

July 12, 1949.

C. OPALEK

2,476,111

MECHANISM FOR AUTOMATIC STOPPING AND REVERSAL
OF ELECTROMECHANICALLY OPERATED DOORS

Filed July 7, 1945

4 Sheets-Sheet 1

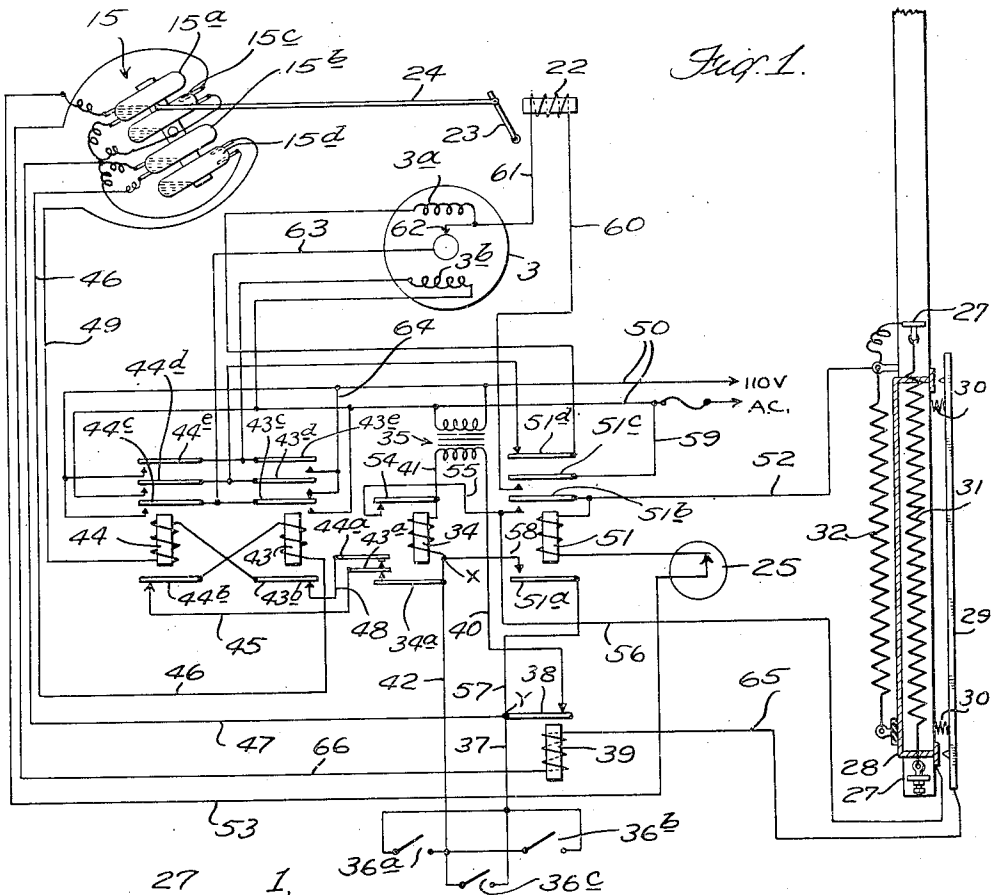


Fig. 1.

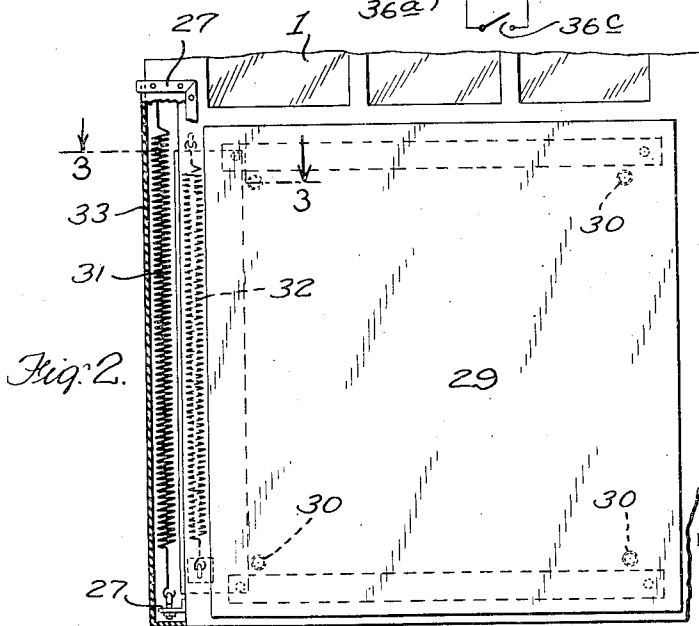


Fig. 2.

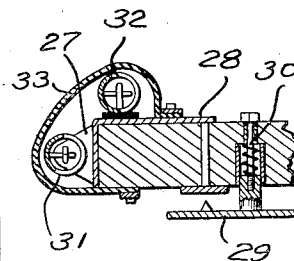


Fig. 3.

