Nov. 30, 1965 L. A. WIKKERINK 3,220,718

DOOR OPERATOR

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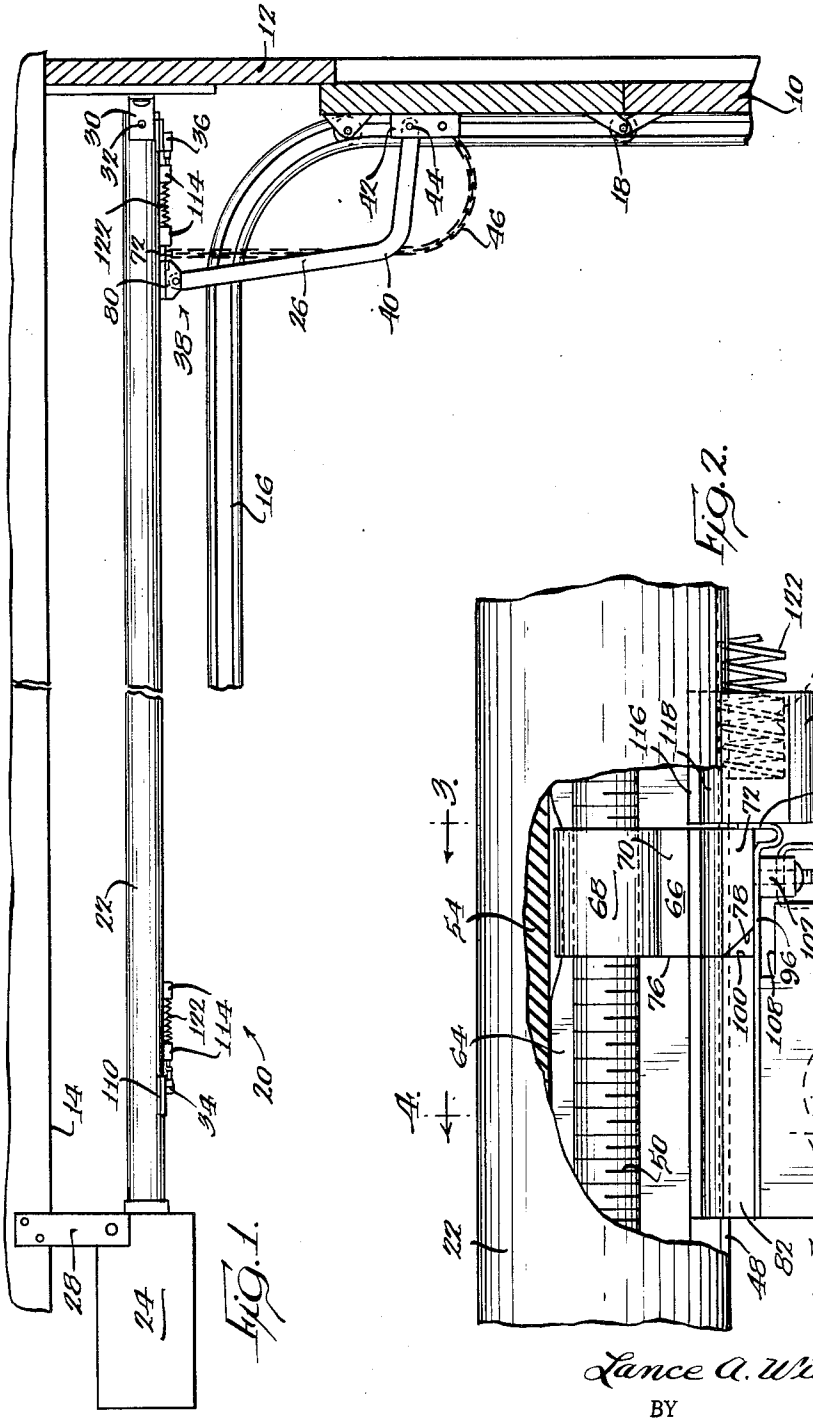

FIG. 1.

FIG. 2.

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Fig. 3.

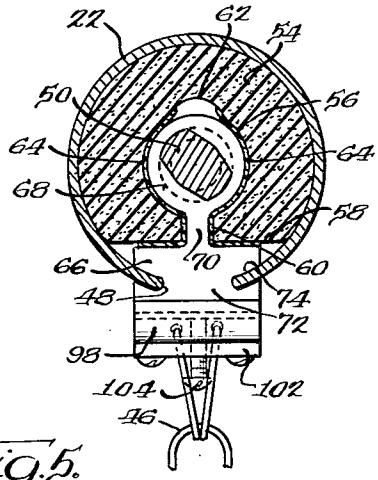

Fig. 4.

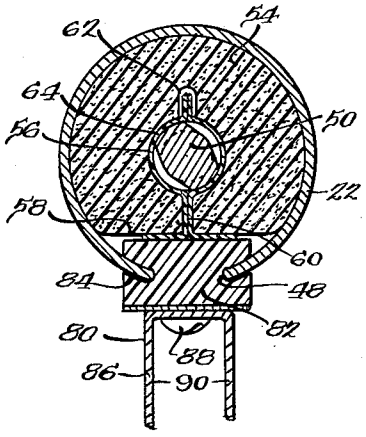

Fig. 5.

