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[54] **ELECTRONIC INTERLOCK FOR DOOR OPERATOR**

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[51] **Int. Cl.** **H02p 1/00**

[58] **Field of Search** ..... 318/267, 468, 467, 318/466, 446; 317/134, 135 A, 135 R, 157.61; 307/119

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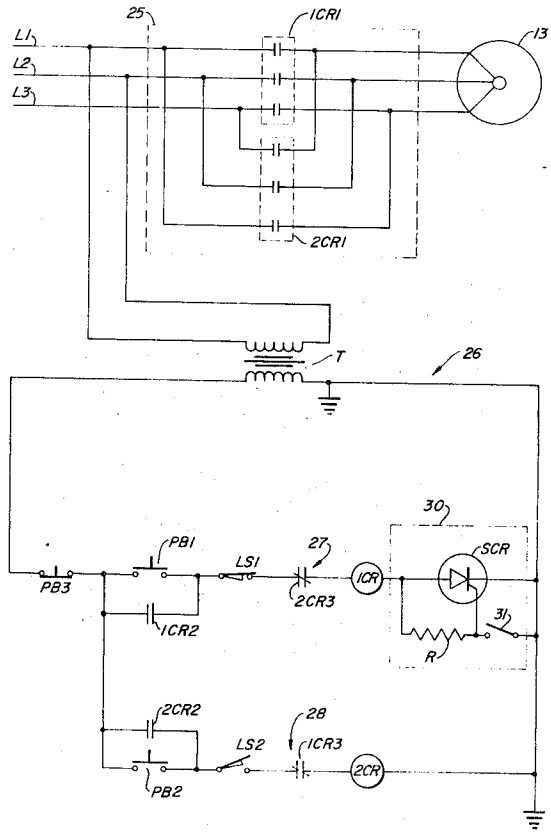
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Assistant Examiner—William J. Smith
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[57] **ABSTRACT**

An electrical control circuit for a door operator is provided having an electronic interlock. Doors or closures of the type for which this electrical control circuit and interlock are intended to be utilized are of a type known as a roll-up door having a plurality of hingedly interconnected slats or panels. This type of door may be opened through roll-up of the hinged slats. Closures of this type are often of a large physical size requiring electrically driven motors for operation. A control circuit is provided permitting selective operation of the electrical drive motor in the desired direction and mechanical locking means is usually provided to secure the closure in a closed provision relative to the opening. An interlock must be provided to prevent inadvertent operation when the mechanical lock is securing the closure in this closed position. The electrical control circuit of this invention incorporates an electronic interlock which prevents motor operation when the mechanical lock is engaged and prevents damage to the door operator and motor or permits operation with the mechanical lock disengaged.