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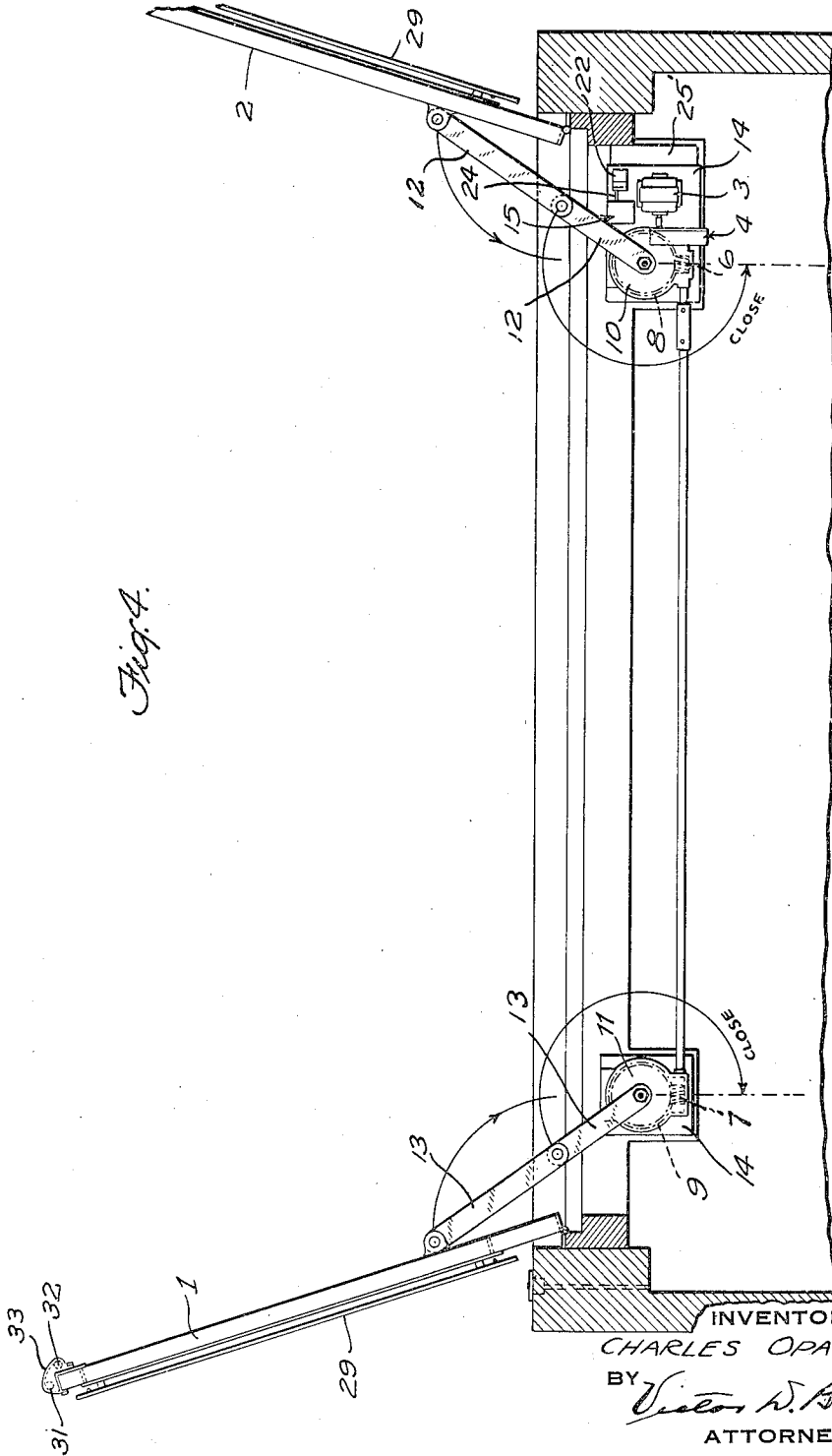
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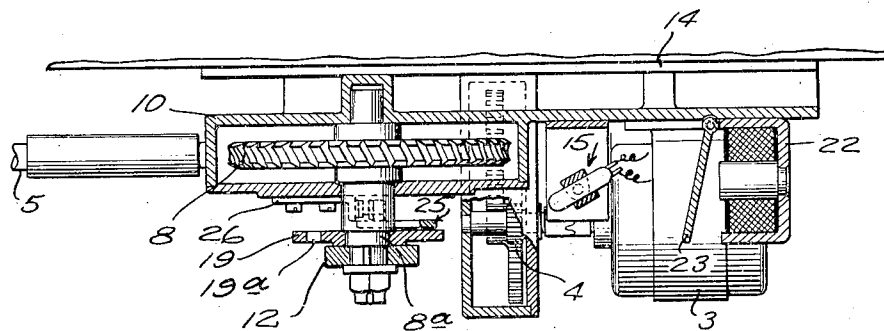
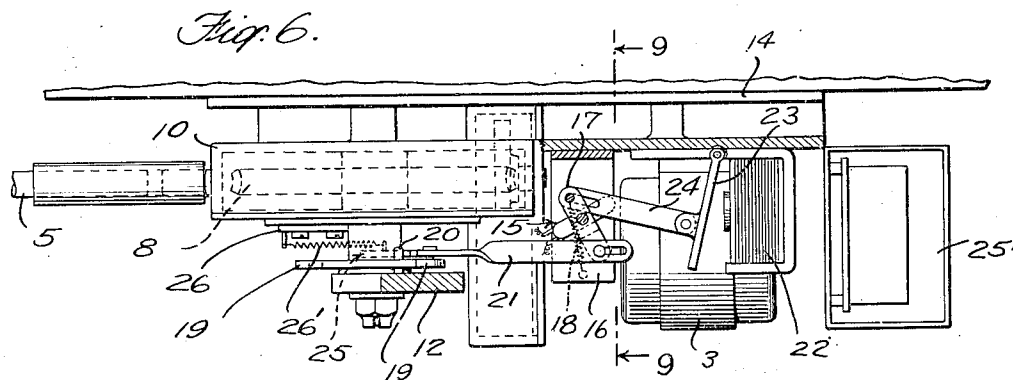
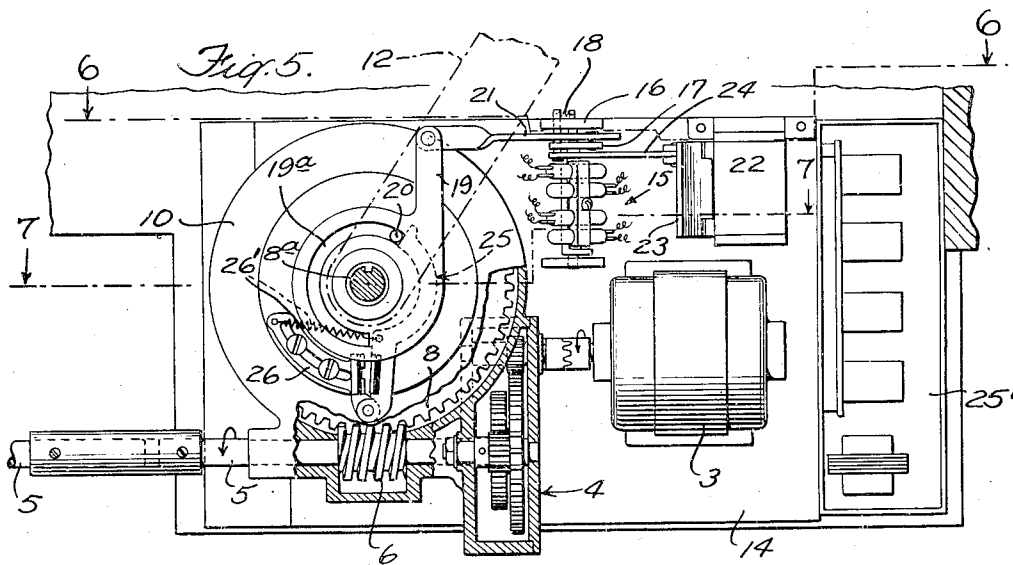
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MECHANISM FOR AUTOMATIC STOPPING AND REVERSAL
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4 Sheets-Sheet 3



