Feb. 4, 1930. H. B. GOLDMAN 1,745,990

AUTOMATIC STOPPING AND REVERSAL OF ELECTROMECHANICALLY OPERATED DOORS AND THE LIKE

Filed Feb. 9, 1929 2 Sheets-Sheet 1

Fig. 1.

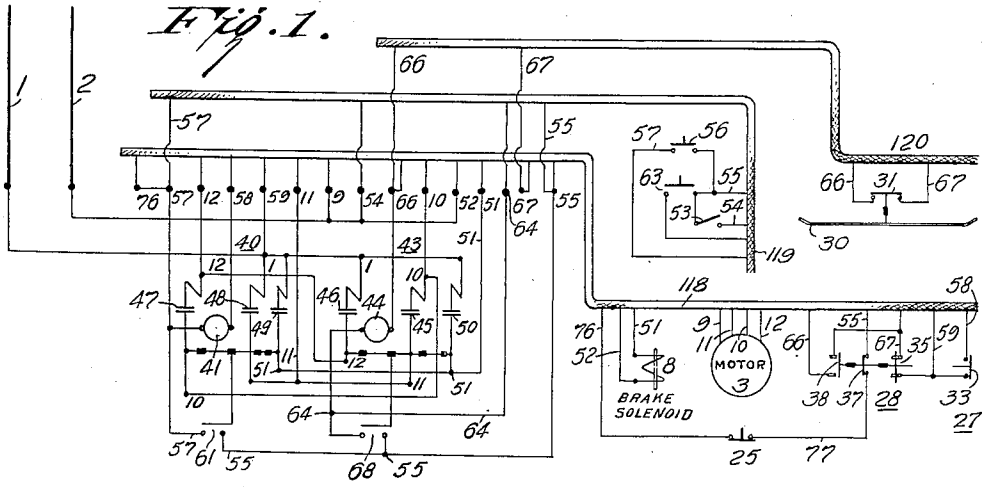


Fig. 2.

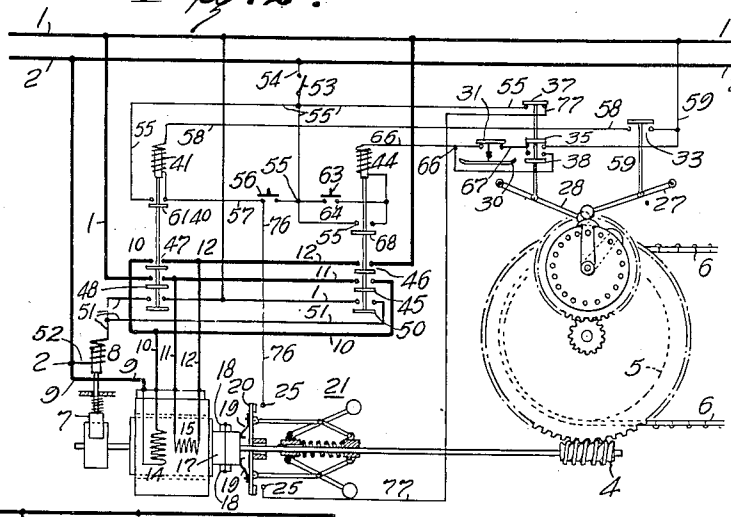
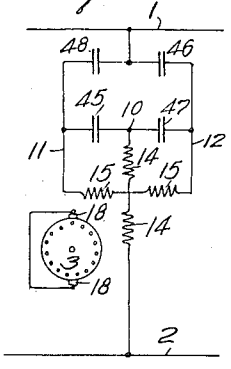


Fig. 3.



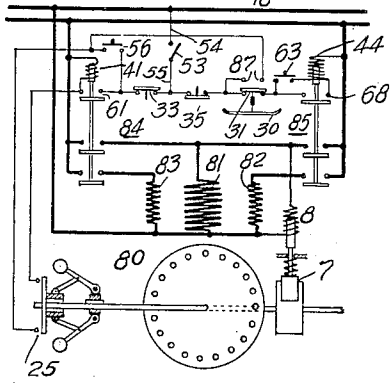


Fig. 4.

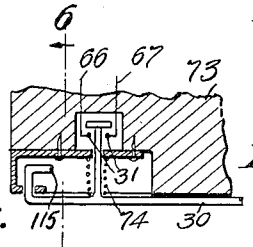


Fig. 5.

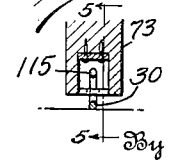


Fig. 6.

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Fig. 7.

