. The rate of discharge of capacitor 41 may be controlled by adjusting variable resistance 43. When capacitor 41 discharges to a predetermined level, transistors 37 and 44 will cease to conduct, relay coil 26RL will become de-energized and contacts 26A and 26B will return to their normal condition. When contacts 26B return to their de-energized or rest condition they actuate the driving means to close door 12. Thus, the variable resistor 43 may be used to adjust the "hold open time" of door 12. That is it may be used to provide an adjustable time delay between switch 14 opening and door 12 closing.

If traffic has opened door 12 and moves from mat 10 to mat 11 in the normal manner, then switch 14 opens and switch 15 closes. Contacts 26A are in an activated position connecting conductors 17 and 18 and applying power to diode 40 as before. Switch 15 is, in effect, operating as switch 14. When the traffic moves off mat 11 and switch 15 opens, the door will close following the time delay determined by capacitor 41 and resistors 42 and 43.

Suppose now that the control unit is in its normal or rest condition with door 12 closed, switch 14 open and relay 26 de-energized, and the mat 11 is actuated. When switch 15 is closed power is now applied to Zener diode 27 and diode 28. Capacitor 33 charges up very rapidly biasing transistor 36 to its conducting state and creating a potential short circuit between the base of transistor 37 and conductor 30. If switch 14 were to close any voltage developed across capacitor 41 would not be effective to cause transistor 37 to conduct. Thus, the door 12 is prevented from opening, and as the door 12 would open in the direction of traffic, towards mat 11, this is a safety feature. When the traffic moves off mat 11, switch 15 opens and capacitor 33 discharges through resistor 34 until transistor 36 switches to a non-conducting state. The time delay for the safety mat 11, operating as described, may be set by selection of resistor 34 and capacitor 33. This time delay is independent of the time delay associated with the operating mat 10. It is frequently desirable to have a shorter time delay for the safety mat 11 than for the normal operation with operating mat 10. However the time delay for safety mat 11 should be sufficient that children jumping on the safety mat cannot circumvent the safety function.

It will be noted that resistors 31 and 32 (or more broadly impedances 31 and 32) constitute a part of a network with the mat resistance. The value of impedance or resistance 31 and 32 is selected in accordance with the degraded values of mat resistance which are considered as maximum. The network may be better explained by reference to FIG. 2.

FIG. 2 is a graph of voltage plotted against impedance. The voltage is the voltage available at the junction of impedance (or resistance) 31 or 32 and the respective mat 11 or 12 for different values of the impedance (or resistance) 31 or 32. Curve 47 represents the relationship where the closed resistance of a mat has degraded so that it is no longer substantially zero but is, by way of example, 200 ohms. Curve 48 represents the relationship where the open circuit resistance of a mat has degraded so that it is no longer substantially infinite but is, by way of example, 600 ohms. It is desirable that the unit be able to differentiate between closed and open mat state as represented by degraded resistances, and it will be seen that there is a value of impedance (indicated at line 50) which will give a maximum difference in voltage under these conditions. It will be noted that there is a considerable range of values on either side which would give quite satisfactory results. The impedance value is normally a value lying between the degraded open circuit and closed circuit mat resistances. The use of the network as described ensures satisfactory operation of the control unit even when mat resistance has deteriorated considerably.

Referring again to FIG. 1, the Zener diode 27 is used as a barrier to leakage voltage resulting from degradation of open condition resistance of the safety mat 11. The open circuit

condition of safety mat 11 is ideally a substantially infinite resistance, and a mat 11 in ideal circumstances would, when the mat is not actuated (i.e. when switch 15 is open), result in no alternating voltage across resistor 32. However, as the mat 11 deteriorates with use and the open resistance degrades, a voltage will appear across resistor 32 and be applied to Zener diode 27. The Zener diode 27 and diode 28 are connected back to back and consequently, with respect to one-half of the alternating cycle, voltage passed by diode 27 will be stopped by diode 28. With respect to the other half of the cycle, Zener diode 27 will act as a barrier until a breakdown voltage is reached, at which time it will conduct and so will diode 28 charging capacitor 33. Thus, as long as the barrier voltage is not exceeded by the leakage voltage resulting from degradation of resistance in mat 11, the leakage will not cause the transistor 36 to conduct thereby preventing the door opening. It is convenient to select a barrier voltage which corresponds to the design figure for the maximum open condition leakage degradation. The Zener diode 27, has the effect of extending the leakage range of the safety mat 11.

It has been found that an automatic door control unit according to this invention will operate when contact resistance deteriorates up to about 200 ohms and when leakage or open circuit resistance deteriorates to as low as about 600 ohms.

It will be apparent from the foregoing that this invention provides an automatic door control unit having improved circuitry, less sensitive to degradation of resistance in actuating devices, with separate time delays for operating and safety functions and incorporating means for preventing irregular operation.

We claim:

1. An automatic door control unit for controlling the opening and closing of a power operated door in accordance with the state of a traffic responsive operating mat and a traffic responsive safety mat positioned one on each side of the door, each mat having a closed state where the resistance under ideal conditions is substantially zero and an open state where the resistance under ideal conditions is substantially infinite, the mats being subject to degradation of resistance values with use, said unit comprising

amplifier means having an input and an output,

a door operating relay connected to said output and being responsive to a signal at said output to change from a door closed to a door opened state,

a first impedance connected to said input and including means for connection to said operating mat to form a network decreasing the operating mat resistance degradation sensitivity of the unit,

a transistor circuit connected across said input and having a non-conducting and a conducting state,

said transistor circuit in its conducting state preventing operation of said amplifier means to actuate said relay to said door opened state,

a second impedance connected to said transistor circuit and including means for connection to said safety mat to form a network decreasing safety mat resistance degradation sensitivity,

a Zener diode and a diode series connected in back to back relationship between said second impedance and said transistor circuit to provide a barrier to voltage resulting from open state safety mat resistance degradation to a predetermined value.

2. An automatic door control unit as defined in claim 1 in which said first and second impedances are resistances and in which the value of the resistance is between the lowest permissible degraded open state resistance and the highest permissible degraded closed state resistance presented at the respective means for connection to said operating mat and to said safety mat.

3. An automatic door control unit for controlling the opening and closing of a power operated door in accordance with the state of a traffic responsive operating mat and a traffic responsive safety mat positioned one on each side of a door

where the traffic flow is over the operating mat, through the door; and over the safety mat,
amplifier means having an input and an output,
a door operating relay connected to said output and being responsive to a signal at said output to change from a door closed to a door opened state, 5
an operating mat connection means connected to said input of said amplifier means and being responsive to a resistance change from a first value to a second value to provide said signal at said output, 10
a first delay network connected to said input of said amplifier means for continuing said signal at said output for a predetermined time after a reversal of said resistance change from said second value to said first value,
a transistor circuit connected across said input of said am- 15

plifier means and having a non-conducting and a conducting state,
said transistor circuit in its conducting state preventing operation of said amplifier means to actuate said relay to said door opened state,
a safety mat connection means connected to said transistor circuit switching said transistor circuit to said conducting state, in response to a resistance change from a first value to a second value, and
a second delay network connected to said transistor circuit for retaining said transistor circuit in its conducting state for a predetermined time after a reversal of said resistance change from said second value to said first value.
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