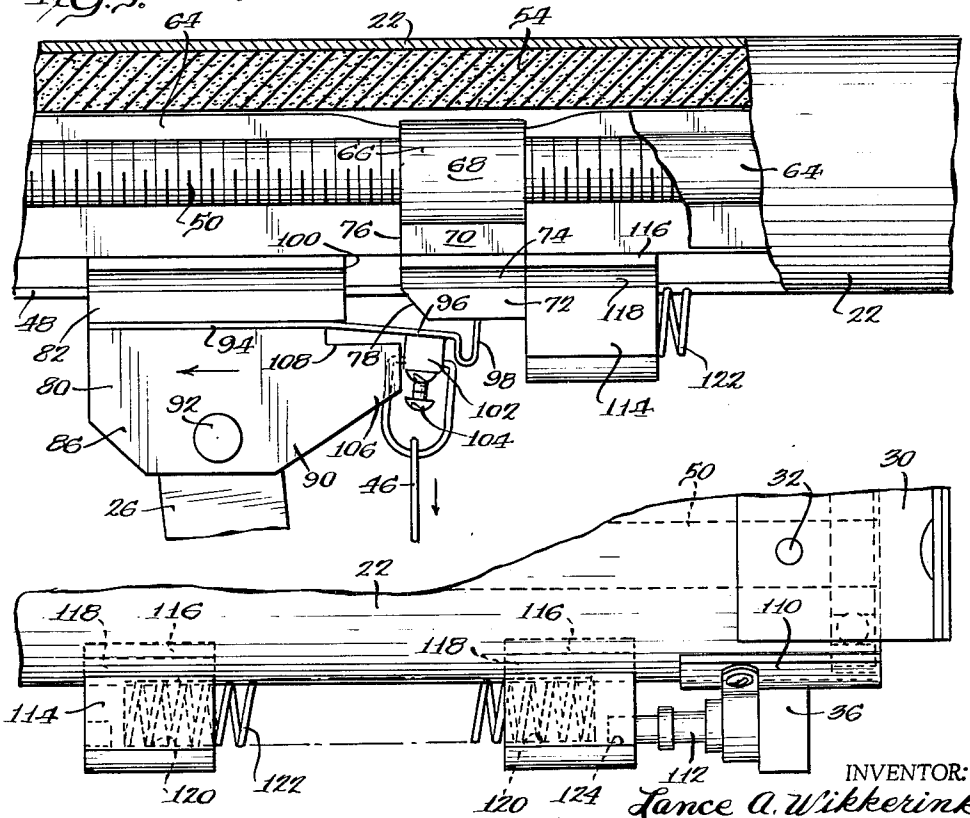

Fig. 6.

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Fig. 7.

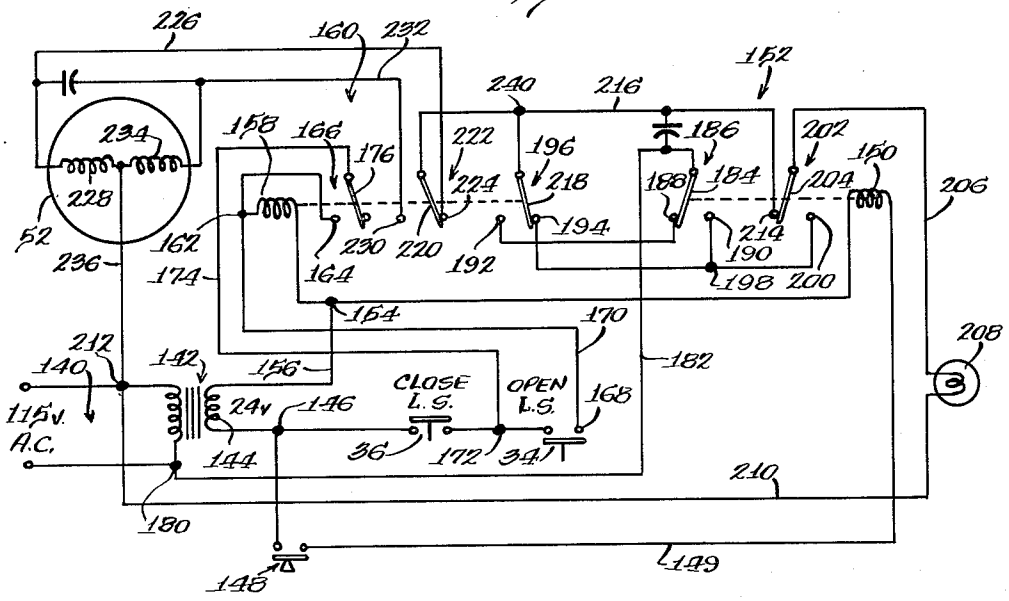

Fig. 8.