6 Claims, 4 Drawing Figures



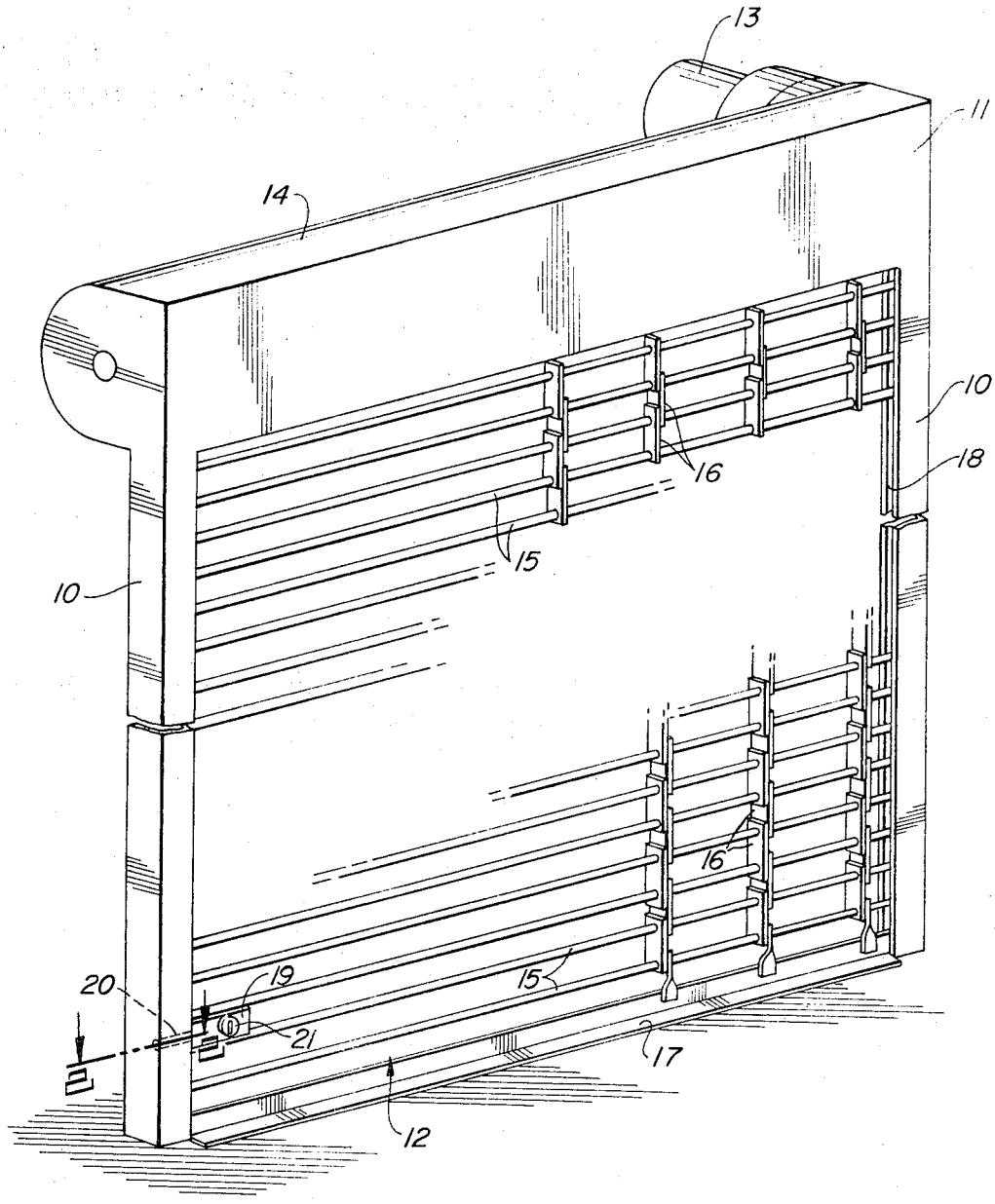