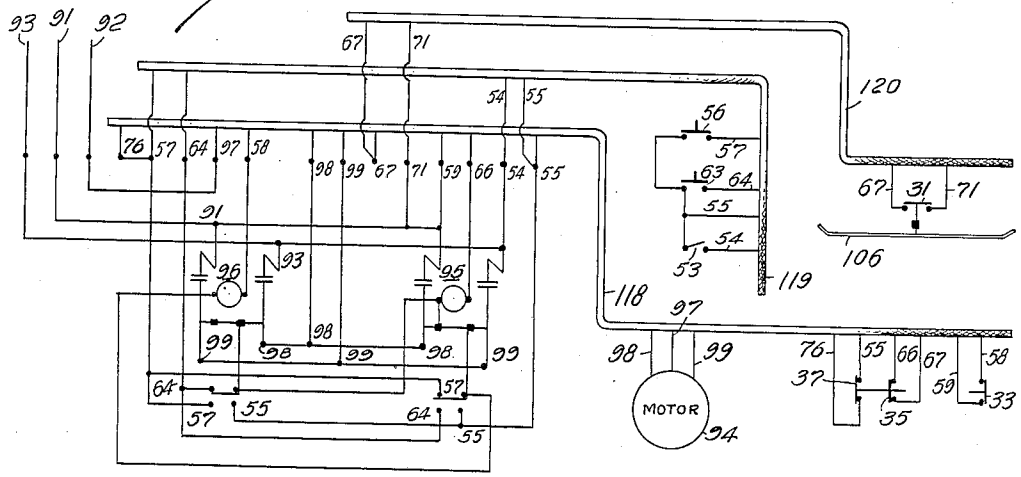
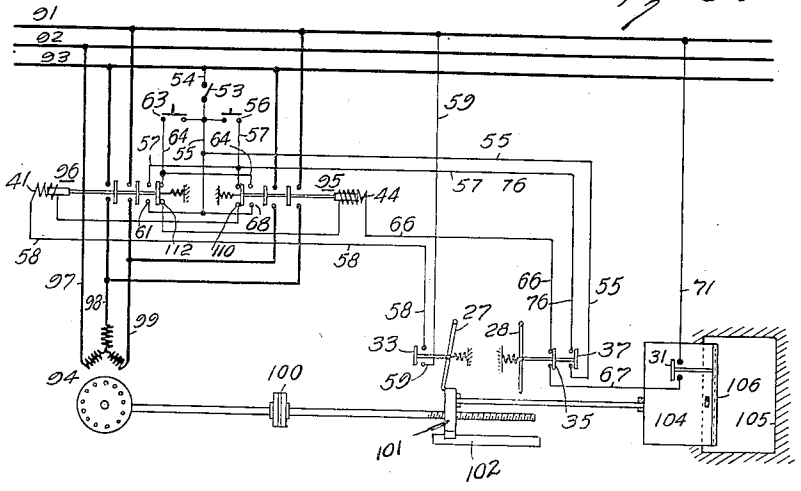


Fig. 8.



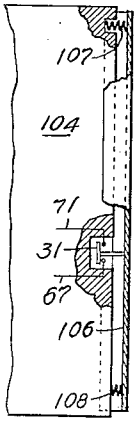
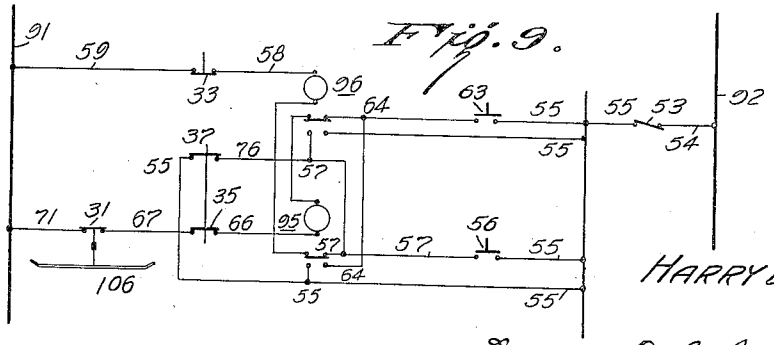


Fig. 10.

Fig. 9.



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UNITED STATES PATENT OFFICE

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AUTOMATIC STOPPING AND REVERSAL OF ELECTROMECHANICALLY-OPERATED DOORS AND THE LIKE

Application filed February 9, 1929. Serial No. 338,683.

My invention relates to a door-reversing guard as applied to motor-driven overhead doors, and it also relates to a non-jamming mechanism as applied to automatically operated elevator doors, whereby the door will be automatically opened wide if it strikes an obstruction while closing.

As applied to overhead doors, my invention is particularly designed for the "Door mechanisms," shown in a Patent No. 1,661,719, granted March 6, 1928, to Roy M. Edwards and Julius P. Poschen. Such doors vary, in size, from the smallest garage door, to doors weighing several tons, and are made with a number of narrow horizontal panels which are hinged together and are guided in channels which carry the door back into a horizontal overhead position when the door is raised or opened. The operation of the door is effected by means of a motor.

If such a door should strike an obstruction, such as an automobile top, while it was closing, the only protection which could be obtained prior to my invention was to trip out a circuit breaker on the motor or to slip a clutch or other driving connection. In either event, the door would be more or less perfectly protected, (if an attendant were near enough at hand to remedy matters in time), but the obstacle might be crushed by the force back of the door, particularly if the door is very large and heavy.

As applied to the power-driven doors of a completely automatic elevator with push-button control, which I have invented, my reversing guards or non-jamming devices on the edges of the car door and the shaftway doors are of utmost importance, because without some such means for protecting passengers against injury a full-automatic elevator control, including automatic door-movement, would be impossible.

My invention comprises a light-weight yieldably mounted bar or guard, on the advancing edge of the door, with a guard-actuated switch arranged not only to stop the door, on reaching an obstruction, but also to automatically reverse it, so as to open the door wide. The amount of yield of the guard, or the distance which it can be depressed before it strikes the door, should be somewhat greater than the distance necessary to bring the door to a full stop, which is usually about two inches for overhead doors.