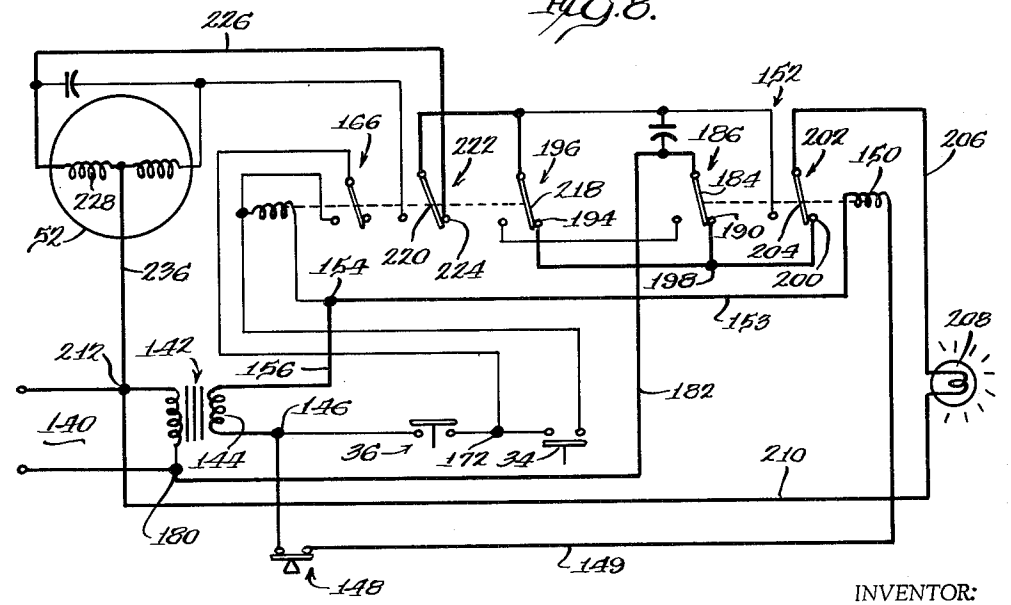

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Fig. 9.

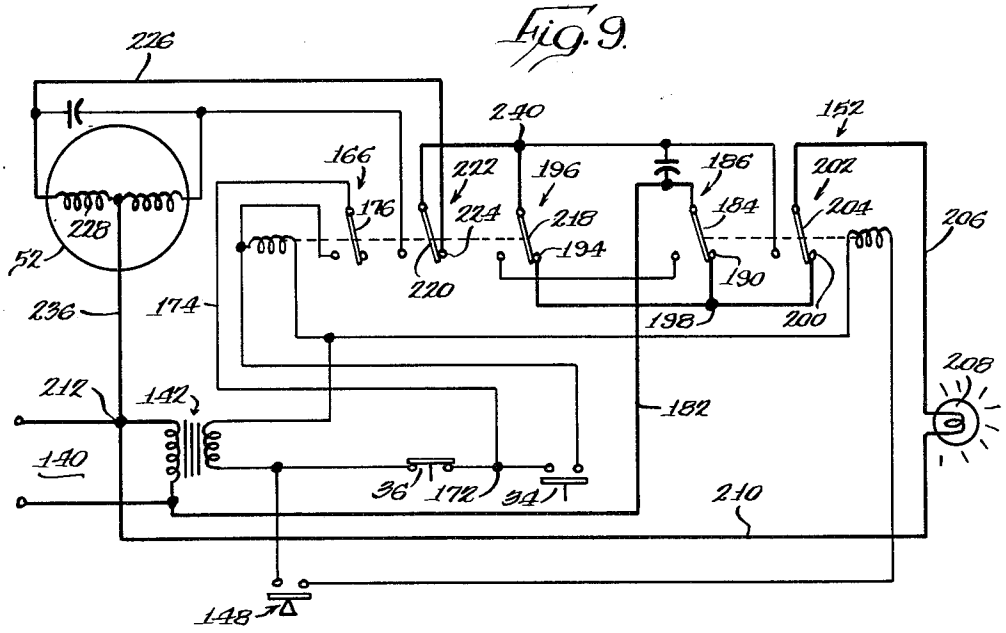

Fig. 10.

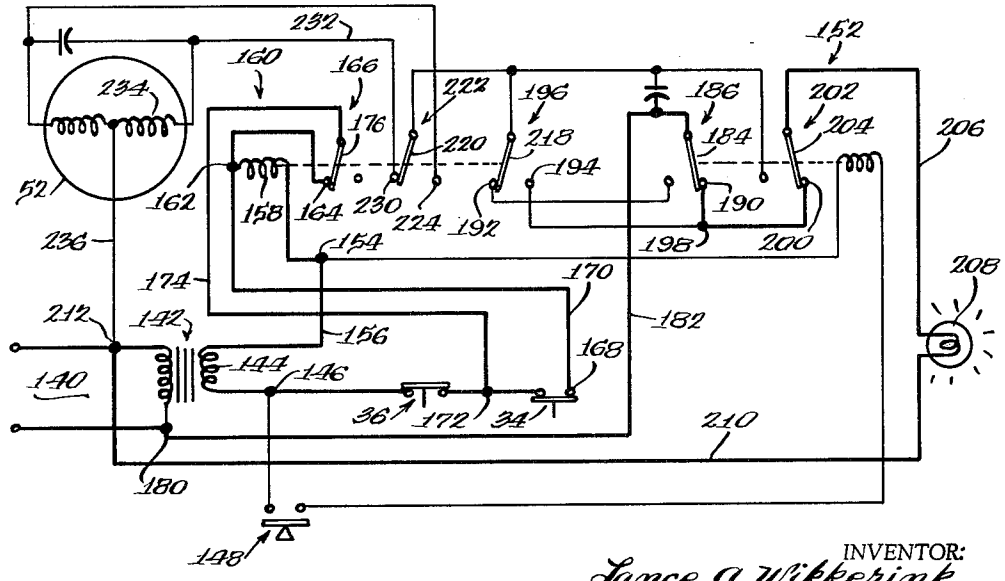

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Fig. 11.

