Aug. 8, 1961 M. K. RICHMOND 2,995,634

GARAGE DOOR OPERATOR

Filed Oct. 28, 1957 3 Sheets-Sheet 1

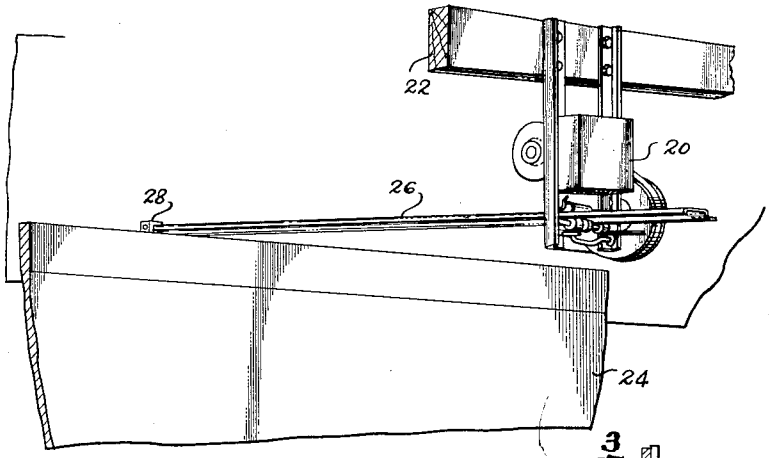

Fig. 1

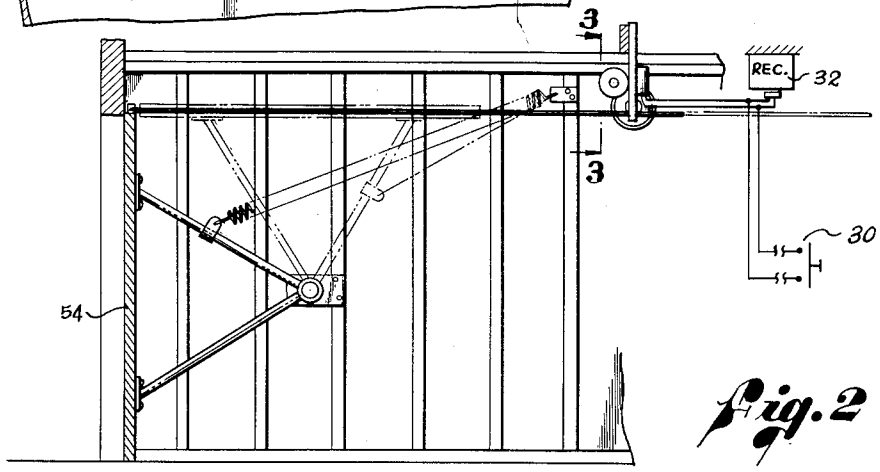

Fig. 2

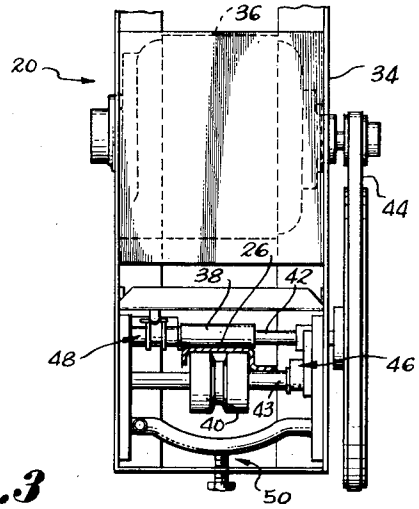

Fig. 3

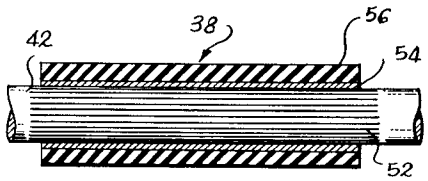

Fig. 4

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GARAGE DOOR OPERATOR

Filed Oct. 28, 1957 3 Sheets-Sheet 2

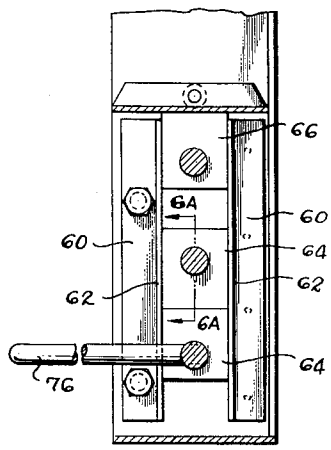

Fig. 6