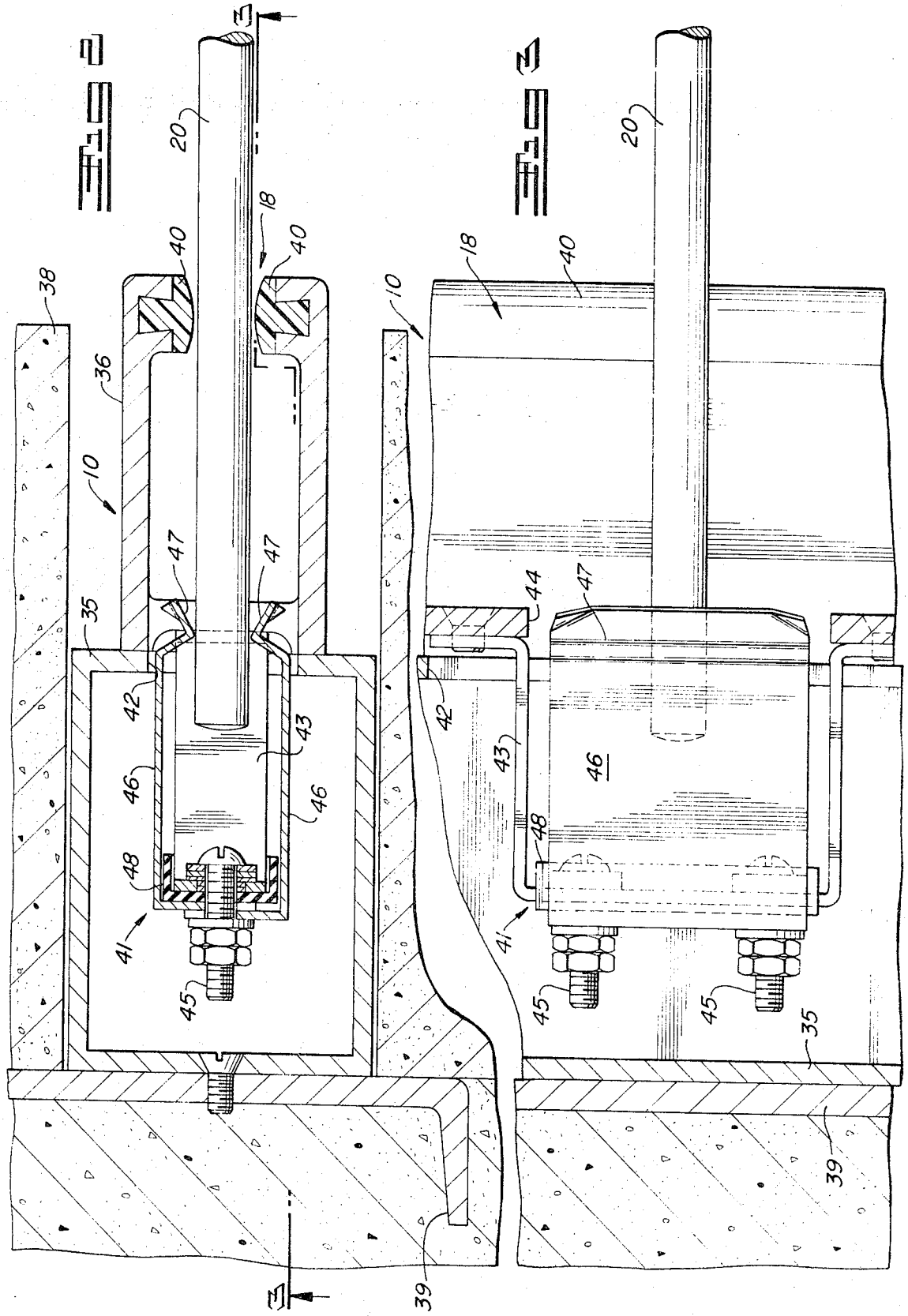