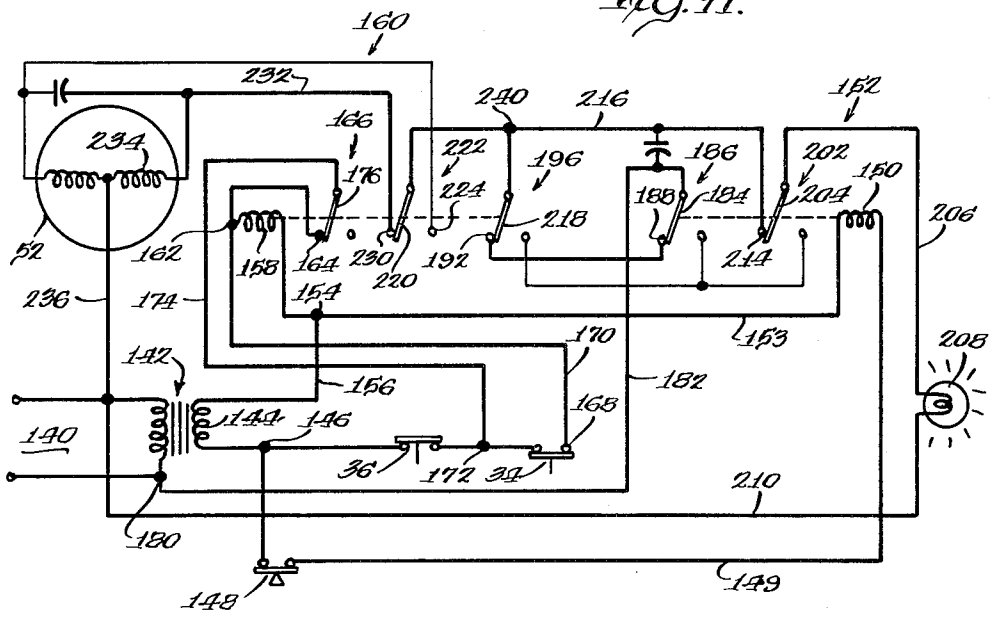
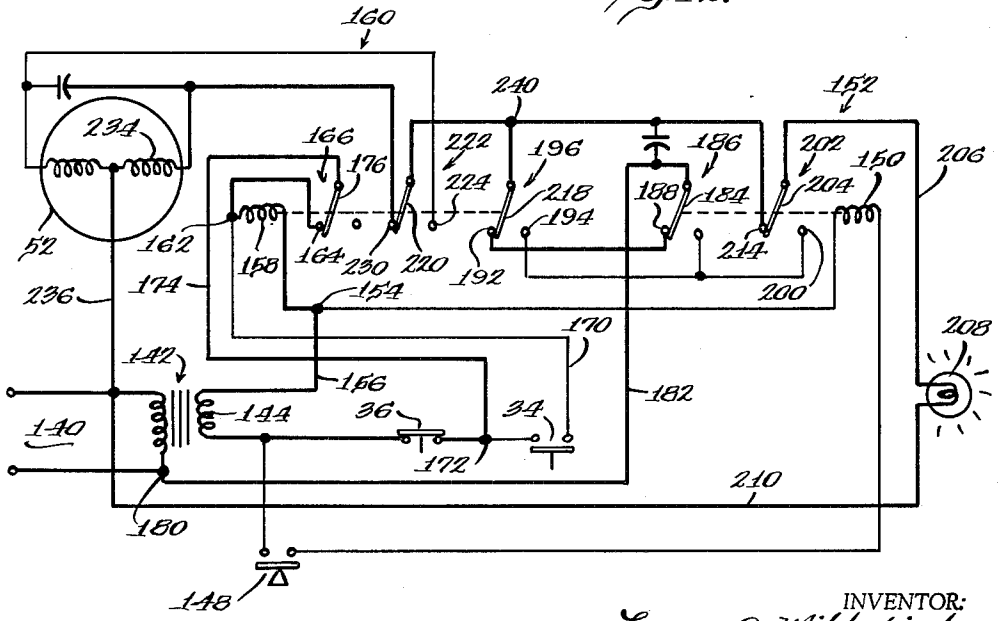


Fig. 12.



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United States Patent Office 3,220,718 Patented Nov. 30, 1965

3,220,718

DOOR OPERATOR

Lance A. Wikkerink, Milwaukee, Wis., assignor to Republic Industries, Inc., Chicago, Ill., a corporation of Illinois

Filed May 9, 1963, Ser. No. 279,148
3 Claims. (Cl. 268—59)

My invention relates to a door operator for overhead doors, particularly as used in garages.

While overhead garage door openers, either directly or remotely operated, are a commonplace, the opener of my invention has many advantages over those currently being sold.

It employs a screw transport for a door which eliminates a speed reducer and thus avoids cost of fabrication, maintenance, and possibility of failure.

It employs a novel system of screw support whereby the screw is supported over substantially its whole length for effective support, prevention of bowing, and quietness of operation. As a consequence, a screw of remarkably small diameter may be employed which will have the non-bowing characteristics of one of much larger diameter.

The operator of my invention likewise includes safety mechanism whereby, as the door is being moved to its closed position, it will be disengaged from the driving mechanism in the event that an obstacle to full closure is encountered that otherwise might injure the mechanism. The same mechanism is manually operable to disengage the door from the drive mechanism if it should be desired to open the door manually as in case of a power failure, etc.

The operator likewise includes unique circuitry controlling the operation of the operating motor whereby the limit switches determining the end point of travel of the door-moving mechanism control exclusively the energization or de-energization of the motor.

Thus a single button or other signal controls both the opening or closing of the door. The circuitry of my invention likewise includes provision whereby, once the signal is delivered, opening and closing proceeds without the need for maintaining the signal through limit switch clearance. Finally, the circuit is simple, positive, and free from malfunction.