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MECHANISM FOR AUTOMATIC STOPPING AND REVERSAL
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Fig. 8.

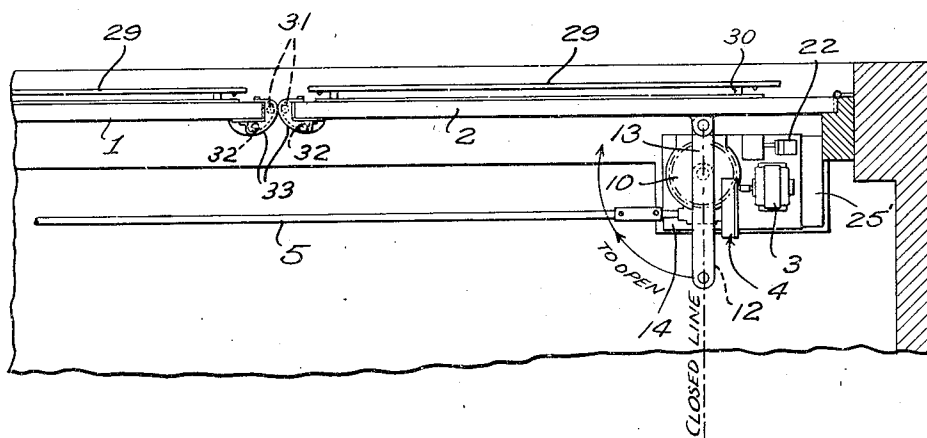


Fig. 9.

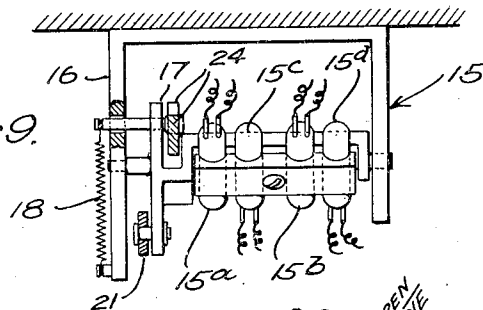


Fig. 10.