Fig 1


FIG 2
FIG 3
20
18
40
38
36
10
47
35
42
43
46
48
41
45
39
44

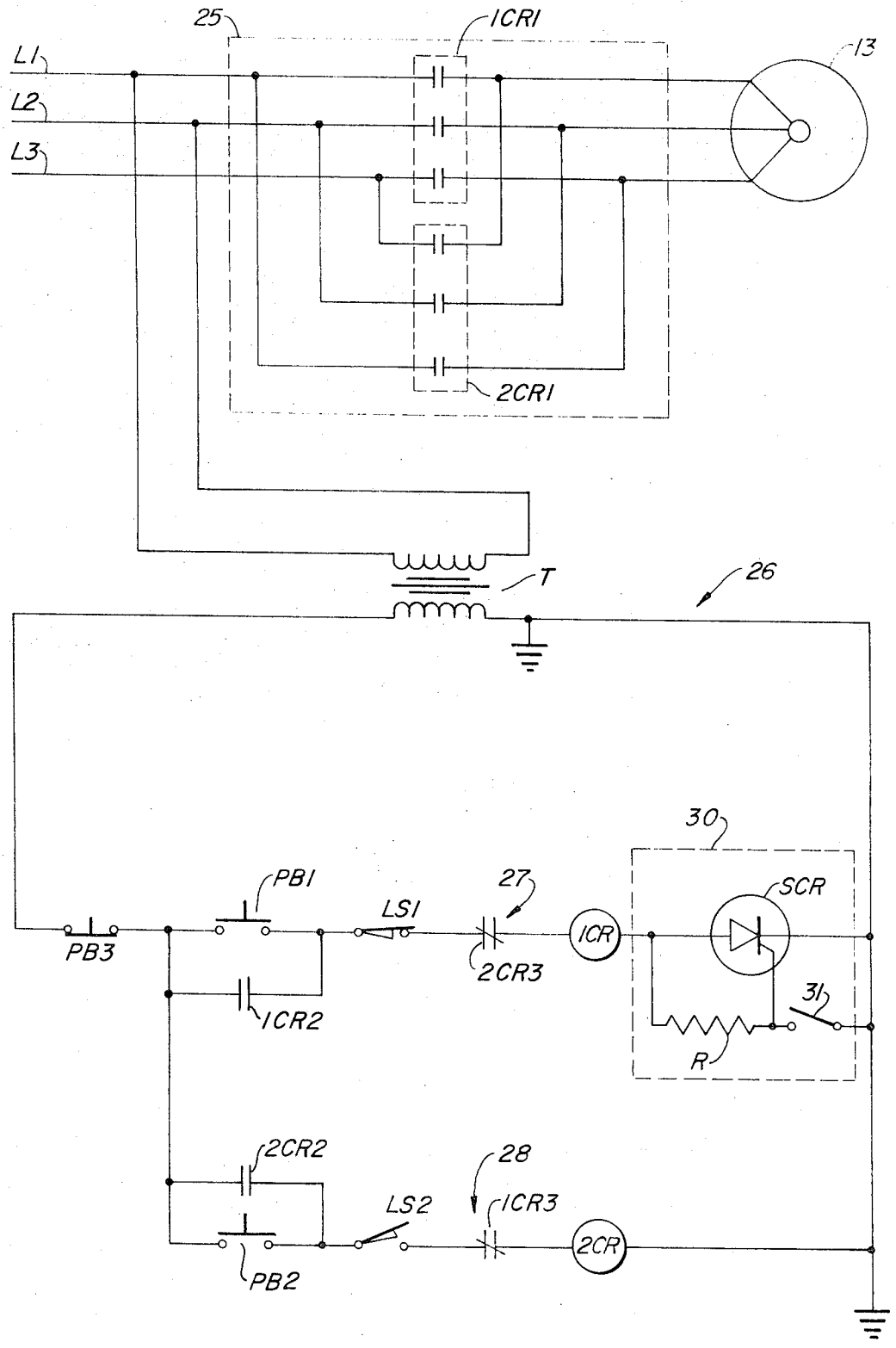

25
1CR1
13
L1
L2
L3
2CR1
T
26
30
PB1
27
SCR
LS1
PB3
1CR
2CR3
31
1CR2
R
2CR2
28
LS2
1CR3
2CR
PB2

Fig 4

ELECTRONIC INTERLOCK FOR DOOR OPERATOR

BACKGROUND OF THE INVENTION

It has been the prior practice to provide an interlock or means of preventing inadvertent operation of the electrical control circuit for door operators. The mechanical lock that is usually provided with a door of this type is a slidebolt carried by the movable door closure and which is selectively engageable with a socket in the door frame. Interlocking of the electrical control circuit in the prior art has been effected by means of mechanically actuated electrical switches. These electrical switches positioned on the door frame to be mechanically responsive to the door being closed and that the mechanical lock on the movable door is engaged with the door frame.

Mechanically actuated electrical switches utilized in prior art door control circuits must, of necessity, be physically positioned in or adjacent the door frame and are very susceptible to environmental conditions such as weather and physical damage. For example, these switches may be easily frozen in cold winter climates as a result of moisture accumulated on the switch and the switches may not be operable to prevent or to permit operation of the door operator control even though the mechanical lock has been appropriately actuated. Inadvertent operation of the door operator will accordingly result in damage to the driving motor or to the door structure, or both. Also, it may not be possible to open the door if the switch is inoperable and is in a position to prevent door operation even though the mechanical lock is unlocked.

SUMMARY OF THE INVENTION

An electrical control circuit for a door operator in accordance with this invention is provided with an electronic interlock that obviates failures of the interlock when the mechanical lock is engaged. This electronic interlock comprises an electronic switching circuit interposed in the door operator circuit and which will prevent operation of the door operator to move the door to an open position whenever the mechanical lock is engaged or permit operation when the mechanical lock is disengaged. In accordance with this invention, the mechanical lock also forms an electrical switch in the electronic switching circuit and is operable to prevent switching of the electronic switch to a conductive state whenever the mechanical lock is engaged and to permit switching of an electronic switch to a conductive state whenever the mechanical lock is disengaged. This combining of the electrical and mechanical interlocking features of such a door structure results in a novel control circuit and apparatus that prevents inadvertent damaging operation of the electrical circuit and door operator and permits operation whenever the mechanical lock is disengaged.

