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W. M. REYNOLDS

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DOOR OPERATOR MECHANISM

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3 Sheets-Sheet 1

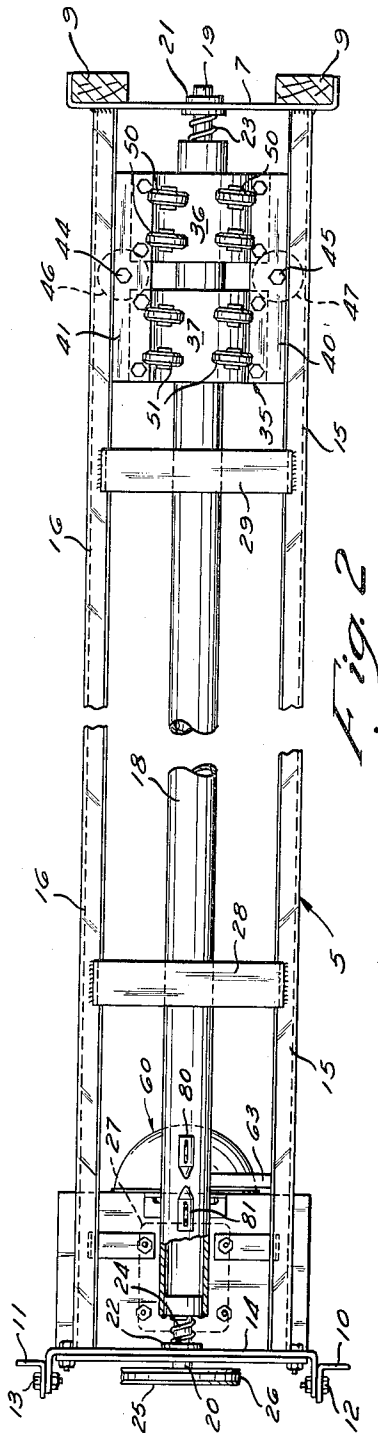


Fig. 2