My invention further comprises means for rendering the reversing-guard action effective only when the door is closing, and not when it is opening.

My invention further comprises means for preventing the automatic reversal of the door when the reversing guard comes into contact with the floor, in the case of overhead doors, or into contact with the door jamb, in the case of elevator doors, in the fully closed position.

As many houses are equipped only with single-phase power lines, and as induction motors are the most readily adaptable motors for door-driving purposes, it is necessary to overcome a difficulty which arises by reason of the fact that such motors cannot be reversed until their speed has been reduced a certain amount. This is because the "teaser" coils of such motors produce what is called an elliptical field which is not sufficient to reverse the motor from full-speed ahead to full-speed reverse. A repulsion-start, induction-running motor has the same defect.

With the foregoing difficulty in mind, I have further provided a simple centrifugal switch, which, at negligible additional expense, will reliably prevent the too rapid operation of the reversing control circuits when an obstruction comes into the path of the closing door, and thus I am able, with a single-phase motor, to reliably reverse the door in the quickest possible time, in response to a depression of my reversing guard, as soon as the motor speed has been reduced to a value which admits of reversal.

A still further feature of my invention is a provision against the possibility that the door might be held immovable, in closed position, by ice forming on its lower edge.

With the foregoing and other objects in view, my invention consists in the structures and circuit systems hereinafter described and claimed, and shown in the accompanying drawing, wherein—

Fig. 1 is a complete diagram of connections

for a single-phase door-operating mechanism according to my invention;

Fig. 2 is a circuit diagram showing the same thing, with details of the motor, centrifugal switch, brake and driving connections;

Fig. 3 is a simplified diagram of the motor connections alone;

Fig. 4 is a view similar to Fig. 2, showing a modification;

Fig. 5 is a longitudinal sectional view of the bottom portion of an overhead door, showing my reversing guard in place, the sectional plane being indicated by the line 5—5 in Fig. 6;

Fig. 6 is a transverse sectional view of the same, on the line 6—6 of Fig. 5;

Figs. 7 and 8 are views similar to Figs. 1 and 2, respectively, showing a three-phase system, as applied to an elevator door mechanism;

Fig. 9 is a simplified diagram of the control connections of the system shown in Figs. 7 and 8; and

Fig. 10 is an elevational side view showing the edge of an elevator door embodying my non-jamming guard, with parts broken away to show the construction.

In the embodiment of my invention shown in Figs. 1 to 3, I utilize a single-phase line 1, 2, from which energy is supplied to a reversible single-phase motor 3, carrying, on its shaft, a worm drive 4 for driving the sprocket wheel 5 of the chain drive 6 for the overhead door, such as is shown in the above-mentioned Edwards and Poschen patent. As the driving mechanism for the door is merely a conventional device, a good embodiment of which is shown in said patent, no detailed description thereof is necessary in the present application. It is sufficient to say that my motor 3 closes and opens a door (not shown in Figs. 1 to 3), according as the motor rotates in a forward or reverse direction.

The motor 3 is provided with a spring-applied brake 7 which is released by means of a brake solenoid 8 which is energized whenever the motor is energized.

The motor 3 is provided with four terminal leads, 9, 10, 11 and 12, whereby the motor can be energized in either the forward or the reverse direction. As illustrated in Fig. 2, the motor is provided with main and auxiliary primary windings 14 and 15, at right angles to each other, having the terminals 9, 10 and 11, 12, respectively. The motor 3 is also provided with a rotor member having a commutator cylinder 17 with which are associated a pair of permanently short-circuited brushes 18.

The motor 3 is what is commonly known as a repulsion-induction motor, starting as a repulsion motor with the brushes 18 effective, and operating at full speed as an induction motor, which operation is secured by means of a large number of short-circuiting fingers 19 carried by a conducting disc 20 and pressed against the end of the commutator cylinder 17 when the motor attains a predetermined speed, such as about 75% of its synchronous speed. The commutator short-circuiting device 19, 20 is operated by means of a centrifugal switch, indicated in its entirety by 21, in such manner that the commutator is short-circuited at about 75% speed and is again open-circuited when the speed falls to a value somewhat below 75%.

The conducting disc 20 of the centrifugal device 21 is adapted to cooperate with two stationary back-contacts 25 which are closed when the motor speed falls to a value somewhere around 75% of its full speed, or a somewhat lower figure. The purpose of these centrifugal switch contacts 25 is to prevent the motor connections from being reversed, when the door is closing, until the speed has dropped to such value that a reversal of the driving connections will actually effect a reversal of the motor. This is necessary because of the peculiar difficulties in reversing certain single-phase motors, and it is true in straight single-phase induction motors, as shown in Fig. 4, as well as in the repulsion-induction motor which is shown for illustrative purposes in Fig. 2.

Two other kinds of protective devices, in addition to the centrifugal switch contacts 25, are utilized in my control device; to wit, the usual "up" and "down" limit switches 27 and 28 which are opened when the door reaches its respective limits of travel, and my novel reversing guard 30 which is mounted on the advancing edge of the door and which, when it comes into engagement with an obstruction, opens the switch contacts 31.

The "up" limit switch 27 is provided with "up limit" contacts 33 which are opened when the door is in its extreme open position.