These and other objects and advantages of this invention will be readily apparent from the following detailed description of an embodiment thereof and the accompanying drawings.

DESCRIPTION OF THE DRAWING FIGURES

FIG. 1 is a perspective view of a door frame structure having a roll-type closure and provided with the electrical control circuit and electrical interlock of this invention.

FIG. 2 is a fragmentary horizontal sectional view on an enlarged scale taken along line 2—2 of FIG. 1.

FIG. 3 is a fragmentary vertical sectional view taken along line 3—3 of FIG. 2.

FIG. 4 is an electrical schematic of an electrical control circuit for a door operator and which is provided with the electronic interlock of this invention.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

FIG. 1 illustrates a typical door installation with which this invention may be advantageously utilized. This door installation comprises in general a rigid frame structure having a pair of vertical spaced apart uprights 10 and a horizontal beam 11 positioned at the upper end of the uprights and interconnecting with the uprights. The vertical uprights and horizontal beam combine to form a frame structure that is secured in the opening of a building structure that is not otherwise shown in any detail. Portions of such a building structure are illustrated as shown in FIGS. 2 and 3 to give a better perspective of the installation.

The vertical uprights 10 and horizontal beam 11 thus define a rectangular-shaped opening which is provided with a roll-type closure or door 12. The upper end of the door 12 is mechanically coupled with an operating mechanism that includes an electrical driving motor 13 and a rotatable reel 14 which is mechanically coupled with the motor. As is well known with this type of structure, the roll-type door is secured to the reel and thus operation of the motor 13 may be utilized in effecting movement of the door between the illustrated closed position and an open position where the door is rolled up on the reel 14. The illustrated roll-type door 12 comprises a plurality of horizontally disposed rods 15 that are hingedly interconnected by links 16. The lower end of the door is provided with a structural angle member 17. Each of the rods 15 is of a length to extend transversely of the door opening and project into a guide track 18 or slot provided in the respective vertical upright 10. Mechanically secured to the door 12 is a mechanical lock mechanism 19. This mechanical lock 19 comprises a structural frame that is secured to adjacent ones of the rods 15 and includes a horizontally movable slidebolt 20. A key actuated mechanism 21 incorporated in the mechanical lock 19 is selectively operable to move the slidebolt 20 to either a locking position or to an unlocked position.

An electrical control circuit for the illustrative door operator is schematically shown in FIG. 4. In this circuit, the electrical driving motor 13 is shown as being selectively connectable with a suitable electrical power source that is diagrammatically illustrated as power lines L1, L2, and L3. Energization of the motor 13 along with directional control permitting operation and movement of the door in either direction is effected through a reversing contactor 25 having two sets of contacts designated as 1CR1 and 2CR1 that are respectively actuated to open and close the door.

Also connected with the power source lines L1 and L2 is a control circuit generally designated by the numeral 26 and which preferably operates on a relatively lower voltage by means of a step-down voltage transformer T. Included in the control circuit 26 are the two branch circuits that are designated as a first or opening circuit 27, and a second or closing circuit 28. Each of the circuits 27 and 28 includes a relay coil 1CR and

2CR that are respectively energized for actuation of the associated contacts or sets of contacts 1CR1 and 2CR1 in the reversing contactor 25. Each of the circuits also includes an initiating circuit and a holding circuit comprising the respective push button contacts PB1 and PB2, and respective auxiliary relay contacts 1CR2 and 2CR2. The holding and initiating circuit components are series connected to the respective relay coil through protective limit switches LS1, LS2, and interlocking auxiliary relay contacts, 2CR3 and 1CR3. Protective limit switch LS1 is positioned on the door frame in relation to the door closure to be actuated to an open position when the door reaches an open position and thus de-energize this branch of the control circuit. Similarly, the protective limit switch LS2 is positioned to be actuated to an open position when the door reaches a closed position and thereby de-energize its respective circuit. A third push button switch PB3 is provided in series circuit with both branch circuits 27 and 28 to provide a means of de-energizing either circuit in the event of an emergency and is designated as an emergency stop switch. Also included in series with the relay coil 1CR in the opening circuit 27 is the electronic interlock switch 30 of this invention.