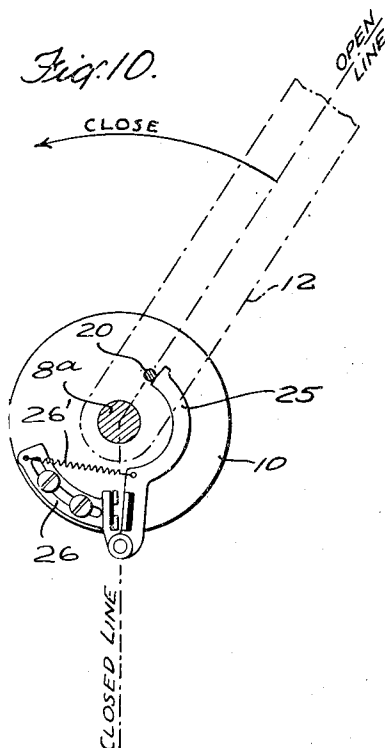
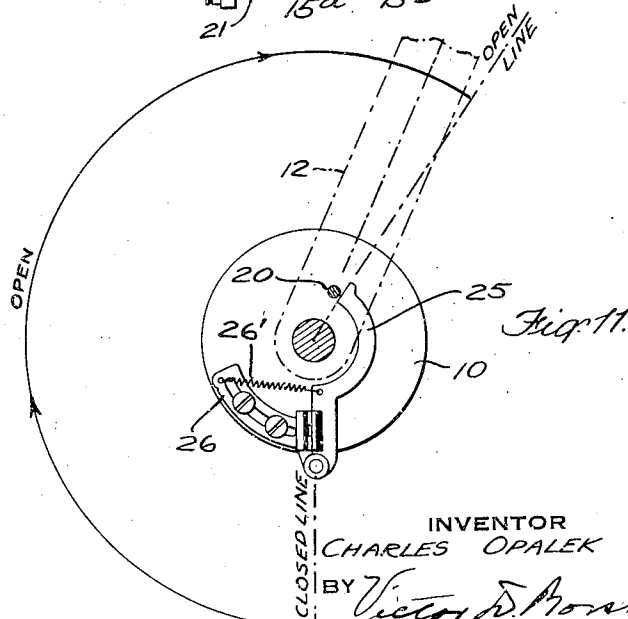


Fig. 11.



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UNITED STATES PATENT OFFICE

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MECHANISM FOR AUTOMATIC STOPPING
AND REVERSAL OF ELECTROMECHANICALLY OPERATED DOORS

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Application July 7, 1945, Serial No. 603,721

12 Claims. (Cl. 268—63)

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This invention is related to and constitutes an addition to my invention disclosed and patented in Letters Patent Nos. 2,342,597 and 2,366,048.

In those prior patents are disclosed a system and mechanism for automatically effecting the operation of doors, such as garage doors, under the control of manual switches either within or outside the garage.

The purpose of this invention is to add to such system and mechanism safety means for avoiding damage or injury in case the doors encounter an obstruction during their movement either toward closed or open position.

Preferably the means of this invention will operate to reverse the power device if an obstruction is met while a door is closing and thus cause the partially closed door to return to open position. As a precautionary measure in case an obstruction is met while a door is opening, it will ordinarily suffice to disable the power device, as, for example, to open the circuit of an electric motor and avoid damaging the motor.

The objects and advantages of the invention will be understood from the following description of the embodiment of the invention illustrated in the accompanying drawings, in which

Figs. 1 is a diagram of the electrical system.

Fig. 2 is an elevation, partly in section, of the lower part of a door equipped with the contacts forming part of the system.

Fig. 3 is an enlarged fragmentary section on line 3—3 of Fig. 2.

Fig. 4 is a bottom plan view with the door frame in section, showing the doors open and the operating mechanism as viewed by one standing in the doorway and looking up.

Fig. 5 is a view similar to Fig. 4 on an enlarged scale and partially in section, of the operating mechanism shown for the right hand door in Fig. 4.

Fig. 6 is an elevation, partly in section, as indicated on the line 6—6 of Fig. 5.

Fig. 7 is a sectional elevation on the line 7—7 of Fig. 5.

Fig. 8 is a view similar to Fig. 4 of the right hand door and part of the left hand door and the operating mechanism therefor, showing the doors closed.

Fig. 9 is a detail in side elevation, indicated by the line 9—9 in Fig. 6, of the reversing switch and its support with the operating links in section.

Fig. 10 is an underside view of the gear box and cut-out switch thereon and indicating the position of the parts when the switch is open.

Fig. 11 is a view similar to Fig. 10 but indicat-

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ing the position of the parts when the arm has moved substantially 10° from its extreme open position, allowing the switch to close.

The invention is shown as applied to swinging doors, but it will be understood that it is equally applicable to so-called overhead doors, that is, doors that articulate and slide up and down to open and close.