The "down" limit switch 28 is provided with main "down limit" contacts 35 and also auxiliary "down" contacts 37, both of which are closed except when the door is within one or two inches of its extreme closed position. It is further provided with normally open auxiliary contacts 38 which are in shunt with the reversing-guard contacts 31 and short-circuit the same when the door is within three or four inches of its extreme closed position, or before the reversing guard 30 comes into contact with the floor, which occurs when the door is about three inches from the floor.

The construction and operation of my controlling device for the main motor 3 may now be described.

The control is effected by two electrically operated main control elements or contactors, an "up" or backward contactor 40 having an actuating coil 41 for closing the same, being opened by gravity or its equivalent; and a

"down" or forward contactor 43 having an actuating coil 44 for closing the same, being also opened by gravity or its equivalent. The two contactors are usually protected by a well-known mechanical interlock (not shown) having provision for a lost-motion connection which permits either one of the contactors to close freely while the other one is open, but does not permit both contractors to be closed at the same time.

The motor 3 is adapted to have its main and auxiliary windings connected in series, with the auxiliary windings reversed for reversed rotation. Thus, the current flows in the direction 9—10—11—12 for forward or downward movement, and in the direction 9—10—12—11 for reverse or upward movement. To this end, the "down" contactor 43 is provided with two main contacts 45 and 46 for connecting the terminal 10 to the terminal 11 and the terminal 12 to the line 1. The "up" contactor 40 has main contacts 47 and 48 for connecting the terminal 10 to the terminal 12 and the terminal 11 to the line 1. The motor-terminal 9 is permanently connected to the line-wire 2. The "down" and "up" contactors 43 and 40 thus constitute "forward" and "backward" main control elements adapted, when energized, to cause the prime mover or motor 3 to be energized in either the "forward" direction to lower or close the door, or in the "backward" direction to raise or open the door.

The "up" and "down" contactors 40 and 43 are each also provided with a third main contactor, numbered 49 and 50, respectively, both of said contactors 49 and 50 being connected, on one side, to the line-conductor 1, and on the other side to a brake-terminal 51, the other brake-terminal 52 being permanently connected to the other line-conductor 2. Thus, the brake solenoid 8 is energized, to release the brake, whenever either the "up" contactor 40 or the "down" contactor 43 is energized; that is, whenever the door is to be raised or lowered.

The control system is provided with a snapswitch 53 which is connected to the line 2 by a conductor 54 and to certain of the control apparatus by a conductor 55, as will now be described.

The "up" contactor 40 is energized by means of an "up" push button 56, which connects the control-conductor 55, through the push button 56, to an "up" contactor control-line 57 leading to the "up" contactor-coil 41, which is in turn connected by a conductor 58 to the "up-limit" contacts 33, and thence, by means of a conductor 59, to the line-wire 1. As soon as the "up" contactor closes, a "holding" circuit is completed by an auxiliary contact 61, which joins the conductor 57 directly to the control-conductor 55, which is connected, through the snap-switch 53, to the line-wire 2, thus by-passing the push button 56, and holding the contactor closed until the door reaches its upper limit of travel, when the "up" limit switch 27 opens its contacts 33, thus de-energizing the "up" contactor.

The "down" contactor 43 is energized by means of a "down" push button 63, which connects the control-conductor 55, through the push button 63, to a conductor 64 leading to the actuating-coil 44 thereof, which is in turn connected by a conductor 66 to the switch-contacts 31 of the reversing guard 30, thence by a conductor 67 to the "down limit" contacts 35, and thence, by means of the conductor 59 to the line-wire 1. As soon as the "down" contactor closes, a "holding" circuit is completed by an auxiliary contact 68, which joins the actuating coil 44 to the control-conductor 55 which is connected to the snap-switch 53 and thence to the line-wire 2, thus by-passing the push button 63 and normally holding the contactor closed until the door reaches its lower limit of travel, at which time the "down" limit switch 28 opens its contacts 35, thus de-energizing the "down" contactor.

The reversing guard 30, as shown more clearly in Figs. 5 and 6, is set on the advancing edge of the door 73. It is made as light as possible, so that it will not itself injure any object which may be in the path of the closing door, and it is pressed outwardly by a very light spring 74, so that the slightest touch will break its contacts 31, thereby opening the "holding" circuit of the "down" contactor.

If the door should come into contact with any obstruction when it is closing, I not only stop it, by means of my reversing guard, as just described, but I also cause it to be automatically reversed and returned to its fully open position. This reversing operation is effected by my centrifugal switch 25 which is closed whenever the speed of the motor is under about 75% of its full speed, which occurs soon after the de-energization of the "forward" contactor 43 and the main motor 3 by the opening of the guard switch 31 while the door is closing. The centrifugal switch 25 thus constitutes auxiliary switching means which are closed when the "forward" main control element is de-energized. Immediate application of the reversing connections of the single phase motor 3 shown in Figs. 1 and 2 is not desired because a single-phase induction motor will ordinarily not reverse until its speed is reduced a certain amount. I have found that 75% of full forward speed is sufficiently low to assure reversal, in the motors which I have tested; however, I contemplate that the centrifugal switch shall be set to whatever value may be necessary for the particular motor used on any installation. In the repulsion-induction motor which I prefer, and which is shown in Fig. 2, the commutator-short-circuiting means 19

is preferably moved away from the commutator, so that the motor acts purely as a repulsion motor, before reversing its connections.