Operation generally of the control circuit can be best described with the assumption that the electronic interlock switch 30 is in a closed or conducting state. With the door in a closed position, the limit switch LS1 is closed, whereas the limit switch LS2 is open, consequently, momentary closing of push button switch PB1 will complete an electrical circuit through LS1 and the contacts 2CR3 to energize relay 1CR. Contacts 2CR3 are closed since relay 2CR is not energized. Energization of relay 1CR will result in closing of the set of contacts 1CR1 for energization of the motor 13 in driving the door to an open position. Energization of relay coil 1CR also closes its auxiliary contacts 1CR2 to complete a holding circuit obviating manual holding of switch PB1 in a closed position and also opens contacts 1CR3 to prevent inadvertent energization of coil 2CR. When the door reaches its uppermost position, limit switch LS1 is opened and de-energizes coil 1CR to disconnect the motor 13 from the power source.

With the door thus opened, limit switch LS2 is closed, and, if desired, switch PB2 may be momentarily closed to similarly energize its associated relay 2CR and close the set of contacts 2CR1 and energize the motor 13 for operation in a reverse direction or driving of the door to a closed position. The respective holding circuit formed by the contacts 2CR2 function in the same manner as with the first circuit 27 and the electrical interlock relay contacts 2CR3 will be opened to prevent inadvertent operation or energization of relay 1CR.

The electronic interlock switch 30 incorporated in the control circuit of this invention comprises an electronic switching transistor, commonly known as an SCR, in combination with a gating circuit. The gating circuit includes a resistor R and a switch 31. The resistor R is connected between the gating terminal of the SCR and the anode, and when switch 31 is opened, provides a gating circuit that switches the SCR to an ON or conducting state. Closing of the switch 31 grounds the gating terminal and connects the gating terminal with the SCR cathode and prevents a current flow to the gating terminal that would be sufficient to trigger the SCR to a conductive state. Consequently, the SCR will remain in an OFF or non-conducting state whenever the switch 31 is closed.

In accordance with this invention, switch 31 is combined with and forms a part of the mechanical lock 19. The structure of this switch is best seen by reference to FIGS. 2 and 3 which are enlarged sectional views of that portion of the vertical uprights 10 and associated portions of the building structure in the area of the mechanical lock 19. Each of the vertical uprights 10 may comprise a fabricated structure including a tubular box beam or column 35 and a channel-form guide track 36. This vertical upright 10 may be advantageously positioned in a channel-form socket constructed in a building wall 38 defining the door opening. For further structural integrity with the building, the vertical uprights 10 are also mechanically secured to a rigid frame member 39 of the building.

The rods 15 forming the roll-type closure or door 12 project through the open-slot 18 in the side of the guide track 36 as does the slidebolt 20. The rods 15 do not extend completely through the guide track 36 as does the slidebolt 20. Guide-bearing strips 40 are provided on opposite, inwardly-facing surfaces of the guide track 36 to minimize frictional resistance to movement of the door.

Secured to the guide track 36 and disposed within a central portion of the box column 35 is an electrical contact assembly 41. An aperture 42 is provided in the face of the box column 35 to admit the contact assembly 41, which includes a U-shaped mounting bracket 43 fastened to the guide tract 36 through which the slidebolt 20 is extendable to electrically and mechanically engage the electrical contact assembly 41. The aperture 44 also forms the socket that engages with the slidebolt 20 when the bolt is moved to a locking position and restricts movement of the door. Mechanically secured to the bracket 43 by the bolts 45 are two flexible contact plates 46 that project from the base of the bracket 43 into the apertures 42 and 44 terminating in parallel, V-shaped contacts 47. Electrical insulation 48 interposed between the plates 46 and the bracket 43 and the bolts 45 electrically isolates the plates and bolts and plates from the bracket.

One or both of the bolts 45 form a terminal of the contact assembly 41 electrically interconnected in the control circuit as schematically shown in FIG. 4. The contact plates 46 are thus electrically connected to the gate terminal of the SCR and form a fixed contact of the switch 31. Forming the movable contact of the switch 31 is the slidebolt 20 which is electrically grounded through the structure of the door 12. The door 12 is formed from an electrically conductive material and, for reasons of safety, all electrically conductive components of the door 12, doorway and building framing and electrically driven door operator, are electrically grounded, thus providing a very effective ground to complete the electrical circuit with respect to the gating circuit of the electronic interlock circuit. The cathode of the SCR is also connected to this same electrical ground.

