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DOOR OPERATING MECHANISM

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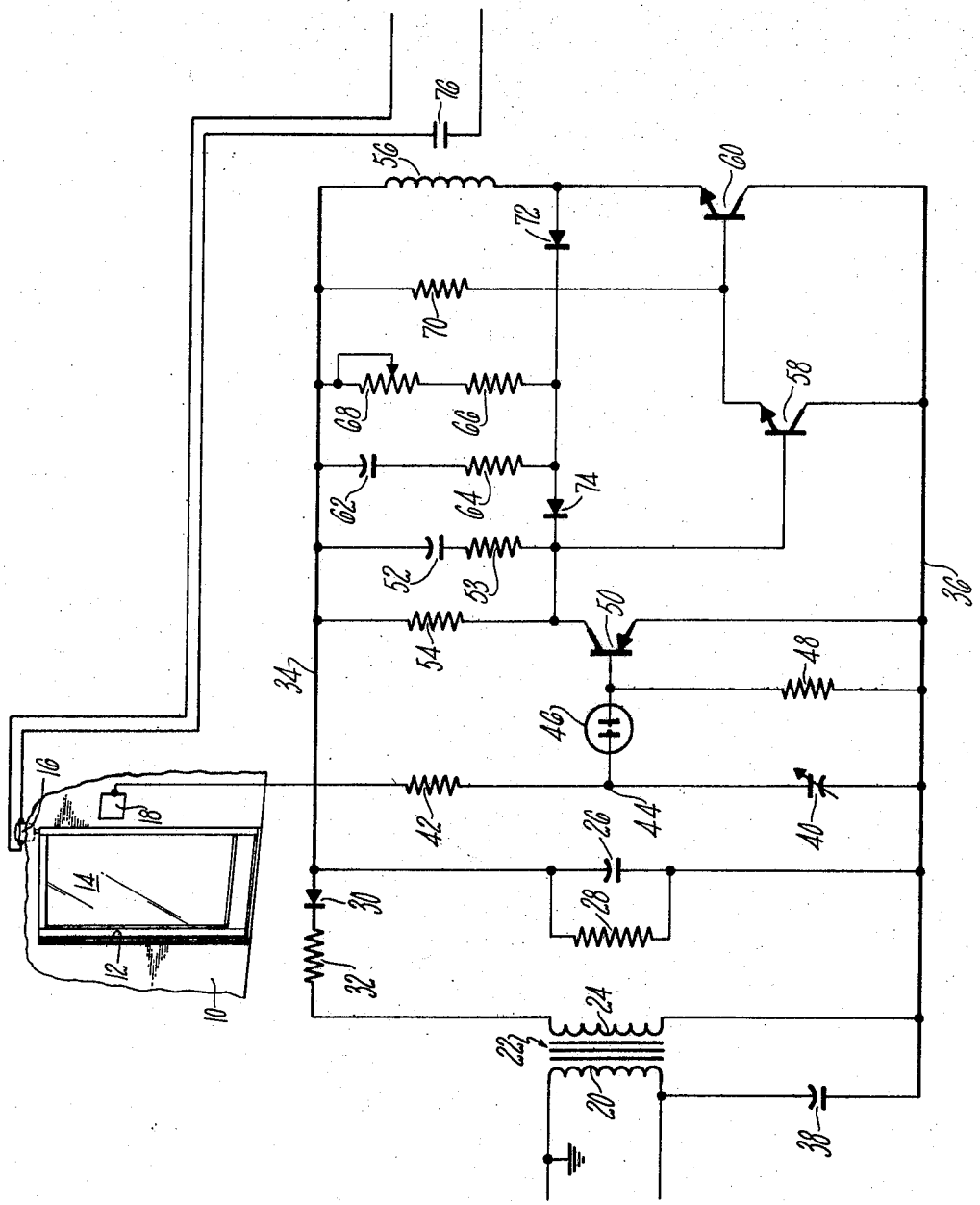

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DOOR OPERATING MECHANISM

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ABSTRACT OF THE DISCLOSURE

A door operating mechanism for a door equipped with a motor for producing an opening movement comprising an electric switching element for directing operating energy to the motor, an electrically conductive plate isolated from ground adjacent the area of approach to the door, means to impress on the plate an alternating current potential and means responsive to an increase in the space capacitance of the plate upon the approach of a body toward the plate to actuate the electric switching element and energize the motor to open the door. The actuating means includes a voltage sensor connected across an impedance element serially connected with the plate to form an input circuit for triggering the actuating means.