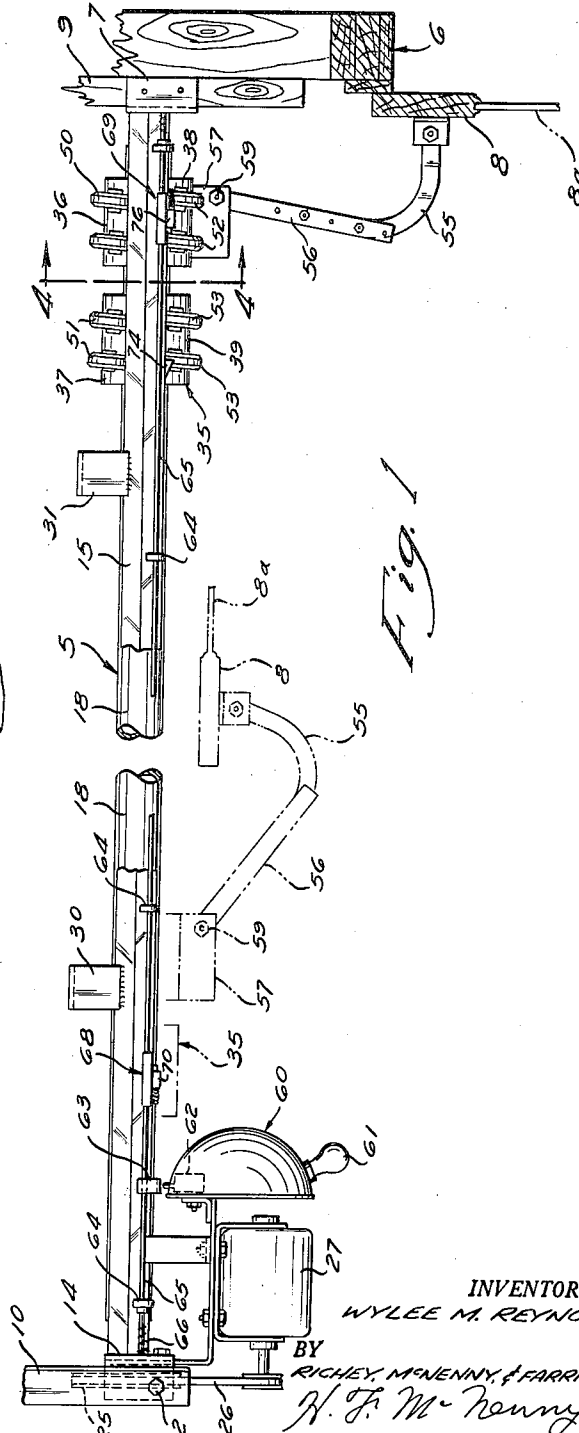


Fig. 1

INVENTOR.
WYLEE M. REYNOLDS

BY
RICHEY, MCNENNY, & FARRINGTON
H. F. McNenny
ATTORNEYS

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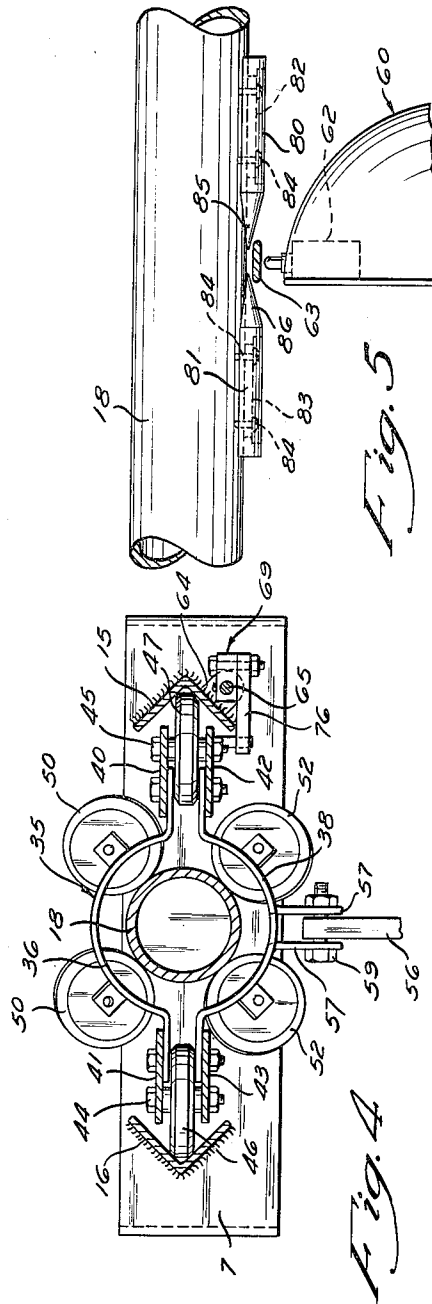
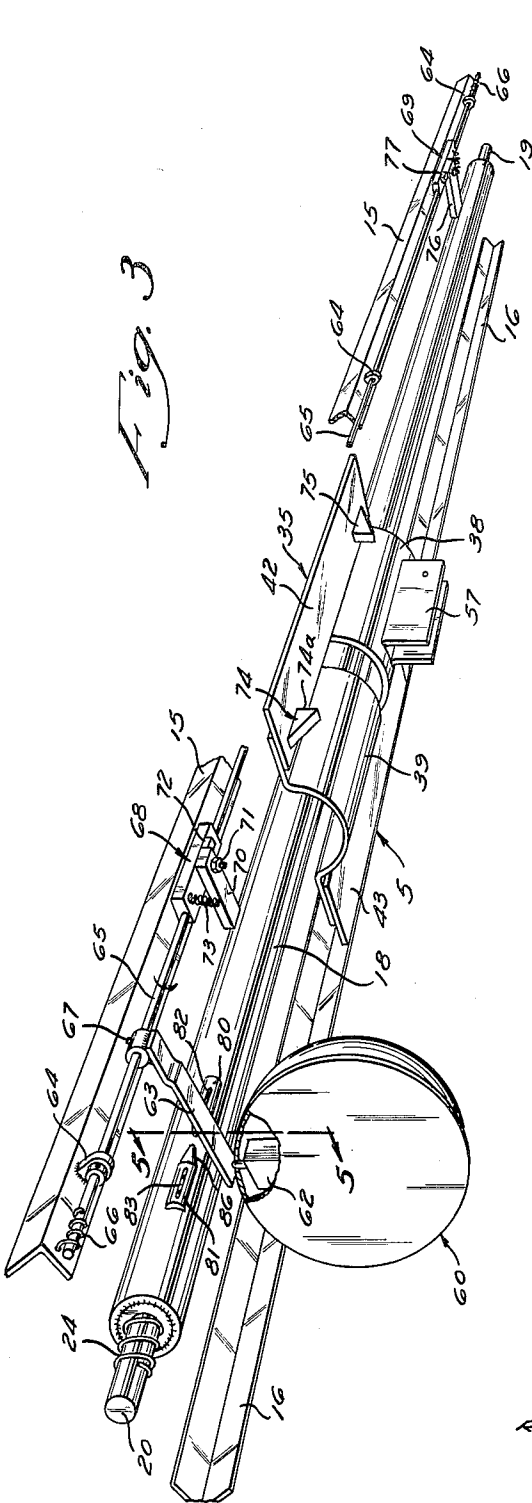
W. M. REYNOLDS