If the reversing guard 30 touches an obstruction in the path of the closing door, the "down" contactor 43 is immediately de-energized, thereby open-circuiting the motor 3 and applying the brake 7, rapidly decelerating the motor. At about 75% speed, the centrifugal switch 25 closes, thereby energizing the "up" contactor control-line 57 by means of a conductor 76, which connects the "up" contactor control-line 57 to the centrifugal switch 25, whence a conductor 77 leads to the auxiliary "down" contacts 37 of the "down" limit switch 28, and so connects on to the energized control-conductor 55, except when the door is at its extreme "down" limit of travel. The circuit and apparatus just outlined constitute means for energizing the "up" contactor 40 just as if the "up" push button 56 had been depressed, and it does it automatically, without any loss of time, as soon as the speed of the motor 3 is such that it may safely be reversed.

If the control-circuit snap-switch 53 is opened, while the door is either ascending or descending, the door will stop and will remain in its place until the snap-switch is again closed, at which time the door will instantly and automatically start up, through the circuit comprising the centrifugal switch contacts 25 and the auxiliary "down" contacts 37 of the limit switch 28.

As it takes about two inches to stop a heavy garage door, and as the reversing guard 30 must not become fully depressed before the door reverses, it is usual to provide three inches of movement of the reversing guard, its switch contacts 31 being instantly opened by the first movement of the guard. On reaching its "down" position, the door would first be stopped by the reversing guard which would strike the floor at about three inches above it and would bring the door to a stop at about one inch from the floor. If the "down" limit-switch contacts 37 open before the motor slows sufficiently to close the centrifugal switch 25, the door will not be reversed and will come to rest within about one inch from the floor.

Where it is desired to bring the door to fully closed position, the auxiliary normally open switch-contacts 38 may be provided on the "down" limit switch 28, for short-circuiting the reversing-guard switch 31 at between three and four inches of the floor. This is done by having the first movement of the "down" switch close the contacts 38, and later on, when the door is two inches from the floor, the main "down" limit contacts 35, for stopping the motor, will open, thus bringing the door to rest in contact with the floor. The reversing guard-switch 31 and its circuit 66, together with the by-passing switch 38 on the "down" or "forward" limit switch 28, thus constitute means responsive to the operation of said guard switch, when the door is closing and before it is fully closed, to automatically deenergize the "down" contactor 43, and through the circuit 37—77—25—76—57 to energize the reversing contactor 40, as previously described, but this does not occur after the door has reached with in three inches of its fully closed position, when the by-passing limit switch 38 closes and renders the guard switch 31 inoperative.

In the embodiment of my invention shown in Fig. 4, a straight induction motor 80 is shown, having a main primary coil 81 and two "teaser" coils 82 and 83 for forward and reverse operation, respectively. The "up" contractor 84 energizes coils 81 and 83; and the down contactor 85 energizes coils 81 and 82.

Instead of using an auxiliary "down" contact 37 on the "down" limit switch 28, I may, as shown in Fig. 4, use auxiliary back-contacts 87 on the reversing guard 30, whereby the door is automatically returned to full open position, on hitting an obstruction.

The order of arrangement of the various safeguard devices is somewhat different in Fig. 4 from that shown in Fig. 2, and will be very briefly traced, as follows, using the same reference numerals as in Fig. 2 wherever possible. The normal push-button energizing circuit for the "up" contactor 84 is from the control line 55, through the "up limit" contacts 33 to the "up" push button 56, and thence through the centrifugal switch contacts 25 to the energizing coil 41. As soon as the "up" contactor 84 closes, a "holding" circuit is established through the auxiliary contact 61 and the "up limit" contacts 33. The automatic reversal of the motor is effected by a control circuit from the control line 55 through the "down limit" contacts 35, the back-contacts 87 on the reversing guard 30, and the centrifugal switch 25 to the "up" contactor coil 41.

The normal push button energizing circuit for the "down" contactor 85 in Fig. 4 is from the control line 55, through the "down limit" contacts 35, the normally closed reversing-guard contacts 31, and the "down" push button 63, to the actuating coil 44, the "down" push button being immediately by-passed by the auxiliary "holding" contacts 68.

In the apparatus shown in Fig. 4, if the control-circuit snap-switch 53 is opened while the door is in motion, the door will stop in its place, as in Figs. 1 and 2, but when the snap-switch is again closed the door will not automatically open, as in Figs. 1 and 2, but will stay in its place until one of the push buttons is depressed.

In the modification shown in Fig. 4, I have

not utilized the auxiliary short-circuiting contacts 38 for enabling the door to close its last inch, or thereabouts, the reversing guard 30 being so constructed that it substantially bridges the space between the door and the floor, notwithstanding the fact that the guard is still able to move up into a groove in the bottom of the door, or some equivalent construction, until it is flush with the bottom surface of the door.

In the three-phase system shown in Figs. 7–9, a three-phase line 91, 92, 93, supplies a three-phase induction motor 94, through forward and reverse contactors 95 and 96, heretofore referred to as "down" and "up" contactors, respectively. In this case, all that is necessary to reverse the motor is to reverse the phase-sequence, no centrifugal switch being necessary. The three motor-terminals 97, 98 and 99 are connected to the contactors in a way which is obvious and which is clearly shown in the drawing.