Operation of this electronic interlock switch 30 was previously described and it will be readily understood that operation of the mechanical lock mechanism 19 is cooperative in effecting opening or closing of the electrical switch 31. With the door 12 in a closed position, key actuation of the mechanism 21 will extend the slidebolt 20 to the illustrated position of FIGS. 2 and 3

to mechanically lock the door **12** in a closed position through engagement of the bolt **20** in the aperture **44** formed in the guide track **36.** In this locking position, the slidebolt **20** is interposed between the contact plates **46** and is maintained in electrically contact therewith through the resiliency of the plates. This is an effective closing of the switch **31** and grounding of the gate terminal of the SCR which prevents the SCR from being switched to an ON or conductive state. Disengaging of the slidebolt **20** from the contact plates **46** by reversing the operation of the key mechanism **21** simultaneously mechanically unlocks the door **12** for opening thereof. This action effectively opens the switch **31** which permits the gating resistor R to switch the SCR to an ON or conductive state if the branch circuit **27** is otherwise configured to energize the relay 1CR.

It will be readily apparent that the electronic interlock switch provided by this invention effectively prevents operation of the control circuit to open the door whenever the mechanical lock mechanism is operated to mechanically lock the door. It will also be readily apparent that the operation of mechanically unlocking the door withdraws the bolt and is an action which effects a positive opening of the switch in the electronic interlock switch. This positive opening of that switch avoids having the door remain inoperative as is often the case with the prior art apparatus where the interlock switch was subject to malfunctions as a consequence of its exposed environment. The electronic switch of this invention is not subject to such environmentally caused manfunctions.

It is not intended that the specific illustrated door structure and mechanical lock be limitative as to the scope of the invention or its application. For example, the door may be of a type designated as a sectional having several sections hinged together with each section provided with rollers that are movable in a suitably configured guide track attached to the vertical sides of the door opening. The mechanical lock may merely comprise a manually operated slidebolt that is engageable with an appropriately configured socket or latch plate mounted in fixed relationship to the door opening. Also, the switch **41** may be modified to be adapted for operation with the particular style of slidebolt while maintaining its desired function.

Having thus described this invention, what is claimed is:

1. In combination with a door selectively movable between a closed and an open position relative to a door frame, an electrically energized door operator drivingly coupled with the door for effecting movement thereof, and mechanical locking means releasably interengageable with the door and door frame to secure the door in a closed position relative to the frame; an electrical control circuit interconnected with the door operator to effect energization thereof comprising:

first and second circuits alternatively energizeable to effect opening and closing of the door, respectively, when energized,

electrical switch means interposed in said first circuit and which may be selectively placed in either an electrically conductive or non-conductive state to control energization of said first circuit, said switch means responsive to the mechanical locking means as to be maintained in a non-conductive state when the locking means is interengaged with the door and frame and which may become electrically conductive when the locking means is disengaged.

2. The electrical control circuit of claim **1** in which said electrical switch means includes an electronic switching circuit having a first switch device series connected in said first circuit and a second switch device connected in circuit with said first switch device to control switching thereof between conductive and non-conductive states.

3. The electrical control circuit of claim **2** wherein said second switch device includes a first electrical contact electrically connected with said first switch device and a second electrical contact comprising a movable element of the mechanical locking means, said movable element interconnected in the electronic control circuit.

4. The electrical control circuit of claim **3** wherein said first switching device is a solid state switch having a gating terminal, an anode terminal and a cathode terminal whereby said solid state switch may be switched between conducting and non-conducting states, said second switch device connected with said gating terminal and said cathode terminal.

5. The electrical control circuit of claim **4** having a gating circuit connected between said anode terminal and said gating terminal.

6. The electrical control circuit of claim **3** wherein said second switch is closed when said movable element is in a locking position maintaining said first switching device in a non-conducting state, said second switch is open when said movable element is in an unlocked position permitting said first switching device to switch to a conducting state.

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