3,048,385

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INVENTOR.
WYLEE M. REYNOLDS

BY
RICHEY MCNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

Aug. 7, 1962

W. M. REYNOLDS

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3 Sheets-Sheet 3

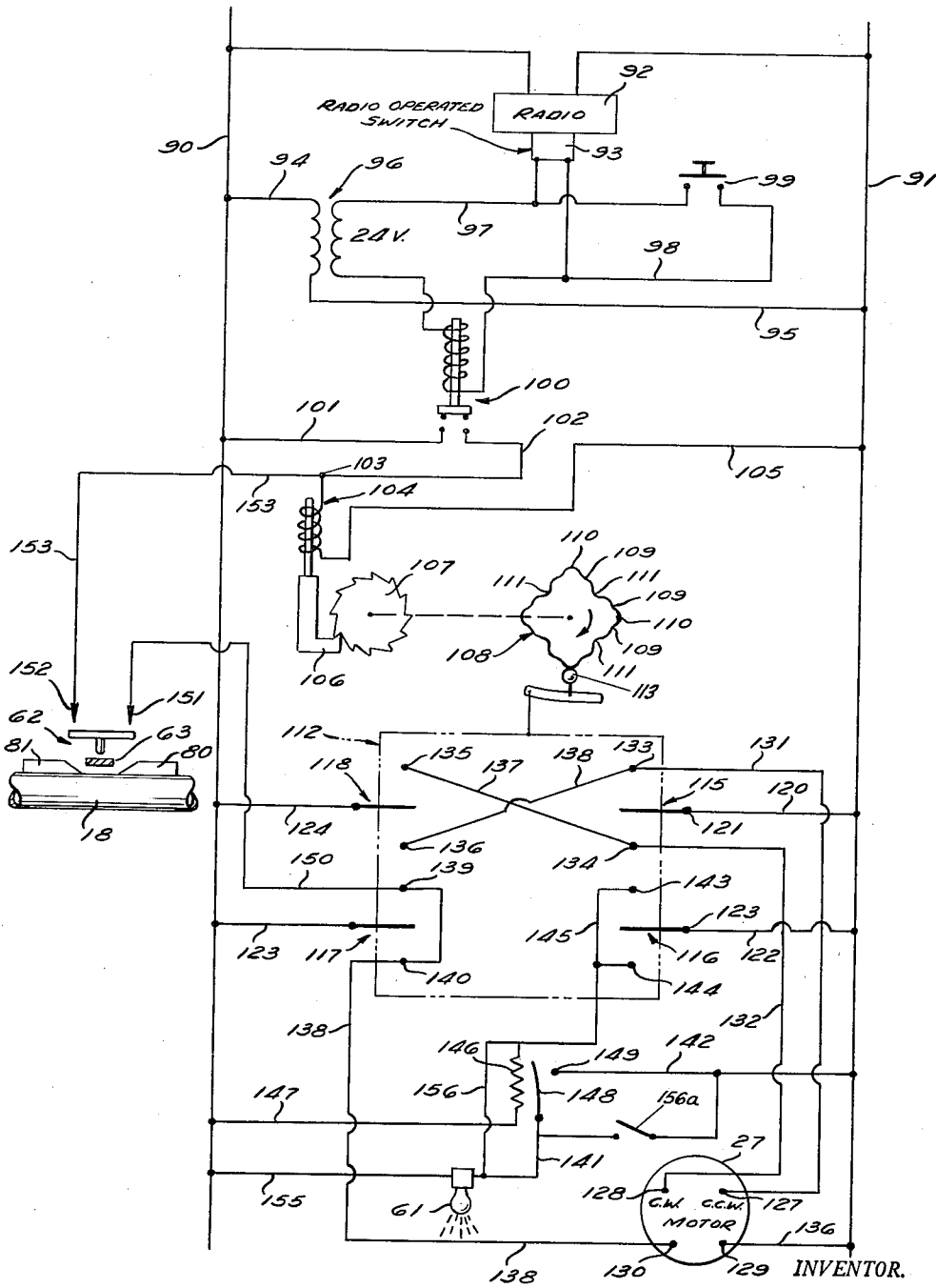


Fig. 6

INVENTOR.
WYLLIE M. REYNOLDS
BY
RICHEY, McNENNY & FARRINGTON
H. F. McNenny
ATTORNEYS

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3,048,385

DOOR OPERATOR MECHANISM

Wylee M. Reynolds, Garrettsville, Ohio, assignor to Graham Industries, Inc., Cleveland, Ohio, a corporation of Ohio

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This invention relates to door operator mechanism and more particularly mechanism for moving an overhead garage door to open and closed positions.

The invention also relates to an electric motor drive and control therefor which automatically and safely determines the sequence of the door movement.