This invention relates to door operating mechanisms and more particularly to the opening and closing of doors by power which is controlled responsive to traffic using the doorway.

An object of this invention is to provide a powered door operator incorporating a control of high reliability and versatility, low maintenance and with the absence of moving parts. Included in this object is a provision of a control which incorporates an adjustable time delay for regulating the period of time the door remains open before returning to its closed position.

Another object of this invention is to provide a door operating mechanism having a low current, low voltage control system which is designed to be electrically affected by a person approaching the doorway. Included in this object is the provision of such a control system which insures against false triggering and for the safety of the users under all operating conditions.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which is exemplified in the construction hereafter set forth, and the scope of the invention is indicated in the appended claims.

In the drawing:

The single figure is a perspective view of a door operating mechanism incorporating this invention.

Referring to the drawing in detail, there is shown a building wall **10** having an opening **12** forming a doorway adapted to be closed by a door **14**. As shown, a motor **16** is supported in the header above the door and is connected thereto in any conventional manner for powering the door between its open and closed positions. Mounted on the wall **10** adjacent the doorway is an electrically conductive touch plate **18** which senses the presence of a part of a body such as a user's finger near or touching the touch plate to initiate the operation of the door opening and closing cycle as hereinafter more fully described.

Generally speaking, the input signal denoting the presence of a person adjacent or touching the touch plate **18** results in the charging of a capacitor during the positive portion of the A.C. input to a level sufficient to trigger a voltage sensing switching device which, in turn, turns on a pair of power switch controlling cascaded transistors. To avoid false triggering, a capacitor is incorporated in an integrating circuit requiring a plurality of pulses resulting from the approach of a body adjacent the touch plate **18** to reduce the possibility of false firing from extraneous impulses. The control includes a built-in holding circuit and an adjustable time delay for maintaining the door in an open position for a predetermined period of time before it begins to return to its closed position.

Power from a suitable source, such as a 110 v. A.C. power line having one side grounded, is applied to the primary winding **20** of transformer **22** having a low voltage secondary winding **24**.

The secondary winding **24** of the transformer **22** is connected across a parallel circuit comprising capacitor **26** and resistor **28** through a semi-conductor diode **30** and a resistor **32** which provides surge protection for the semi-conductor diode **30** to provide a half-wave rectified power supply across the busses **34** and **36**. Capacitor **38** is connected between the ungrounded side of the primary winding **20** of the transformer and one side of the secondary winding **24** (and bus **36**) so that the entire control circuit follows the voltage excursions of the ungrounded side of the power line.

As shown in the drawing, the adjustable capacitor **40**, the resistor **42** and the touch plate **18** are connected in series between bus **36** and ground to form an input circuit producing a control signal at juncture **44** between the capacitor **40** and the resistor **42**. The capacitor **40** is adjustable to provide the input circuit with the desired sensitivity to fire a voltage sensor such as glow tube **46** when the voltage across capacitor **40** is above the threshold level of the voltage sensor due to the approach of a body to within a predetermined distance from touch plate **18** for a predetermined time. As adjusted, the impedance of capacitor **40** and the resistance of resistor **42** do not change and the voltage level at juncture **44** is dependent of changes in the space capacitance of touch plate **18**. When a finger or some other portion of a body approaches the touch plate **18**, the space capacitance thereof (i.e., the capacitance between the touch plate **18** and ground) increases to decrease the impedance thereof. Accordingly, the impedance across capacitor **40** becomes a greater portion of the total impedance of input circuit comprising capacitance **40**, resistor **42** and touch plate **18**, and the voltage drop developed across capacitor **40** increases to reduce the voltage level at junction **44**. The impedance of resistor **42** is quite low compared with the impedance of capacitor **40** and touch plate **18** and its presence does not appreciably affect circuit sensitivity. However, the presence of resistor **42** precludes the passage of any appreciable current through the touch plate **18** to ground through the user.