Other objects and advantages of my invention will be apparent from the following description and drawings of which:

FIG. 1 is a side elevation of a door operator embodying my invention shown mounted in a garage centrally above a garage door;

FIG. 2 is an enlarged side elevation of the right hand portion of the track of FIG. 1 broken away in part and showing the traverse assembly;

FIG. 3 is a section taken substantially along the line 3—3 of FIG. 2 looking in the direction of the arrows;

FIG. 4 is a section taken along the line 4—4 of FIG. 2 looking in the direction of the arrows;

FIG. 5 is a view similar to FIG. 2 showing, however, the disengagement of the carrier assembly as a safety factor or for manual operation of the door;

FIG. 6 is an enlarged side elevation of the right hand end of the track of FIG. 1 showing particularly the limit switch;

FIG. 7 is a diagram of the electrical control circuit for the operator in its condition when the door is closed;

FIG. 8 illustrates the circuit in the condition of door closed, button pushed to open;

FIG. 9 illustrates the condition of the circuit when the button is released and the door is opening;

FIG. 10 illustrates the condition of the circuit when the door is fully opened;

FIG. 11 illustrates the condition of the circuit when the door is opened and the button is pushed to close; and

FIG. 12 illustrates the condition of the circuit when the door is closing, button released.

FIG. 1 is a section of the interior of a garage having a sectional garage door **10** of the overhead type. The garage includes a lintel **12** over the door opening and a ceiling **14**. The door is mounted in guide rails **16** on either side of the door opening which extend vertically downward beside the opening and horizontally to the garage back above the opening. The door is mounted in the rails by rollers **18**.

The operator **20** consists of a tubular track **22** having a motor and control housing **24** rigidly secured to the front end thereof and an arm **26** which is adapted for attachment to the top of the door. The housing and tube are mounted to the interior of the garage longitudinally above the center of the door. A hanger **28** supports the housing **24** from the ceiling **14** or rafter of the garage, and the opposite end of the tube **22** is secured against the lintel **12** by an appropriate bracket **30**. A pin **32** extends between the ears of the bracket and through the end of the tube **22** to lock the tube to the bracket.

The tube mounts an OPEN limit switch **34**, a CLOSE limit switch **36**, and a traverse assembly **38**.

The arm **26** has an elbow **40** to accommodate the top edge of the door when the top section thereof has been moved to the horizontal position within the rails **16**. The arm is pivotally connected to the traverse assembly **38** at one end and, at the other, to a bracket **42** secured to the top section of the door. The bracket **42** may be a short length of angle iron secured by one flange to the surface of the door section and having the arm **26** connected thereto on the other flange by pivot pin **44**.

A slack chain **46** likewise extends between the bracket **42** and the traverse assembly **38**.

Turning to FIGS. 2 through 6, the track **22** is a tube of circular cross section having a longitudinal slot extending its length in the bottom thereof defined by the slot edges **48**. The tube contains a screw **50** extending into the motor and control housing **24** at one end wherein it is directly coupled to the motor **52** (FIGS. 7 through 12). The screw extends the length of the track **22**. It is desirably double threaded in order to speed the movement of the door. The diameter of the screw is substantially smaller than the interior diameter of the track **22**.

The screw is supported within the track in a novel and effective fashion. Referring particularly to FIGS. 3 and 4, the space between the screw and the track is filled by a rubbery sponge **54**. Any of a variety of spongy materials may be employed as long as they have the characteristic of being resiliently compressible. The filler is formed in the general shape of a cylinder fitting snugly within the track **22** and having a central hole **56** therethrough. The bottom of the cylinder is flat as at **58** so that the filler terminates appreciably above the slot edges **48**. The filler likewise is slit as at **60** from the center of the flat bottom to the hole and slightly above as at **62**.

A pair of liners **64**, equal in length to the filler **54**, extend into the top slit **62**, follow the inside surface of the hole **56**, one on each side, extend on down through slit **60** and diverge to follow the flat bottom **58** on each side of the slit **60**. The liners should be made of nylon or some material having comparable characteristics. It should be flexible, wear resistant, have some measure of stiffness, and relatively high anti-friction characteristics. The degree of these requirements will be apparent later.

The screw **50** has mounted thereto a nut **66** which may likewise be formed of nylon. The nut includes an internally threaded sleeve **68** in direct engagement with the screw **50**, a stem **70** extending downward from the sleeve,

and a block **72** at the lower end of the stem. The block is wider than the track slot defined by the edges **48** with longitudinal grooves **74** formed in the sides thereof. The grooves **74** receive the slot edges **48** of the track to guide the block and nut for movement in the track and prevent the nut from rotating. Thus, rotation of the screw **50** will cause the nut to move along the track. The bottom edge of that transverse face **76** of the block leads as the door is drawn upwardly is beveled as at **78**.

The track likewise mounts a follower **80** which is transported from end to end of the track by the nut **66**. The follower includes a block **82** which has longitudinal grooves **84** therein in the sides thereof to receive the slot edges **48** of the track. The block is thus positioned partly within and partly outside the track, the portion within riding directly under the filler liner portion lying against the flat bottom of the filler.

A relatively long U-shaped bracket **86** is secured at its base against the bottom side of the block **82** as by screws **88**. The sides **90** of the bracket are oriented longitudinally of the track and extend downward. The upper end of the arm **26** is pivotally mounted between the sides **90** of the bracket by a pivot pin **92** which spans the sides.

A resilient metal plate **94** is contained between the block **82** and the base of the bracket **86** and extends substantially beyond both of these members at their rearward ends as at **96**. The extremity of this portion **96** is curved first downwardly and then perpendicularly upward to place the end thereof above and at right angles to the plane of the free portion **96** to define a hook end **98**. The spacing between the hook end and the rear surface **100** of the block **82** is such as to accommodate closely block **72** of the nut **66**.