Primarily the illustrated embodiment is designed to prevent injury to one caught in between the two doors as their proximate edges approach each other, and in the form shown the doors are equipped at or near their free edges with yieldable contacts that cooperate with fixed contacts on the door to close an electric circuit and thereby operate mechanism that will reverse the motor. Preferably the yieldable contacts, such as springs, are covered with a protective fabric such as leather or rubber.

The doors 1 and 2 are operated, as shown in my said patents, by an electric motor 3 which through reducing gearing 4 operates a worm shaft 5 having worms 6 and 7 that mesh with and drive worm gears 8 and 9, respectively, in their respective gear boxes 10 and 11. Toggle linkage 12 connects the shaft of worm wheel 8 to door 2 and similar linkage 13 connects the shaft of worm wheel 9 with door 1. The motor and the associated mechanism just described is secured on the underside of the top of the door frame by a plate 14 on each end attached to the frame by bosses or other suitable means.

A reversible switch 15 of the mercury type is pivotally mounted in the depending arms of an inverted U-shape bracket 16 secured to the same plate 14 as is the motor 3 and disposed between the motor and the reduction gearing 4 with its axis at right angles to the worm shaft 5. The switch 15 is a quadruple switch with two pairs of contact elements 15a and 15b closed with the switch in one position and the other two pairs 15c and 15d closed when the switch is reversed. For reversing the switch it has a lever arm 17 on its shaft extending radially therefrom in opposite directions and actuated by means to be described. A coiled spring 18 is fastened at one end to an arm of the bracket 16 and at its other end to the arm 17 and operates to snap the switch over quickly as it passes center.

Loosely mounted on the shaft 8a of the worm wheel 8 immediately above the link arm 12 is a cam lever 19 having an arcuate slot 19a therein into which extends a pin 20 on the arm 12. The cam lever 19 is connected to a pin on the lower end of the switch arm 17 by a link 21, the link

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having a slot into which the pin engages so as to permit of the snap over of the switch by the spring 18. The length of the arcuate slot 19a and the disposition of the cam lever 19 relative to the pin 20 are such that the link 21 reverses the switch near the end of movement of the arm 12 in both opening and closing the door.

A magnet 22, which I term a reopen magnet, is also secured on the plate 14 alongside the motor 3 and opposite the switch 15. A pivoted armature 23 of the magnet 22 is attached by link 24 to a pin on the other end of the switch arm 17, the link having a slot into which the pin engages so as to permit reciprocation of the switch under the influence of link 21, without interference of link 24, under circumstances that will be later explained. A relay box 25' may be disposed adjacent the motor, as shown.

The reopen magnet 22 is energized when the doors meet an obstruction on their way shut, and the magnet then operates to reverse the switch and thus reverse the motor and open the doors. This can occur, of course, only when the arm 12 and hence the pin 20 has moved sufficiently from the extreme open position to allow the cam lever 19 to turn as much as the reversal of the switch requires. Consequently I provide a cut-out switch 25 also under the control of the pin 20 which opens and closes contacts in the control circuit for the reopen magnet, as will appear from the wiring diagram later to be explained. The switch 25 is pivoted on an adjustable plate 26 on the gear box 10, immediately above the cam lever 19, and the pin 20 extends up through the slot 19a far enough to engage the end of the switch, as shown in Figs. 5 and 6.

The control of this switch by the arm 12 is especially shown in Figs. 10 and 11, from which it will be seen that the pin 20 engages the member 25 and opens the switch in the extreme open position of the door, substantially within the angular distance of 10° from the open line position of the arm 12. A coil spring 26' urges the member 25 in the direction to close the switch.

Both doors have a metallic contact strip 27, the two strips being electrically connected in parallel into one side of a reopen relay circuit which functions in a manner to be described. Both doors also have secured over the lower portion of their free edges an angle plate 28 which covers the edge and overlaps the inner face of the door, the two plates being electrically connected in parallel to the common return lead of the reopen relay and of a stop relay, as will appear. Also both doors have on their outer face a contact plate 29, adapted to make contact with the angle plate 28 when, for example, engaged by a relatively stationary body as the door opens, but normally held out of contact by springs 30, as particularly shown in Fig. 3. The two plates 29 are connected in parallel to one side of the stop relay.

Spring contact members 31 and 32 are vertically disposed on each door opposite and extending the full height of the plate 28 but insulated therefrom and normally out of contact therewith but positioned to be pressed into contact with the plate 28 when either spring engages a relatively stationary body as the door is closing. The two spring contacts are connected to the contact strip 27, and they are protected by a leather or rubber covering 33.

The safety features of the system to which this invention relates are engrafted upon the door

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operating system which is shown in the diagram of Fig. 1 and in the main is the same as that shown and described in my said prior patents. It will, therefore, not be necessary to explain in detail that much of the system as is common to the disclosure of my prior patents.

The master control relay 34 is energized from the secondary of transformer 35 when either one of the button contacts 36a, 36b and 36c is closed, through lead 37, normally closed armature contact 38 of the stop relay 39, lead 40, secondary winding of the transformer, lead 41, winding of relay 34 and lead 42 back to the other side of the button contact.