In Fig. 8, the motor is shown as being provided with a friction clutch 100 for driving a threaded shaft carrying a nut 101 which is guided by a runway 102 and which trips the limit switches 27 and 28 at the extreme limit of travel. The nut 101 is also shown as operating a horizontally sliding door 104, such as an elevator door, for closing a doorway 105. In this case, as shown in Fig. 10, the advancing edge of the door, as it closes, is a vertical surface, which is guarded by a light channel-shaped guard 106 pressed outward by upper and lower springs 107 and 108, the upper spring being preferably the heavier, so that the guard practically pivots thereon, and the lower spring being very light, so that the guard yields to the slightest touch. The guard carries the normally closed contacts 31 previously described.

The control circuits shown in Figs. 7–9 are as follows. Instead of a mechanical interlock with a lost-motion connection for preventing both contactors from closing at once and short-circuiting the line, an electrical interlock is provided. The normal push button control circuit for the door-opening or "up" contactor 96 is from the control-line 55, through the "up" push button 56 and conductor 57, to a normally closed interlock 110 on the "down" contactor 95, said interlock being closed when the contactor is in its normal open position, thence to the actuating coil 41 of the "up" contactor 96, thence through conductor 58, "up limit" contacts 33, and conductor 59, to the line-wire 91. A "holding" circuit is immediately formed around the push button 56, from control-wire 55, through the auxiliary "holding" contacts 61, to the conductor 57.

The normal push button circuit for the door-closing or "down" contactor 95 in Figs. 7–9 is from the control-line 55, through the "down" push button 63 and conductor 64, to a normally closed interlock 112 on the "up" contactor 96, thence to the actuating coil 44 of the "down" contactor 95, thence through conductor 66, "down limit" contacts 35, conductor 67, reversing-guard contacts 31 and conductor 71, to the line-wire 91. A "holding" circuit is immediately formed by the "holding" contacts 68 on the "down" contactor 95.

The "up" push button 56 in Figs. 7–9, besides being by-passed by the "holding" contacts 61, is also by-passed by the auxiliary "down" contacts 37 which are closed at all times except in the fully closed position of the door, said contacts 37 being connected to the "up" conductor 57 by the conductor 76 and being connected, on the other side, directly to the control-line 55. When the door is descending or closing, the "up" contactor circuit is interrupted by the interlock 110 on the open "down" contactor; when the door is fully closed, the auxiliary "down limit" contacts 35 and 37 are open; when the door is fully open, the "up" contactor circuit is interrupted by the "up limit" contacts 33. If the door is stopped by the reversing guard, while descending or closing, the "down contactor 95 is opened, thus closing the interlock 110, and as the auxiliary "down" contacts 37 are already closed, the "up" contactor is immediately energized, reversing the motor 94. The interlock 110 thus constitutes auxiliary switching means which are closed when the "forward" main control element is de-energized.

In the form of my invention shown in Figs. 7 to 10, where my reversing guard 106 is used to protect an elevator door 104 operated by a three-phase motor 94, I do not need a brake on the driving shaft. When the reversing guard is depressed with a very slight pressure, the three-phase motor instantly reverses and opens the door. When the door is nearly closed, the down limit switch 28 opens both of its normally closed contacts 35 and 37, just before the reversing guard 106 comes into contact with the door jamb, and the motor is deenergized, permitting the door to drift into closed position, the motor being finally stopped by the slipping of the clutch 100 when the door is fully closed. It is thus seen that the auxiliary normally open contacts 38 for short-circuiting the reversing-guard contacts at the "down" or "closed" limit of travel is not needed in this embodiment of my invention.

My novel application of the friction-clutch drive for the doors of full-automatic elevators is claimed in my application Serial No. 408,982, filed Nov. 22, 1929.

While I have described by invention with relation to overhead doors and elevator doors, I wish the word "door" to be understood as applying to any power-driven object that may jeopardize life or property by crushing an

interposed object. The terms "down," "forward" or "door-closing" should in like manner be understood as referring broadly to movement in the direction which would crush an interposed object, and the terms "up," "reverse," "backward" or "door-opening," the reverse direction.

While I have illustrated two forms of my reversing guard, as applied to overhead and elevator doors, respectively, I do not wish to be altogether limited to either form. For elevator doors, the channel formation of the guard, as shown in Fig. 10, may sometimes be preferred for decorative reasons and its safety to fingers. For overhead doors, however, I very much prefer a light, three-eighths-inch rod, as shown at 30 in Figs. 5 and 6, pressed downward by light springs 74 and having strong limit-motion devices 115 for limiting the outward movement of the guard, away from the door, to three inches. The springs 74 allow the guard-rod 30 to be depressed fully against the door, or into a groove therein, as the case may be, thereby sealing the doorway as perfectly as is possible without a guard. Where the rod remains in contact with the floor, instead of the door, as shown in Figs. 5 and 6, the rod also presents a small rounded surface, of considerably less area than the bottom panel of the door, for the formation of snow and ice, which, in door-arrangements having no guards, would possibly hold the door immovable until the ice is thawed. Moreover, the three inches play of the guard permits my door-operating motor to get a good start, even if the guard is held down by ice, giving a powerful hammering jerk at the end of the three-inch movement, which, aided by the small area of the frozen surface, will easily break the ice-formation and free the door for operation.