The free portion **96** has a fitting **102** secured thereto inside the hook end **98** which in turn anchors one end of the chain **46**. The other end of the chain may hang free or may be anchored, as illustrated, to the arm bracket **42** on the garage door. Screw **104** adjusts the degree by which the hook end engages the block **72**.

The plate **94** is somewhat wider than the bracket **86**. The sides **90** of the bracket extend rearwardly as at **106** of the base thereof and the block **82** to which the bracket is secured. The top edges **108** of the rearward extensions **106** of the bracket sides, however, are stepped downwardly to be spaced substantially below the normal plane of the free portion **96** of the plate **94**. The downwardly spaced edges **108** permit a downward flexing of the free portion **96** and the hook end **98** thereof, but likewise serve to limit the flexing within the elastic limit of the plate **94**.

The tubular track **22** likewise mounts the OPEN and CLOSE limit switches **34** and **36**. As both of these switches are the same, only the CLOSE limit switch, particularly illustrated in FIG. 6, will be described. A plate **110** is secured to the under side of the track a short distance beyond the desired end point of travel of the traverse assembly **38**, and the swtich **36**, having an actuating button **112**, is secured to the plate with the button facing in the direction of the traverse assembly. A pair of cups **114**, desirably made of nylon or some similar material, are provided which have protrusions **116** on one side thereof similar to the portions of the follower block **82** and the nut block **72** which engages the slot edges **48** of the track. The protrusions have slot edge engaging grooves **118** identical with the grooves **74** and **84** of blocks **72** and **82** respectively. The protrusions support the cups below the track with the cavities **120** thereof facing each other. A compression spring **122** has its end contained in the cup cavities **120**. The cup adjacent the switch **36** has a socket **124** in its base which receives the push button **112** of the switch.

The mechanical functioning of my operator as thus far described is believed apparent from the foregoing description. The block **72** of the nut **66** is normally in the condition illustrated in FIG. 2 of being contained between the rear face **100** of the follower block **82** and the hook end **98** of the plate **94**. As the screw **50** is rotated in one direction or the other, the nut is moved in one direction or the other within the track. The nut block being so contained, the follower moves with the nut to carry the arm **26** between the ends of the track and so raise or lower the door.

The screw **50**, it will be understood, is supported over its entire length within the track **22** by the filler **54**, except in the immediate area of the nut **66**. The filler liners **64** have good antifrictional characteristics, as stated before, and the screw rotates freely in direct contact with the liners in those areas away from the nut **66** without snagging. The same antifrictional characteristics permit an easy passage of the nut through the track. As the nut moves along, it spreads the liners and compresses the filler immediately ahead in the vicinity of the sleeve **68** and the stem **70**, as best seen in FIG. 3. Behind, the filler and liners close to their normal condition of screw support, as illustrated in FIG. 4.

The movement of the nut and follower will continue until one of the limit switches is intercepted. The nut precedes as the door is moved to closure, and it therefore intercepts the CLOSE limit switch, as illustrated in FIGS. 2 and 5. The nut, or the hook end **98** of plate **94**, meets the inner cup **14** and moves it to compress the spring **122**, which in turn carries the outer cup **114** forcibly against the actuating button **112** of the switch **36**. In opening, the follower **80** precedes the nut and actuates the OPEN limit switch.

The provision for the breakaway of the follower **80** from the nut **66** will likewise be readily understood. The need, of course, arises only when the door is being moved to the closed position. The upper horizontal part of the track which holds the door in open position is well protected inside the garage and is at a height to forbid foreign matter getting into the track and jamming door operation. On the other hand, the vertical track part adjacent the door opening, and particularly that part near ground level, may easily become plugged with dirt or snow so as to prevent a full closure of the door. Snow may also gather on the garage floor at the open entrance to prevent full closure of the door. Should the door be checked in its movement to closure by foreign matter of some description, the nut, under continuous power from the screw, will bear with increasing force against the free hook end **96** of the plate **94**. The hook end under this pressure, will flex outwardly (to the right in FIG. 5) and then slide off the face of the block **72** over which it is engaged, so releasing the engagement between the nut and the follower and permitting the nut to travel on to the CLOSE limit switch independently. Likewise, when it is desired to disengage the operator from the door so as to permit manual operation of the door, the chain **46** may be pulled which will bend the free end **96** of the plate **94** downward and out of engagement with the nut block **78**. As stated before, the downwardly spaced edges **108** limit the springing of the plate within the elastic limit thereof to avoid permanent deformation of the plate.

The follower is very simply reengaged with the nut blocker **74**. The door is manually moved to bring the follower block **82** against the nut block **72**. The hook end **98** of plate **94** will strike the bevel **78** and be flexed downward thereby, riding along the bottom face of the nut block until it can snap up on the opposite face of the block.

The electrical circuit controlling the operation of my invention is illustrated in FIGS. 7–12. Power source **140** is connected to the primary of a low voltage transformer **142** which reduces line voltage to 24 volts. One side of the secondary **144** is connected through a terminal **146** to a circuit which includes the normally open START button **148**, the solenoid **150** of an impulse relay **152**, and terminal **154**. Terminal **154** in turn is connected through lead **156** to the other side of the secondary of

the transformer 142 and to the solenoid 158 of a common relay 160. The other side of the solenoid 158 is connected through terminal 162 to a contact 164 of a normally open holding switch 166 of the common relay 160. Terminal 162 is also connected to one side 168 of the normally open OPEN limit switch 34 by lead 170. The other side of the OPEN limit switch 34 is connected to a terminal 172 which in turn is connected through the normally closed CLOSE limit switch 36 to terminal 146. Terminal 172 is also connected through lead 174 to the blade 176 of holding switch 166.