This energizing of relay 34 attracts its armature 34a and thus closes contacts with normally open contact members 43a and 44a in circuit with the windings of motor control solenoids 43 and 44, respectively, through reciprocal cut-out switches 43b and 44b arranged, as shown, so that each solenoid when energized opens the circuit for the other solenoid. Thus the energization of relay 34 sets up the circuit for one or the other of the solenoids 43 and 44 depending upon the position of the switch 15. However, the circuit for the motor control solenoids 43 and 44 is short circuited at points X and Y as long as the button contact is held closed.

The solenoid 43 acts to energize the motor 3 in a direction to close the doors, and the solenoid 44 acts to energize the motor in a direction to open the doors. Switch element 15b is in circuit with solenoid 43, and switch element 15d is in circuit with solenoid 44. Therefore, when the switch 15 is in the position shown in Fig. 1 and the armature 34a is up, the circuit of the closing solenoid is closed from the transformer through wire 41, winding of relay 34, armature 34a, movable contact 43a, wire 45, contact 44b, winding of solenoid 43, wire 46, switch element 15b, common return 47 to point Y, and thence to armature 38 and wire 40 back to the transformer.

With the switch 15 reversed and the armature 34a up, the circuit of the opening solenoid 44 is closed from point X and armature 34a back to point Y through movable contact 44a, wire 48, contact 43b, winding of solenoid 44, wire 49, switch element 15d and common return 47.

Each solenoid 43 and 44 controls three armature operated contacts which determine the direction in which the starting coil 3a of motor 3 is connected across the supply line 50 and also effect the connection of the running coil 3b across the line. Also the closing solenoid cooperates in control of the energization of the reopen magnet 22.

The solenoid 43 actuates three contact armatures 43c, 43d and 43e, and solenoid 44 actuates three contact armatures 44c, 44d and 44e. The fixed contacts for armatures 43e and 44e are both connected with the same side of the line, but the fixed contacts of the other two armatures of the two solenoids are respectively connected to opposite sides of the line. The leads of the running coil of the motor are connected, one to one side of the line and the other to the armatures 43e and 44e, the fixed contacts of which are connected to the other side of the line. One lead of the starting coil is connected to armatures 43d and 44d, and the other lead is connected to armatures 43c and 44c. Therefore it is evident that the switching from one solenoid to the other reverses the starting coil but merely continues the energization of the running coil. Hence the direction of operation of the motor depends upon

which solenoid is energized and therefore upon the position of the switch.

In addition to the three relays or solenoids 34, 43 and 44 which are present also in the system disclosed in my prior patents, this system also employs a fourth relay 51 which I term the reopen relay. This relay controls four contact armatures, the contacts of three of which are normally open and the fourth of which is normally closed, and this relay is energized when a spring contact 31 or 32 is caused to engage plate 28 and the switch 15 is in closing position as shown in Fig. 1, the circuit being closed as follows: spring contact 31 or 32, wire 52, winding of relay 51, contact 25, wire 53, element 15a of the switch, common return 47, contact 38, wire 40, transformer 35, wire 41, back contact 54 controlled by relay 34, wire 55 and wire 56 back to the plate 28. This attracts armature 51a and closes a short across points X and Y through wire 57, armature contact 51a and wire 58. The closing solenoid 43 is thus short circuited and the motor circuit is broken, while relay 34 is kept energized.

At the same time relay 51 attracts armature 51b and closes a holding circuit for itself as follows: from the transformer through wire 41, contact 54, wire 55, contact 51b, winding of relay 51, switch 25, wire 53, switch element 15a, return wire 47, contact 38 and wire 40 back to the transformer. Hence relay 51 stays energized until the switch is reversed, whether or not the spring contact is longer held against plate 28.

Relay 51 also attracts armatures 51c and 51d, the former closing a contact of the reopen magnet 22 and connecting one side of the magnet to one side of the line through wire 59, contact 51c and wire 60.

Armature 51d is the movable part of a normally closed contact in the lead which provides the connection between one side of the motor starting coil 3a and the armature contacts 43d and 44d. Hence when the relay 51 is energized the circuit for the starting coil is broken at contact 51d.

The other side of the starting coil is connected to wire 61 which connects the side of the reopen magnet 22 opposite its connection to wire 60, with a centrifugal contact 62 that breaks contact with the commutator when the motor is running and makes contact when the speed falls below a certain value. The commutator is connected by wire 63 to the armatures 43c and 44c.

Now it will be seen that when armature 51c is attracted and the motor is at rest or below a certain speed so that centrifugal contact 62 is closed, the reopen magnet is connected across the line through wire 59, contact 51c, wire 60, coil 22, wire 61, contact 62 including the commutator, wire 63, armature 43c, a front contact for armature 43c and wire 64 to the other side of the line.