As indicated above, the control circuit follows the excursions of the positive side of the primary winding **20** of the transformer **22** and when the peaks of A.C. voltage developed across capacitor **40** reach the firing voltage of glow tube **46**, which is connected across the terminals of the capacitor **40** through the resistor **48** and the bus **36**, the neon gas in the glow tube **46** ionizes to produce a discharge of the energy from capacitor **40** to cause current pulses to flow through the glow tube **46**. These pulses are extremely feeble and last for, say, approximately 20 microseconds. During positive half cycles of the A.C. voltage, the current pulses through glow tube **46** forward bias transistor **50** (i.e., bias the base negative relative to the emitter due to the voltage drop through resistor **48** to fire the PNP transistor). During negative half cycles of line voltage, these current pulses develop a reverse bias across resistor **48** to turn off transistor **50**.

The pulses which forward bias the base of transistor **50** cause equal width pulses of collector current to flow. These pulses of collector current charge capacitor **52**

which is connected in parallel with resistor 54 between the collector of transistor 50 and bus bar 34.

In accordance with one aspect of the invention, several consecutive pulses resulting from the change in space capacitance of a body approaching but not touching touch plate 18 must occur within a predetermined time interval before the charge in capacitor 52 builds up to a sufficiently high D.C. level to cause power switching device 76 such as a reed relay having a winding 56 to pull in. A resistor 53 may be placed in series with capacitor 52 to increase the time interval. Because of the requirement that several pulses are required across capacitor 52 before the relay 76 is triggered under such conditions, an occasional transient discharge of glow tube 46 will not cause the relay 76 to pull in since resistor 54 provides a discharge circuit for capacitor 52 when the charging pulse from transistor 50 is removed. Resistor 48 also guards against thermal runaway due to excessive collector-base leakage currents in transistor 50.

If a body makes direct electrical contact with the touch plate 18, the current pulses through glow tube 46 will last much longer than the 20 microsecond pulses which will occur as a result of capacitor proximity sensing. Under such circumstances, the space capacitance of touch plate 18 is extremely high (and its impedance quite low) and capacitor 40 will be charged to nearly full supply voltage during a single positive half-cycle of line voltage. A single pulse of current passing through glow tube 46 will accordingly be of sufficient width or duration to charge capacitor 52 to a level sufficient to cause relay 56 to pull in. It should be pointed out that the resistance of resistor 42, while quite low in comparison with the impedance of capacitor 40, is sized so that the magnitude of current pulses are limited to well under a milliamp to prevent injury to the user or damage to transistor 50. The reactance of capacitor 38 is also of the order of about a megohm to prevent any noticeable current flow to the user who touches touch plate 18.

As stated above, capacitor 40 is adjustable and may be used to vary the sensitivity of the input circuit to meet the requirements of the installation. In addition, if touch plate 18 is positioned a substantial distance from juncture 44, it is preferably connected to the juncture by shielded cable to prevent the ground capacitance of the connecting wire from being significant as regards the capacitance changes produced by the approach of a body.

In order to drive the relay coil 56 of the control relay, a pair of cascade-connected transistors 58, 60 shown as being of the NPN type, are provided to detect and amplify the voltage developed across capacitor 52 so that when the voltage across capacitor 52 reaches about, say, 20 volts, the relay 76 will pull in.

Capacitor 62 and resistors 64, 66, 68 and 70 form a holding circuit for holding the relay 56 in for a desired period of time following the departure of a body from a position adjacent the touch plate 18 and its influence on the space capacitance thereof. When an input signal causes a voltage to be developed across the relay coil 56, the capacitor 62 is charged to the same voltage through rectifier diode 72 and resistor 68 with resistor 64 limiting the peak charging current to prevent damage to transistor 60.