It will be understood, also, that any suitable cable or extension cord may be utilized with my invention, or any suitable reeling device for the guard contact conductors on the door. In Figs. 1 and 7, I have shown the apparatus at the controller as being connected, by three cables 118, 119 and 120, to the parts located, respectively, at the motor, at the push buttons and on the door, but such showing should be taken only as illustrative.

In like manner, my illustration of a centrifugal device in Figs. 2 and 4 is intended merely as typical or suggestive of this entire class of devices and not as limiting myself to any particular form or style of speed-responsive device.

I claim as my invention:

1. The combination with an object which is movable in a limited path in the forward and backward directions and which is so disposed that its forward edge may exert a crushing action on an obstruction interposed in its way when it is moving forward, of a reversible prime mover mechanically connected thereto to drive the same, protective devices for cutting off the power to said prime mover when said object reaches either extreme limit of its travel, a guard yieldably disposed on said forward edge, means responsive to a depression of said guard, when said object is moving forward, to automatically reverse said prime-mover, and means operative, when said object reaches its extreme forward limit of travel, to prevent said automatic reversal by said guard-responsive device.

2. The combination with an object which is movable in a limited path in the forward and backward directions and which is so disposed that its forward edge may exert a crushing action on an obstruction interposed in its way when it is moving forward, of a reversible power driving means for driving the same, protective devices for cutting off the power to said prime mover when said object reaches either extreme limit of its travel, a guard yieldably disposed on said forward edge, means operative in response to a depression of said guard for causing said reversible power driving means to be energized in a direction to drive said object backward, and means operative at the extreme forward limit of travel of said object to prevent the said action of said guard-responsive means.

3. The combination with an object which is movable forward and backward in a limited space, one end of said space being accessible so that an obstruction may become interposed where it would cause damage by reason of the advancing forward edge of said object, of a reversible prime mover mechanically connected to said object to drive the same, a brake on said driving connection, means for energizing said prime-mover in either direction at will and for deenergizing the same, means for causing said brake to be released when said prime mover is energized in either direction and to be applied when said prime mover is deenergized, protective devices for deenergizing said prime mover whenever said object is at either extreme limit of its travel, a guard yieldably disposed on said forward edge of the object, means responsive to a displacement of said guard to deenergize said prime mover, and means operative, whenever said prime mover is deenergized, to reenergize the same in the direction necessary to move said object backward, except when either one of said protective devices is effective at either limit of travel.

4. The combination as recited in claim 3, characterized by the fact that said guard-responsive means is effective to interrupt only the forward movement of said prime mover and not its backward movement.

5. The combination as recited in claim 3, characterized by having means, responsive to an operating condition of said prime mover, for delaying said re-energization of the prime

mover in the backward direction until a predetermined value of said operating condition has been obtained.

6. The combination as recited in claim 3, characterized by having means, responsive to the speed of said prime mover, for delaying said re-energization of the prime mover until it has been decelerated to a predetermined speed.

7. The combination with an object which is movable forward and backward in a limited space, one end of said space being accessible so that an obstruction may become interposed where it would cause damage by reason of the advancing forward edge of said object, of a reversible prime mover mechanically connected to said object to drive the same, a brake on said driving connection, means for energizing said prime mover in either direction at will and for deenergizing the same, means for causing said brake to be released when said prime mover is energized in either direction and to be applied when said prime mover is deenergized, protective devices for deenergizing said prime mover whenever said object is at either extreme limit of its travel, means for automatically energizing the prime mover in a backward direction when the advance of the door is interrupted before it reaches its forward limit of travel, and means responsive to the speed of said prime mover to make it impossible to initiate the said automatic energization of the prime mover in a backward direction unless its speed is less than a predetermined minimum.

8. The combination with an object which is movable in a limited path in the forward and backward directions and which is so disposed that its forward edge may exert a crushing action on an obstruction interposed in its way when it is moving forward, of a reversible prime mover mechanically connected to said object to drive the same, an electrically operated "forward" main control element adapted, when energized, to cause said prime mover to be energized in the forward direction, an electrically operated "backward" main control element adapted, when energized, to cause said prime mover to be energized in the backward direction, each of said main control elements being adapted, when deenergized, to cause the energization of said prime mover to be discontinued, normally closed limit switches for deenergizing the respective main control elements when said object reaches its respective limits of travel, a guard yieldably disposed on said forward edge of the object, a normally closed switch operative by a depression of the guard, and means responsive to the operation of said guard switch, when said object is moving forward before it reaches the limit of its travel, to automatically deenergize said "forward" main control element and energize said "backward" main control element.

9. The combination with an object which is movable in a limited path in the forward and backward directions and which is so disposed that its forward edge may exert a crushing action on an obstruction interposed in its way when it is moving forward, of a reversible power driving means for driving the same, an electrically operated "forward" main control element adapted, when energized, to cause said power driving means to be disposed in the forward driving condition, an electrically operated "backward" main control element adapted, when energized, to cause said power driving means to be disposed in the backward driving condition, said main control elements, when both deenergized, being adapted to cause said power driving means to be disposed in the non-driving condition and to cause said object to be stopped, normally closed limit switches for deenergizing the respective main control elements when said object reaches its respective limits of travel, a guard yieldably disposed on said forward edge of the object, a normally closed switch operative by a depression of said guard, and circuit connections whereby the operation of said guard switch, when said "forward" main control element is energized, deenergizes the same and energizes the "backward" main control element, the forward limit switch comprising means for preventing the reversing action of the guard switch when the guard switch is actuated by the engagement of the guard with the forward limit of travel of said object.