Numerous operating mechanisms have been proposed for the control and actuation of overhead garage doors. Certain of the prior art devices have included electric motors and counter-balancing springs to assist in moving the garage door to open and closed position. It has also been proposed in the prior art door operators to mount an elongated cylindrical shaft in a horizontal position above the door to rotate the shaft and to reciprocate a carriage along said shaft by means of inclined rollers on the carriage in frictional engagement with the shaft.

The principal object of the present invention is positively to prevent the motor of such a door actuator remaining so energized as to urge the door to move farther in the same direction after it has reached the normal limit of its motion in that direction and thereby eliminate the possibility of rapidly wearing out the actuator and burning out the motor, which has been one of the defects of prior door actuators.

A further object is to decrease wear and increase the life and reliability of doors and door operators by controlling the motor so that the power is cut off just before the door reaches the limit of its movement in either direction, and at the same time cutting off the motor power whenever the door encounters excessive resistance at any point in its travel.

A further object is to simplify and improve the operation and reliability of an automatic motor control for a door operator which may be actuated by limit controls or by overload controls or both.

Other objects and advantages relating to reliability in operation, ruggedness of construction and safety in use will appear from the following description and the appended drawings wherein:

FIG. 1 is an elevation showing the door operator mechanism made according to my invention mounted in a garage and connected to the garage door;

FIG. 2 is a plan view of the operator mechanism shown in FIG. 1;

FIG. 3 is a perspective view looking from below at the actuator mechanism and illustrating the carrier and parts of the electric control circuit;

FIG. 4 is a transverse view with parts in section taken through the carrier as indicated in plane 4—4 of FIG. 1;

FIG. 5 is an elevation showing the parts of the safety mechanism embodied in the door operator according to my invention; and

FIG. 6 is a diagrammatic showing of the electric circuit and certain parts of the operator as related to the electrical circuit.

Referring to the drawings, the door operator, indicated in its entirety as at 5, is mounted horizontally within the garage adjacent the door opening 6. The right-hand end of the operator mechanism, as viewed in FIGS. 1 and 2, includes a transverse bracket 7 which is supported in any suitable way, as by being secured above the garage door 8 to vertical studs 9. The left-hand end of the operator may be suspended from the garage roof (not shown) by

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means of depending angle irons 10 and 11 which are secured as at 12 and 13 to a transverse bracket 14.

In the illustrated embodiment, horizontally disposed angle iron 15 is welded at one end to the bracket 7 and at its other end to the bracket 14. A parallel angle iron 16 is spaced from the first iron 15 and is similarly welded to the brackets 7 and 14. Preferably the angle irons 15 and 16 are arranged so as to face each other and provide opposite webs at 45° to the horizontal as best shown in FIG. 4.

The angle irons 15—16 and the brackets 7—14 form a rectangular frame which supports a tubular drive shaft 18. The shaft 18 is provided with a stub shaft 19 at its right-hand end and a stub shaft 20 at its left-hand end. The stub shafts 19 and 20 are preferably welded within the tube 18 as indicated in the cut away section in FIG. 2. The stub shaft portions 19 and 20 are journaled in bearings 21 and 22 carried by the brackets 7 and 14, respectively. A spring 23 surrounds the stub shaft 19 and a spring 24 surrounds the stub shaft 20 so as to bias the tubular member 19 to a central position with respect to the end brackets 7 and 14.

The outer end of the shaft 20 projecting beyond bracket 14 is provided with a pulley 25 which receives a V-belt 26 that is driven by a pulley on the driving motor 27. The rectangular frame supporting the tubular drive shaft 18 may be suitably reinforced by cross members 28 and 29. The cross members 28 and 29 are each provided with down-turned ears such as 30 and 31 so that the mid-portions of the cross members 28 and 29 are spaced above the tubular member 18 and also clear the rollers on the reciprocating carriage 35.

The reciprocating carriage, indicated in its entirety as at 35, is provided with a plurality of rollers mounted for rotation on the carriage about an axis inclined a few degrees with respect to the horizontal axis of the tubular member 18. Preferably the carriage 35 comprises two upper sections 36 and 37 and two complementary lower sections 38 and 39. The two upper sections are secured to each other by a bar 40 at one side of the carriage and a bar 41 at the other side of the carriage. Parallel bars 42 and 43 connect the lower carriage sections 38 and 39 to each other. The upper and lower sections of the carriage 35 are connected to each other by a vertically extending bolt 44 at one side of the carriage and bolt 45 at the other side of the carriage.

A rubber-faced roller 46 is journaled on the bolt 44 and a similar roller 47 is journaled on the bolt 45. The rollers 46 and 47 fit into the bottom of the trough or groove formed by the diverging sides of the angle irons 15 and 16.

The upper carriage section 36 is provided with a plurality of rollers 50 which are journaled to rotate on axes slightly inclined with respect to the axis of the member 18. The section 37 is similarly provided with a plurality of rollers 51 which are similarly mounted with respect to the member 18. The lower carriage sections 38 and 39 are provided with rollers as at 52 and 53, respectively. These rollers are preferably faced with rubber and press against the shaft 18.