115 volt current is delivered to the operating motor 52 in the following fashion. Current flows from one side of the 115 volt line to a terminal 180, and thence through line 182 to the blade 184 of a first double throw power switch 186 associated with the impulse relay 152. The contacts 188 and 190 of switch 186 are respectively connected to the contacts 192 and 194 of a second double throw power switch 196 associated with the general purpose relay 160. Contact 190 of relay 186 is also connected through terminal 198 with one contact 200 of a double throw light switch 202 associated with the impulse relay 152.

The blade 204 of switch 202 is connected through lead 206, a light bulb 208, a lead 210, to a terminal 212 on the other side of the 115 volt power line. The other terminal 214 of light switch 202 is connected by a lead 216 to the blade 218 of switch 196 and to the blade 220 of a motor reversing switch 222. The motor reversing switch is associated with the general purpose relay 160. Contact 224 of switch 222 is connected through lead 226 to the DOOR CLOSE winding 228 of the motor 52. Contact 230 of reversing switch 222 is connected through lead 232 to the DOOR OPEN windings 234 of the motor 52. The motor is grounded through lead 236 to terminal 212 on the other side of the 115 volt power line.

As stated before, FIG. 7 illustrates the condition of the circuit when the door is closed and awaiting operation. The impulse relay 152 is of that type where, upon successive energizations thereof, the blades of switches 186 and 202 swing first to the right and then back to the left. The blades of the common relay 160 are biased to the right and, upon energization, are moved to the left. The normally closed CLOSE limit switch is open by virtue of the nut block 66 or hook end 98 of the plate 94 bearing against the CLOSE limit switch 36. Thus, the 115 volt circuit is open by virtue of the open contact 192 of the second power switch 196 (terminal 180, lead 182, switch 186), and the 24 volt circuit is open by virtue of the open CLOSE limit switch and the open START button.

In FIGS. 8 through 12, the conducting parts of the circuit are shown in heavier lines.

FIG. 8 illustrates the circuit upon closure of the START button. It will be appreciated that my door operator will probably be operated remotely, and therefore that the starting button will be electrically actuated. However, since such remote switch operation is entirely familiar and plays no part in this invention, it has been shown as a manually operated button.

Closure of the START button closes the circuit from the secondary of the transformer 142 through terminal 146, button 148, lead 149, the winding 150 of the impulse relay 152, lead 153, terminal 154, and lead 156 to the other side of the transformer secondary to close the circuit through the impulse relay and move the switch blades 184 and 204 of switches 186 and 202 respectively into contact with terminals 190 and 200 of the switches. The closure of the blade of the first power switch 186 on the contact 190 energizes that contact with line power from terminal 180, lead 182, and switch blade 184. From contact 190, current flows through contact 200 and switch blade 204 of light switch 202 and lead 206 to light the pilot or garage light 208, the circuit continuing through lead 210 and terminal 212 to the other side of the primary voltage supply.

Current also flows from contact 190 of switch 186 to energize contact 194 of the second power switch 196. Current then flows through switch blade 218, blade 220, and contact 224 of motor reversing switch 222, and lead 226 to energize the OPEN winding 228 of the motor 52, the circuit being completed through ground 236 to terminal 212. The motor thus begins to rotate the screw 50 in a direction to move nut 66 away from the door opening.

FIG. 9 illustrates the condition of the circuit while the door is opening. It will be noted that the impulse relay 152 has been deenergized by virtue of the release of the START button 148 interrupting the secondary circuit, but that otherwise the circuit is the same as in FIG. 8 with the components of the primary circuit in the same relation. It will further be appreciated that the circuitry associated with the energization of the OPEN windings of the motor does not incorporate the CLOSE limit switch, and that the opening of the door will continue whether or not the CLOSE limit switch has been released prior to the release of the START button 148. As the nut 66 releases the normally closed CLOSE limit switch, however, the secondary circuit is closed through to the blade 176 of the now open holding switch 166, through terminal 172 and lead 174.

The door continues to open until the follower 80 meets and closes the normally open OPEN limit switch 34. The circuit condition is then as shown in FIG. 10.

When the normally open OPEN limit switch is actuated, its closes, and a secondary circuit is established through the solenoid 162 of the common relay 160. This circuit extends from one side of the secondary 144 of the transformer through terminal 146, the closed CLOSE limit switch 36, terminal 172, the now closed OPEN limit switch 34, lead 163, the solenoid winding 162, terminal 154, and lead 156 to the other side of the secondary. The common relay being thus energized, the holding switch blade 176 is moved to the left, and a holding circuit for the common relay is established through switch 176. This circuit extends from one side of the transformer secondary 144 through terminal 146, closed CLOSE limit switch 36, terminal 172, lead 174, switch blade 176 and terminal 164 of holding switch 166, the winding 162 of the relay 160, terminal 154, and lead 156 to the other side of the transformer secondary. It will thus be appreciated that the common relay 160 will remain energized following initial energization by the closure of the OPEN limit switch 34 as long as the normally closed CLOSE limit switch 36 is in its normally closed condition.

Energization of the common relay 160 shifts the blade 220 to the motor reversing switch 222 to the CLOSE contact 230, and the motor is thus conditioned to rotate in the direction to close the garage door through motor ground 236, DOOR CLOSE windings 234, lead 232, terminal 230, and blade 220 of reversing switch 222, and blade 218 of the second power switch 196 upon energization of terminal 192. Terminal 192, however, is dead until the START button 148 is again closed to energize again the impulse relay 152. A primary circuit exists through the light bulb 208, the circuit extending from terminal 212, lead 210, the light bulb 208, lead 206, contact 200 of switch 202, contact 190 of switch 186, lead 182, and terminal 180.