When the input signal ends, by the departure of a body from adjacent touch plate 18, glow tube 46 no longer charges capacitor 52 which begins to discharge through resistor 54 and the voltage across capacitor 62 forward (positively) biases transistor 58 through diode 74 to deliver current thereto. In this connection, diode 74 assures that capacitor 62 can be charged only through transistor 60 and similarly, diode 72 isolates capacitor 62 from the relay coil 56 during discharge of capacitor 62.

Resistors 66 and 68 provide a discharge circuit for capacitor 62 and the discharge occurs at a rate controlled by the adjustable setting of resistor 68. The maximum holding time for the relay coil 56 may be increased by increasing the resistance setting of resistor 68 but since capacitor 62 may also be discharged through semi-conductor diode 74 and resistor 54, the value of resistor 54 sets the absolute limit for the maximum holding time for relay coil 56.

As will be apparent from the power circuit illustrated in the drawing, the power switching device 76 closes the power circuit for the motor 16 to energize the motor to power the door 14 to its open position where it will remain until the relay coil 56 is deenergized at which time the door will be returned to its closed position. If desired, the power circuit may include any safety or supplemental control devices, it being understood, however, that the low voltage control circuit incorporates an adjustable holding circuit for regulating the time delay between the termination of the input signal and the beginning of door closing movement.

From the foregoing, it will be apparent that this invention provides a door operator mechanism incorporating a unique space capacitance and contact initiated input circuit incorporating means for preventing inadvertent operation as a result of spurious signals involving a safe, temperature stable, low voltage control circuit utilizing all solid state components and providing an adjustable input signal sensitivity level and time delay for a substantially maintenance free, long life door operator mechanism.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above-described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. In a door operating mechanism for a door equipped with a motor for producing an opening movement thereof and an electric switching element for directing operating energy thereto, the combination with said door and electric switching element of an electrically conductive plate isolated from ground adjacent the area of approach to the door, means to impress on said plate an alternating current potential, means responsive to an increase in the space capacitance of said plate upon the approach of a body toward said plate to actuate said electric switching element and energize said motor to open the door, said actuating means including a voltage sensor connected across an impedance element serially connected with said plate to form an input circuit for triggering said actuating means.

2. A device as recited in claim 1 wherein the means to impress an alternating current potential on said plate comprises a transformer having a primary winding one side of which is grounded and the other side of which is connected to a side of the secondary winding of the transformer so that the voltage excursions thereof follow the ungrounded side of the primary winding.

3. A device as recited in claim 2 wherein said connected sides of the primary and secondary windings are connected together through a high impedance conductor.

4. A device as recited in claim 3 wherein the high impedance conductor is a capacitor.

5. A device as recited in claim 1 wherein the voltage sensor is a glow tube.

6. A device as recited in claim 1 wherein the impedance element is adjustable to vary the sensitivity of the input circuit.

7. A device as recited in claim 1 wherein said actuating means includes a timing means for maintaining the door open for a predetermined time following the departure of said body from said door.

8. A device as recited in claim 1 wherein said timing means includes a capacitor which is charged when said electric switching element is actuated and provides the

source of energy for the switching element beginning after the body departs from said door.

9. A device as recited in claim **1** wherein the voltage sensor is connected to a juncture between said impedance element and said plate and is responsive to changes in the voltage level at the juncture to trigger said actuating means.

10. A device as recited in claim **1**, wherein said actuating means includes means responsive to the sum of a plurality of signals received during a predetermined time interval to prevent the actuation of said electric switching element except when the sum of such signals reaches a pre-selected level.

11. A device as recited in claim **10** wherein said means responsive to the sum of such signals is a capacitor connected to the output of said voltage sensor, said capacitor having a discharge circuit connected to provide a continuous discharge path for the charge on said capacitor.

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