When the tubular member 18 is rotated by the driving motor 27 the skewed rollers 50, 51, 52 and 53 frictionally urge the carriage 35 axially along the member 18. Rotation of the member 18 in one direction carries the carriage 35 in one direction along the operator frame and rotation of the member 18 in the opposite direction moves the carriage back in an opposite direction along the operator frame.

In FIG. 1 the garage door 8a is connected by links 55—56 to a bracket 57 depending from the carriage section 38. The bracket 57 comprises two depending ears

and a pin or bolt 59 extends through the ears to pivotally connect the link 56 to the bracket 57. Upon rotation of the tubular member 18 in a predetermined direction by the motor 27, the carriage 35 is moved to the dotted outline position illustrated in FIG. 1. This moves the top section 8 of the door to the dotted outline position which will be referred to here as the open position.

It will be understood by those skilled in the art that the sections which make up the door 8a may be provided with laterally extending rollers which ride in tracks carried within the garage. The particular sectional construction of the door and the track and the rollers and the counter-balancing mechanism for the door form no essential part of the instant invention.

As illustrated in FIGS. 1 and 2, the motor 27 is suspended from the operator frame. The frame supporting the motor 27 also supports a relay box indicated at 60. An electric light bulb 61 may, if desired, be mounted at the under side of the relay box, and a portion of a micro-switch 62 projects at the upper side of the relay box. As best shown in FIGS. 3 and 5 a switch arm 63 is disposed over the projecting portion of the micro-switch 62. The micro-switch 62 and the switch arm 63 are parts of the control arrangement for the motor 27, as will be described in connection with the electric circuits.

The angle iron 15 carries on the lowermost web thereof a plurality of apertured brackets 64. The brackets 64 support a rod 65 for rotation. The rod 65 extends along the web of the angle iron 15. A coil spring 66 is interposed between the rod 65 and the web of the angle iron 15 so that rod 65 and the switch arm 63 fixed thereto is biased to a position illustrated in FIG. 5 where it is out of contact or slightly above the actuating button of the micro-switch 62. The switch arm 63 may be swung downwardly against the action of the spring 66 so as to depress the button of the micro-switch 62.

The switch arm 63 is secured to rotate with the rod 65 by means of set screw 67. An actuating assembly 68 is secured to the rod 65 adjacent one end of the travel of the carriage 35. A similar actuating assembly 69 is secured to the rod 65 adjacent the other end of the carriage travel. The assembly 68 includes a transverse bar 70 pivoted as at 71. The pivoting movement of the bar 70 in one direction is limited by the block 72. The bar 70 is biased to swing into the position shown against the block 72 by a coil spring 73 interposed between the bar 70 and the assembly base carried by the rod 65.

The carriage 35 is provided with a pair of spaced depending cams 74 and 75. When the carriage 35 in moving to the left-hand end of the operator frame brings the cam 74 into engagement with the bar 70 of the actuator 68, the stop 72 prevents pivoting of the bar 70 on its pivot 71. Accordingly the edge of the bar 70 in contact with the sloping face of the cam 74 is rocked downwardly by the cam and thus the shaft 65 is rocked and the switch bar 63 depresses the micro-switch 62. This movement interrupts the power circuit to the motor 27, as explained hereinafter.

The bar rocking assembly 68 is preferably adjustably secured to the rod 65 so that power to the motor 27 is interrupted as the garage door approaches its fully open position. The motor 27 and the shaft 18 continue to rotate from momentum after the power is interrupted so that the cam 74 moves completely past the bar 70, and the carriage 35 and the door coast to fully opened position, instead of being driven by power against a limiting stop. This greatly reduces wear and shock on the operator mechanism and the door itself.

Assuming that the cam 74 has interrupted the motor drive and has passed beyond the bar 70 as above described, when the operator is actuated so as to move the carriage 35 in the opposite direction, the motion of the carriage brings the straight side 74a of the cam 74 into engagement with the bar 70. The carriage overcomes the bias of the spring 73 and the bar merely pivots away

from its stop 72 and the carriage 35 moves to the other end of its travel. Thus on the return of the carriage, cam 74 does not move the lever arm 63.

The actuator assembly 69 is constructed substantially as the actuator assembly 68. It includes a pivoted bar 76 which is spring-biased about its pivot against a block 77. When the carriage 35 is moved to the right-hand end of the operator frame (as viewed in FIG. 3), the cam 75, by means of the bar 76, rocks the rod 65 and again depresses the arm 63 and the micro-switch 62 to interrupt the power to the motor. The assembly 69 is adjustably positioned so as to cut off the power and allow the door and the carriage to coast to fully closed position, carrying the cam 75 completely past the bar 76.