The operation of the safety feature may now be followed. It will be assumed that the switch is in the closing position shown in Fig. 1 and that a button has been pushed to close the door, thus setting up the circuit of closing solenoid 43 and starting the motor in the direction to close the door, as above explained. Then it will be assumed that one of the doors on its closing movement encounters an obstruction so as to deflect one of the safety spring contacts against plate 28.

This energizes reopen relay 51 through the circuit above traced. This closes the holding circuit through contact 51b and also short circuits points X and Y through closing of contact 51a. It also closes the connection through contact 51c be-

tween one side of reopen magnet 22 and one side of the line.

The short circuit between points X and Y deenergizes the closing solenoid 43 and releases its contacts, thus stopping the motor. The centrifugal contact 62 is therefore closed and the circuit of the reopen magnet is thus closed to the other side of the line. The starting coil is not closed, however, being open at contact 51d so long as relay 51 is energized.

The above assumes that the door had closed far enough from its fully open position to effect a closing of switch 25, otherwise, of course, the circuit of relay 51 would not have been completed.

The energizing of magnet 22 causes the armature 23 to be attracted which reverses the switch and throws it over to opening position. This sets up the circuit for opening solenoid 44, the master relay 34 being energized and holding contact 44a in the circuit as long as the short circuit between points X and Y continues. The reversal of the switch breaks the circuit of relay 51, but the release of contact 51a is timed so as to succeed the closing of the circuit for solenoid 44, and hence the energization of relay 34 and the continuing of contact 44a in the circuit is not interrupted.

The opening of the circuit for the reopen relay 51 removes the short from the circuit through the opening solenoid 44. It also effects the closing of the starting coil circuit at contact 51d, with the result that the motor promptly starts in the other direction and moves the door toward open position away from the obstruction.

The plate 29 and the stop solenoid 39 operate to stop the motor when an obstruction is encountered during the opening movement of the door. During that movement the switch is in the opposite position from that shown. Then if plate 29 is made to contact plate 28 the circuit through solenoid 39 is closed as follows: from plate 29 through wire 65, coil 39, wire 66, switch element 15c, return wire 47, contact 38, wire 40, the transformer coil, wire 41, contact 54, wire 55 and wire 56 back to plate 28.

This attracts armature 38 and breaks the circuit of relay 34. Incidentally it breaks the circuit of the stop solenoid 39 also, but the return of armature 38 is timed so that relay 34 is surely deenergized.

It is obvious that changes may be made in the construction shown in the drawings and above particularly described within the principle and scope of the invention.

I claim:

1. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by the said connected means and arranged to connect the motor selectively in reverse directions to the source of power, an electro-magnetic power device connected to the reversible switch and operative when energized to move the switch from its closing position to its opening position, a relay in control of the power device, and means for energizing the relay including normally open contact elements carried by the door and adapted to be closed by engagement with a relatively stationary body.

2. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by the said connected means and arranged to connect the motor selectively in reverse directions to the source of pow-

er, an electro-magnetic power device connected to the reversible switch and operative when energized to move the switch from its closing position to its opening position, a relay in control of the power device, a circuit adapted to connect the relay with the source of electric power including normally open contact elements carried by the door and adapted to be closed by engagement with a relatively stationary body, a normally closed cut-off switch in said circuit, and means operated by the said connected means near the limit of the opening movement of the door to open the cut-off switch.

3. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by the said connected means, a pair of solenoids having corresponding ends connected respectively to opposite sides of the switch and having their other ends connected in parallel to a common lead connectible to the source of electric power, reversing contacts controlled respectively by the solenoids and adapted to connect the motor selectively in reverse directions to the source of power, a shunt circuit connected across the solenoids and adapted when closed to short circuit the solenoids and including a normally open contact, a relay adapted when energized to close the said contact, and means for connecting the relay in circuit with the source of power, said means including the reversing switch and normally open contact elements carried by the door in position to be closed when engaged by a relatively stationary body as the door is closing.

4. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by the said reversing means, a pair of solenoids having corresponding ends connected respectively to opposite sides of the switch and having their other ends connected in parallel to a common lead connectible to the source of electric power, reversing contacts controlled respectively by the solenoids and adapted to connect the motor selectively in reverse directions to the source of power, a shunt circuit connected across the solenoids and adapted when closed to short circuit the solenoids and including a normally open contact, a relay adapted when energized to close the said contact, means for connecting the relay in circuit with the source of power, said means including the reversing switch and normally open contact elements carried by the door in position to be closed when engaged by a relatively stationary body as the door is closing, a normally closed cut-off switch in the relay circuit, and means operated by the door near the limit of its opening movement to open the cut-off switch.

5. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by the said connected means, a pair of solenoids having corresponding ends connected respectively to opposite sides of the switch and having their other ends connected in parallel to a common lead connectible to the source of electric power, reversing contacts controlled respectively by the solenoids and adapted to connect the motor selectively in reverse directions to the source of power, a shunt circuit connected across the solenoids and adapted when closed to short circuit the solenoids and including a normally open contact, a relay adapted

when energized to close the said contact, means for connecting the relay in circuit with the source of power, said means including normally open contact elements carried by the door in position to be closed when engaged by a relatively stationary body as the door is closing, a reopen magnet connected to the reversing switch and operative to move the switch from its closing position to its opening position, and an energizing circuit for the magnet including a normally open contact adapted to be closed by the relay.