10. The combination with an object which is movable forward and backward in a limited space, one end of said space being accessible so that an obstruction may become interposed against the forward limit of said space, where it would be damaged by the advancing forward edge of said object, of a reversible prime mover mechanically connected to said object to drive the same, a brake on the driving connections from the prime-mover, an electrically operated "forward" main control element adapted, when energized, to cause said prime mover to be energized in the forward direction, an electrically operated "backward" main control elements adapted, when energized, to cause said prime mover to be energized in the backward direction, each of said main control element being adapted, when deenergized, to discontinue its energization of said prime mover, means for causing the brake to be released when the prime mover is energized in either direction and to be applied when the prime mover is deenergized, "forward" and "backward" control circuits adapted, when energized, to control the respective main control elements, and a switch responsive to the speed of said prime mover to place an open point in, and thus prevent the energization of, a "backward" control circuit whenever said speed is over a predetermined percentage of full speed.

11. The combination with an object which is movable forward and backward in a limited space, one end of said space being accessible so that an obstruction may become interposed against the forward limit of said space, where it would be damaged by the advancing forward edge of said object, of a reversible prime mover mechanically connected to said object to drive the same, an electrically operated "forward" main control element adapted, when energized, to cause said prime mover to be energized in the forward direction, an electrically operated "backward" main control element adapted, when energized, to cause said prime mover to be energized in the backward direction, each of said main control elements being adapted, when deenergized, to cause the energization of said prime mover to be discontinued, normally closed "forward" and "backward" limit switches in series with the respective main control elements for deenergizing the same at the respective limits of travel of said object, a guard yieldably disposed on the aforesaid forward edge of said object, a normally closed switch opened by said guard and connected in circuit with said "forward" main control element to deenergize the same when the guard is depressed, an auxiliary switching means which is closed when said "forward" main control element is deenergized, and an auxiliary contact, on said "forward" limit switch, which is closed when said "forward" limit switch is undisturbed, said auxiliary switching means and auxiliary contact being in series with said "backward" main control element to automatically energize the same whenever the "forward" main control element is deenergized after having been energized while said object is in some intermediate position between its extreme limits of travel.

12. The combination with an object which is movable forward and backward in a limited space, one end of said space being accessible so that an obstruction may become interposed against the forward limit of said space, where it would be damaged by the advancing forward edge of said object, of a reversible prime mover mechanically connected to said object to drive the same, an electrically operated "forward" main control element adapted, when energized, to cause said prime mover to be energized in the forward direction, an electrically operated "backward" main control element adapted, when energized, to cause said prime mover to be energized in the backward direction, each of said main control elements being adapted, when deenergized, to cause the energization of said prime mover to be discontinued, normally closed "forward" and "backward" limit contact devices operative at the extreme limits of travel of said object, a guard yieldably disposed on the aforesaid forward edge of said object, a normally closed guard contact device actuated by a displacement of said guard, an electrical circuit responsive to said "forward" limit contact device for deenergizing said "forward" main control element at the forward limit of travel, an electrical circuit responsive to said "backward" limit contact device for deenergizing said "backward" main control element at the backward limit of travel, an electrical circuit responsive to said guard contact device for deenergizing said "forward" main control element when the guard is depressed, and means including an electrical circuit responsive to both said guard contact device and said "forward" limit contact device for automatically effecting the energization of said "backward" main control element when said guard is depressed before the "forward" limit contact device is depressed.

13. An automatically operated door comprising a reversible electric motor, a mechanical driving connection between the motor and the door, means for energizing the motor to either open or close the door, limit switch devices for stopping the motor when the door reaches either its fully open position or its fully closed position, a guard yieldably disposed on the closing edge of the door, a normally closed guard-actuated switch for stopping the motor when the advancing edge of the guard comes into contact with anything, and means responsive to the opening of said guard switch when the closed-position limit switch is disturbed for automatically energizing the motor in the opening direction.

14. The combination with an object which is movable in a limited path in the forward and backward directions and which is so disposed that its forward edge may exert a crushing action on an obstruction interposed in its way when it is moving forward, of a reversible prime mover mechanically connected to said object to drive the same, an electrically operated "forward" main control element adapted, when energized, to cause said prime mover to be energized in the forward direction, an electrically operated "backward" main control element adapted, when energized, to cause said prime mover to be energized in the backward direction, each of said main control elements being adapted, when deenergized, to cause the energization of said prime mover to be discontinued, normally closed limit switches for deenergizing the respective main control elements when said object reaches its respective limits of travel, a guard yieldably disposed on said forward edge of the object, a normally closed switch operative by a depression of the guard, connections for deenergizing said "forward" main control element when said guard switch is opened, and means responsive to the "forward" limit switch for rendering the guard switch

inoperative just before the depression of the guard at the forward limit of travel.

15. A mechanically operated door or the like, comprising a reversible prime mover for operating the same, "forward" and "backward" main control elements for controlling said prime mover, and automatic means responsive to the de-energization of said "forward" main control element when said door is advancing, and before it reaches its fully closed position, to automatically energize said "backward" control element.

In testimony whereof, I have hereunto subscribed my name this 21st day of January, 1929.

HARRY B. GOLDMAN.