The drive shaft 18 is preferably provided with a pair of oppositely disposed cam lugs 80 and 81 adjacent the arm 63 and also adjacent the micro-switch 62. Preferably the lugs 80 and 81 are mounted for axial adjustment by reason of the slots 82 and 83, respectively. Fastening means such as cap screws 84 are threaded into the member 18 and may be drawn up after the proper axial adjustment is made of the lugs 80 and 81.

The springs 23 and 24 carried by the stub shafts 19 and 20, respectively, permit limited axial movement of the tubular driving shaft 18, and such movement changes the path of rotation of the cam lugs 80 and 81. During the normal operation of the door no loads are imposed on the tubular driving shaft 18 such as would produce substantial axial movement of the driving shaft 18. When, however, the movement of the door is retarded as, for example, it strikes an automobile or other object on its way down, or is caught on its way up, then the force of the drive imparted to the tubular driving shaft 18 produces axial movement of the driving shaft 18. As will be best seen in FIG. 5, axial movement of the driving shaft in either direction causes either the lug 80 or 81 to strike against the bar 63 during rotation of the shaft 18 and bring about a depression of the micro-switch 62. By circuit control means hereinafter described in detail, the first depression of the micro-switch by the cams 80 or 81 sufficiently far to close a circuit therethrough interrupts the flow of current to the driving motor, and also breaks the circuit to the micro-switch so that further movements that may be imparted to the micro-switch by the cams as the shaft 18 continues to rotate during deceleration of the motor are ineffective. In the event the microswitch 62 fails to operate or sticks, the continued rotation of the shaft causes the cam to cycle the switch until it is operated properly. This insures reliable operation, eliminating fire hazards and the like.

The cams 80 and 81 preferably have rounded exterior surfaces on their body portions and tapering rounded points 85 and 86, respectively. The points 85 and 86 taper up to a radial height sufficient to cam the micro-switch 62 closed upon axial displacement of the shaft 18 less than the axial length of the points 85 and 86. The radial height of the body portions of the cams 80 and 81 is sufficient to insure depressing the micro-switch far enough to close it firmly but insufficient to damage or break the switch if the shaft should rotate several times after shifting axially through a greater length than the length of the points 85 and 86. The axial length of the cams 80 and 81 exceeds the maximum possible axial movement of the shaft 18 permitted by the stub shafts 20 and 21 and the frame members 7 and 14.

Referring particularly to FIG. 6, I have illustrated diagrammatically the electrical control forming a part of my invention. Lines 90 and 91 indicate the conventional single-phase A.C. power supply line, usually 110-115 volts. The motor 27 may be any conventional single-phase induction motor provided with a starting winding such as a split-phase or capacitor motor. Such motors can be started in either direction depending upon the relative connections from the supply line to the running winding and the starting winding. One problem in connection with single-phase reversing motors, however, is

that a certain time must be allowed to elapse between cutting off the power when the motor is running in one direction and attempting to start the motor in the opposite direction. If insufficient time is allowed the motor, instead of starting in the reverse direction, will again start or continue to run in the same direction in which it was previously run.

The control means and circuit of the present invention eliminate any danger to the door operator mechanism or to the motor from this characteristic. Generally speaking, the control means and circuit are arranged to provide for starting, stopping and reversing of the motor at the will of the operator by a radio-operated switch or one or more manual push buttons. Automatic controls are arranged to interrupt the power to the motor when the door has travelled to a predetermined point in either direction and also to interrupt the power to the motor when the door is subjected to excessive resistance to motion in either direction. The automatic controls also override the manual controls and cut off the power to the motor in the event a manual control should be operated in an effort to reverse the motor but should be operated too soon after interruption of drive in one direction. In this event the motor instead of reversing would attempt to continue to operate in the same direction even though the connection should be reversed by the switch. If this occurs when the door has been stopped by an obstacle or by reaching the limit of its travel in one direction the cam 80 or 81 again cuts off the motor power as soon as the shaft 18 has made a revolution.

A low voltage control circuit is preferably provided for the manual push buttons for safety reasons. A transformer 96 is connected by means of lines 94 and 95 to the power line 90-91. The transformer output may be about 24 volts and is effective in the circuit including lines 97 and 98. One or more push button switches such as 99 are in the circuit 97-98 as well as the radio switch 93, which may be operated by any suitable type of radio 92. Closing of the radio switch 93 which may be effected by a suitable signal received by the radio 92 or closing of the manual push button switch 99 makes a circuit through the lines 97 and 98 to close the normally open relay switch 100. When the push button 99 is released or the radio switch 93 opened by termination of the radio signal the relay 100 again opens. When the relay 100 is closed it establishes a circuit through the lines 101 and 102 from the power supply line 90 through the alternating current solenoid 104 of a ratchet or stepper relay and the line 105 to the power line 91.