6. The combination of a door, a source of electric power, a reversible electric motor and means connected therewith to operate the door, a reversible switch arranged to connect the motor selectively in reverse directions to the source of power, a reopen magnet including an armature, a lost motion connection between the armature and the switch adapted to allow the switch to reverse freely when the armature is unattracted and to move the switch from closing to opening position when the armature is attracted, a pivoted lever having operative connection with the switch, means operated by the said connected means to reciprocate the lever at the limits of movement of the door and thus reverse the switch, a relay in control of the reopen magnet, and means for energizing the relay including normally open contact elements carried by the door and adapted to be closed by engagement with a relatively stationary body.

7. The combination of a door, a source of electric power, a reversible electric motor and means connected therewith to operate the door, a reversible switch arranged to connect the motor selectively in reverse directions to the source of power, a reopen magnet including an armature, a lost motion connection between the armature and the switch adapted to allow the switch to reverse freely when the armature is unattracted and to move the switch from closing to opening position when the armature is attracted, a pivoted lever having operative connection with the switch, means operated by the said connected means to reciprocate the lever at the limits of movement of the door and thus reverse the switch, a relay in control of the reopen magnet, a circuit adapted to connect the relay with the source of electric power including normally open contact elements carried by the door and adapted to be closed by engagement with a relatively stationary body, a normally closed cut-off switch in said circuit, and means operated by the said connected means near the limit of the opening movement of the door to open the cut-off switch.

8. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by the said connected means, a pair of solenoids having corresponding ends connected respectively to opposite sides of the switch and having their other ends connected in parallel to a common lead connectible to the source of electric power, reversing contacts controlled respectively by the solenoids and adapted to connect the motor selectively in reverse directions to the source of power, a normally closed stop switch in the common lead, a stop solenoid operative when energized to open the stop switch, and a circuit for connecting the stop solenoid to the source of power including the reversing switch and a normally open contact member carried by the door and adapted to close the circuit when

engaged by a relatively stationary body as the door moves.

9. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by the said connected means, a pair of motor controlling solenoids having corresponding ends connected respectively to opposite sides of the switch and having their other ends connected in parallel to a common lead connectible to the source of electric power, reversing contacts controlled respectively by the motor controlling solenoids and adapted to connect the motor selectively in reverse directions to the source of electric power, a normally closed stop switch in the common lead, a stop solenoid operative when energized to open the stop switch, and a circuit for connecting the stop solenoid to the source of electric power including the reversing switch and a normally open contact member carried by the outer face of the door and adapted to close the circuit when engaged by a relatively stationary body as the door is opening.

10. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by the said connected means, a pair of motor controlling solenoids having corresponding ends connected respectively to opposite sides of the switch and having their other ends connected in parallel to a common lead connectible to the source of electric power, reversing contacts controlled respectively by the motor controlling solenoids and adapted to connect the motor selectively in reverse directions to the source of electric power, a normally closed stop switch in the common lead, a stop solenoid operative when energized to open the stop switch, a circuit for connecting the stop solenoid to the source of electric power including the reversible switch and a normally open contact member carried by the outer face of the door and adapted to close the circuit when engaged by a relatively stationary body as the door is opening, a shunt circuit connected across the motor controlling solenoids and including a normally open contact, a relay adapted when energized to close the said contact, and means for connecting the relay in circuit with the source of power, said means including the reversible switch and normally open contact elements carried by the door in position to be closed when engaged by a relatively stationary body as the door is closing.

11. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a re-

versible switch operated by the said connected means, a pair of motor controlling solenoids having corresponding ends connected respectively to opposite sides of the switch and having their other ends connected in parallel to a common lead connectible to the source of electric power, reversing contacts controlled respectively by the motor controlling solenoids and adapted to connect the motor selectively in reverse directions to the source of electric power, a normally closed stop switch in the common lead, a stop solenoid operative when energized to open the stop switch, a circuit for connecting the stop solenoid to the source of electric power including the reversible switch and a normally open contact member carried by the outer face of the door and adapted to close the circuit when engaged by a relatively stationary body as the door is opening, an electromagnetic power device connected to the reversible switch and operative when energized to move the switch from its closing to its opening position, a relay in control of the power device, and means for energizing the relay including the reversible switch and normally open contact elements carried by the door and adapted to be closed by engagement with a relatively stationary body.

12. The combination of a door, a reversible electric motor and means connected therewith to operate the door, a source of electric power, a reversible switch operated by said connected means, a motor control circuit for controlling the connection of the motor to the power source controlled by the reversing switch and including a normally closed contact, a stop solenoid operative when energized to open the normally closed contact, and a circuit for connecting the stop solenoid to the source of electric power including the reversible switch, and a normally open contact member carried by the outer face of the door and adapted to close the circuit for the stop solenoid when engaged by a relatively stationary body as the door is opening.

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