FIG. 11 illustrates the condition of the circuit when the START button 148 is pushed (or equivalently actuated) to begin closure of the door. It will be borne in mind that the CLOSE windings 234 of the motor 52 are conditioned for energization upon energization of terminal 192 of reversing switch 196 of the common relay 160. Operation of the button 148 energizes the impulse relay 152 through terminal 146, switch 148, lead 149, the winding 150 of the impulse relay 152, lead 153, terminal 154, and lead 156 to throw the switch blades 184 and 204 to the left. Terminal 192 is then energized to start door

closure through (reading backwards) terminal **188** and blade **184** of the first power switch **186**, lead **182**, and terminal **180** connected to the other side of the primary power source from the motor **52**. At the same time, the garage or pilot light continues to be energized through terminal **240** and switch **202**. The door thus commences to open.

FIG. 12 illustrates the condition of the circuit after the release of the START button **148** and after the follower has moved away from the open limit switch **34**. It is very much the same as that shown in FIG. 11. The START button **148** has been released, deenergizing the solenoid **150** of impulse relay **152**. The switch elements, however, maintain their position. Primary current continues through starting switch **186** to terminal **240**. Energization of the light thus continues. The solenoid **162** of the common relay **160** energized in FIG. 11 through the alternative paths of lead **174** including just the CLOSE limit switch **136** and lead **163** including both the CLOSE limit switch and the OPEN limit switch **34** is now energized only through the former. It will be appreciated that the condition of the OPEN limit switch is irrelevant here, and the operation of the door is not affected by the possibility of a release of the START button **148** before the OPEN limit switch is cleared.

When the door reaches its closed position, the CLOSE limit switch **36** is encountered by the nut **66** and opened. This breaks the remaining circuit to the common relay solenoid **162**, deenergizing it. The switches **166**, **222** and **196** thereupon close on their right hand terminals. Holding circuit switch **166** opens. Motor reversing switch **222** moves to condition the motor for door-opening operation. The second power switch **196** swings to the now-dead terminal **194**, breaking the primary circuit both to the light bulb **208** and to the motor **52**. The circuit is thus returned to the condition of FIG. 7.

The circuitry can be summarized as follows. The impulse relay **152** responds only to the START button **148**. The common relay **160** assumes one condition when the door is closed and opening and the other condition when the door is open and closing. The second power switch **196** of the common relay and the first power switch **186** of the impulse relay operate as a pair; for motor operating current to flow, each switch must be closed on a certain one of its contacts or, alternatively, on the other of its contacts. In the drawings, the switches must be either both on the left hand contacts or both on the right hand contacts. In opening, both switches are on the right hand contacts (FIGS. 8 and 9). When the door is fully opened, the OPEN limit switch is actuated, energizing the common relay (and its own holding switch) and moving one of the pair, switch **196**, to the left hand contact. Current flow to the motor is interrupted, but switch **196** is conditioned for the correlative movement of the other of the pair. (Concurrently, of course, the direction of motor rotation is changed.)

When the START button again is actuated, the impulse relay moves the first power switch **186** to the left. The pair of switches again being conductive, the motor is powered. This condition continues until the CLOSE limit switch is encountered, breaking the holding circuit of the common relay and closing switch **196** on the right hand contact out of conductive relation with switch **186**.

From the foregoing description, it will be appreciated that my door opener meets admirably its stated objectives. With the directly driven screw, the need for a speed reducer is avoided. Cost, complication, and maintenance are saved. The novel support system for the screw over virtually its entire length permits the use of a relatively small diameter screw. The operation is sure, powerful and quiet.

It will likewise be appreciated that the opener of my invention is effectively protected against the possibility of jamming. The break-away protective mechanism is simple and certain in operation and makes provision additionally for manual operation.

The circuitry also is simple and yet certain in operation. It is controlled by a single button or signal. Opening the door conditions the circuit for a following closure and vice versa. The paired switches provide an effective and simple answer to the alternate response to consecutive energization and reversing requirements. The switches operate to stop the motor of the end point of travel of the door regardless of misuse of the start button such as a malfunction of a remote operator maintaining continuous contact.

It will be further understood that I have described an embodiment only of my invention and that many alternatives in the practice thereof will undoubtedly suggest themselves. I therefore desire that my invention be regarded as being limited only as set forth in the following claims.

I claim:

1. A door operator comprising a longitudinally slotted tubular track, a screw rotatably supported within said track, reversible means for rotating said screw, a nut on said screw, means connected to said nut and extending through said slot and adapted for connection to a door, and a resiliently compressible filler within said tubular track closely encompassing and supporting said screw and adapted to yield locally to permit the passage of said nut along said screw.

2. The combination as set forth in claim **1** including additionally a liner interposed between said filler and said screw and nut and having a low coefficient of friction and limited flexibility to prevent said screw and nut snagging on said filler.

3. A door operator comprising a longitudinally slotted, relatively large diameter, tubular track, a relatively small diameter screw within said track, reversible means for rotating said scew, a nut on said screw, means movable in said slot associated with said nut and adapted for connection to a door, and a resiliently compressible filler filling said track and supporting said screw having a longtiudinal slit opening to said slot, said filler being adapted to spread and compress locally to permit the passage of said nut and associated means and elsewhere to support said screw totally.

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