As known in the art the ratchet or stepper relay includes a pawl 106 adapted to engage the teeth of a ratchet disc 107. As diagrammatically illustrated the pawl 106 is normally lowered and is lifted one tooth or step each time the solenoid 104 is energized. The disc 107 is secured to a shaft to which is also secured a cam disc 108 so that the cam disc 108 is turned one step each time the solenoid 104 is energized.

As illustrated diagrammatically in FIG. 6 the cam plate 108 is divided into steps having three different lift heights, each alternate step 109 being of intermediate height and separating a high lift step 110 and a low lift step 111.

The dash-dot outline 112 in FIG. 6 represents a frame which is spring-pressed upwardly and connected to a suitable cam follower 113, the frame 112 being arranged to raise and lower switch contact members 115, 116, 117 and 118, each of which is movable between upper and lower contact points. When the follower 113 is in engagement with an intermediate step 109 of the cam plate 108 the switch members 115 and 118 are in their central or off positions as illustrated in FIG. 6. When the cam follower 113 is in engagement with a high lift step 110 each of the four switch elements 115 to 118 is lowered into engagement with its lower contact point and when the follower engages a lower lift step 111 each of the four switch ele-

ments is raised into engagement with its upper contact point.

The switch elements 115 and 116 are connected to the power supply line 91 by connecting lines 120 and 122, respectively. The switch elements 117 and 118 are connected to the power supply line 90 by connecting lines 123 and 124, respectively.

The motor 27 has its starting and running windings brought out to separate terminals 127, 128 and 129, 130. One of the windings, for example the starting winding, has its terminals 127 and 128 connected by lines 131 and 132, respectively, with the upper and lower switch contacts 133 and 134 which are arranged to be engaged alternatively by the movable switch element 115. Switch contacts 135 and 136 are the upper and lower contacts, respectively, adapted to be engaged by the switch element 118. The contacts 135 and 136 are cross-connected with the contacts 133 and 134 by connectors 137 and 138. Thus, when the switch elements 115 and 118 are in their upper position the power line 91 is connected through the switch element 115, contact 133 and line 131 with the terminal 127, and the power line 90 is connected through the switch element 118, contact 135, cross-connector 137 and line 132 with the terminal 128. When the switch elements 115 and 118 are in their lower position these connections are reversed; that is, power line 91 is connected to terminal 128 and power line 90 is connected to terminal 127.

The other winding of the motor 27, which in the assumed example is the running winding, has its opposite ends connected to the terminals 129 and 130. Terminal 129 is constantly connected by line 136 to power line 91. Terminal 130 is connected by a line 138 to each of two switch contacts 139 and 140 constituting the upper and lower switch contacts adapted to be engaged by the switch member 117. Thus, when the switch member 117 is in either its upper or lower position the power line 90 is connected through line 123, switch member 117, switch contact 139 or 140 and line 138 with the motor terminal 130.

With this arrangement moving the switch contacts from upper to lower position reverses the relative connections of the two windings of the motor 27 and in the intermediate position of the switch contacts, as illustrated in FIG. 6, both motor circuits are interrupted.

In order to provide illumination when the door is being opened or closed and for a period of time after the motor power has been cut off, the switch element 116 is provided with upper and lower contacts 143 and 144 which are connected together by a line 145. The line leads to one side of a heating coil 146 of a thermal delay switch, the other side of the coil 146 being connected by a line 147 to the power line 90. The thermal delay switch includes a member such as a bi-metal strip diagrammatically indicated at 148 which is connected to a line 141 leading to a lighting device such as the electric lamp 61. The other side of the lamp 61 is connected to the power line 90 by a line 155. The bi-metal element 148 is arranged when hot to bend into contact with a switch contact 149 which is connected to a line 142 leading to the power line 91. When cold the bi-metal element 148 moves away from the contact 149 breaking the circuit. The line 145 is also connected by a line 156 to the line 141 leading to the lamp 61.

When the cam 108 moves the switch elements 115 to 118 into either their upper or lower positions, energizing the motor for operation in one direction or the other, the switch element 116 makes a circuit through the heating coil 146 by means of contact 143 or 144, and at the same time energizes the lamp 61 through the parallel circuit formed by the line 155 and 156. The heating coil 146 and the bi-metal element 148 are arranged so that the bi-metal element is heated and bent into engagement with the contact 149 in a shorter period of time than that normally required to operate the door from one of its opened or closed positions to the other. Thus, another circuit through the lamp 61 is established

from the power line 90 through the line 142, contact 149, bi-metal element 148 and lines 141 and 155 before the circuit through the lamp established by the switch element 116 is broken by the next movement of the control relay to off position. Thus, when the switch elements 115 to 118 move to their off positions current continues to flow through the lamp until the heating coil 146 and the bi-metal element 148 have cooled off sufficiently to permit the bi-metal element to bend away from the contact 149 and break the circuit. It will be understood, of course, that any desired form of time delay switch may be used and the timing may be adjusted to maintain the lamp energized for as long a period as desired after each operation of the motor. One or more manual switches, such as 156a, may be arranged to energize the lamp 61 independently of the relay and the thermal switch 146.

The normally opened micro-switch 62 is connected in parallel with the relay switch 100 for energizing the solenoid 104 of the stepper relay, but is supplied with current only when the motor is being operated in one direction or the other. For this purpose the switch contacts 139 and 140, which are connected together, are also connected by a line 150 with a contact 151 of the micro-switch. The other contact 152 of the micro-switch is connected by a line 153 to the line 102 at connection 103.

In FIG. 6 a portion of the shaft 18 and switch arm 63 are illustrated diagrammatically in inverted position to indicate their relation with the micro-switch 62. When the switch 62 is depressed by the arm 63, either as a result of the cam 74 or 75 rocking the shaft 65, or as a result of axial displacement of the shaft 18 and engagement of the cam 80 or 81 with the arm 63, the switch element 62 engages and establishes a circuit between the contacts 151 and 152. If the switch elements 115 to 118 are in either their upper or lower positions so that the motor is energized for operation in one direction or the other, closing of the circuit through the contacts 151 and 152 by the micro-switch 62 supplies current from the power line 90 through the switch element 117 and the lines 150 and 153 to one side of the solenoid 104 of the stepper relay, the other side of the solenoid being connected to the power line 91 by the line 105. When this occurs the pawl 106 moves the ratchet 107 through one step and thereby turns the cam plate 108 one step so that the switch elements 115 to 118 are moved to their central positions opening all of the circuits except the lighting circuit which has been established through the bi-metal element 148. Subsequent operations of the micro-switch 62, which may occur as the motor and the operator mechanism decelerate, have no effect since the circuit to the micro-switch has been opened by the switch element 117.

If the door has been moved to either its opened or closed position and the motor circuit has been interrupted and a person should press the push button 99 or operate the radio switch 93 before the motor has had time to completely decelerate, the solenoid 104 would be energized and would move the cam 108 to its next step, closing the switches in a way intended to start the operation of the motor in the opposite direction. When this occurs, however, the motor continues to operate in the same direction in which it has been turning. Since the door has reached the limit of its movement in that direc-

tion the shaft 18 shifts axially to cause one of the cams 80 or 81 to again interrupt the circuit through the micro-switch 62 and quickly bring the motor to a stop. The skewed rubber-faced rollers 51, 52 and 53 are arranged to provide a substantial driving force on the carriage but are free to skid on the shaft 18 without breaking any of the parts or damaging the motor in the event the shaft rotates further after the maximum permitted axial movement of the shaft. Thus, if the push button or radio switch should be improperly actuated in an effort to drive the door farther in one direction after it has reached the limit of its motion or encountered an obstacle neither the mechanism of the door operator nor the motor are subjected to excessive shock or heating. By adjusting the frictional engagement of the skewed rollers with the shaft so that they are incapable of stalling the motor, even though neither the carriage nor the shaft 18 can move axially, the present invention insures that the shaft 18 will nevertheless rotate far enough to actuate the micro-switch 62 by one of the cams 80 or 81 thereby interrupting the motor drive.

While a preferred embodiment of the invention has been described in considerable detail it will be understood that various rearrangements and modifications may be resorted to without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. Door operator means comprising a rotatable shaft mounted for rotation and limited axial movement from a normal position, a carriage engaging said shaft and adapted to be reciprocated therealong by rotation of said shaft, a motor for rotating said shaft, a control circuit for said motor including a switch mounted adjacent said shaft, said shaft having a pair of axially spaced cam members projecting from the surface thereof the peripheral extent of said cam being less than 360°, said switch being mounted in a position axially between said cam members in the normal axial position of said shaft and, said switch being engaged and operated between opened and closed positions by one of said cam members during each rotation of said shaft when said shaft is shifted axially in either direction from its normal axial position.

2. A door operator means comprising a rotatable shaft mounted for rotation and limited axial movement from a normal position, a carriage engaging such shaft and adapted to be reciprocated therealong by rotation of such shaft, a motor for rotating such shaft, a control circuit for said motor including switching means mounted adjacent such shaft, said shaft having a pair of axially spaced elongated cam members projecting from only one side thereof, said switching means being mounted in a position axially between said cam members in the normal axial position of said shaft, said switching means being engaged and operated between opened and closed positions by one of said cam members each time said shaft rotates through one revolution when said shaft is shifted axially in either direction from its normal axial position.

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