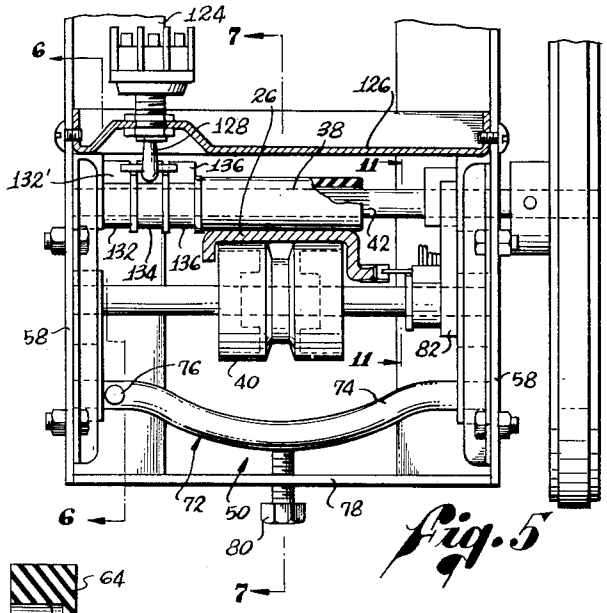

Fig. 5

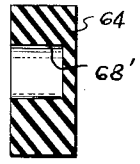

Fig. 6A

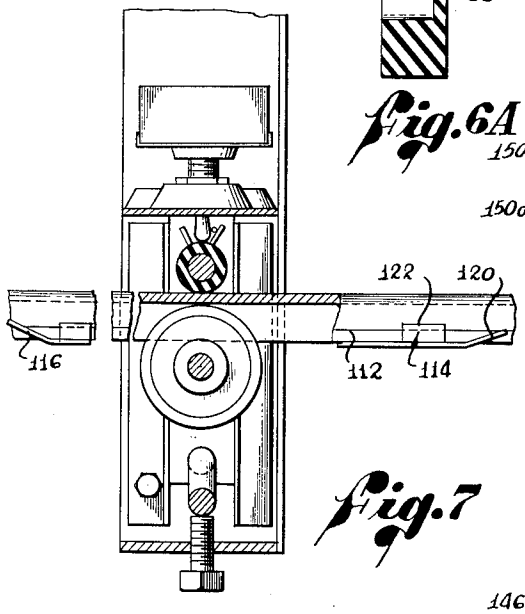

Fig. 7

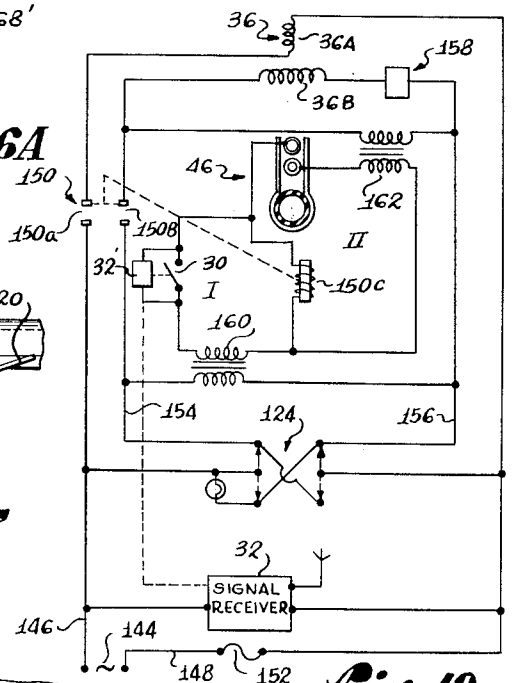

Fig. 19

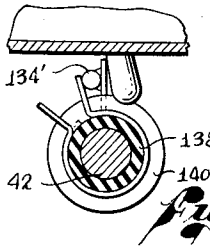

Fig. 8

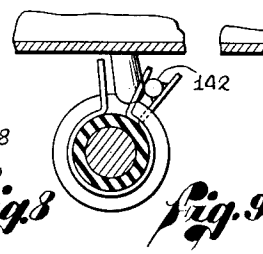

Fig. 9

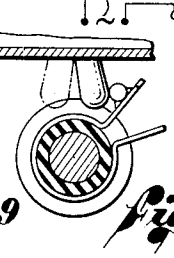

Fig. 10

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GARAGE DOOR OPERATOR

Filed Oct. 28, 1957 3 Sheets-Sheet 3

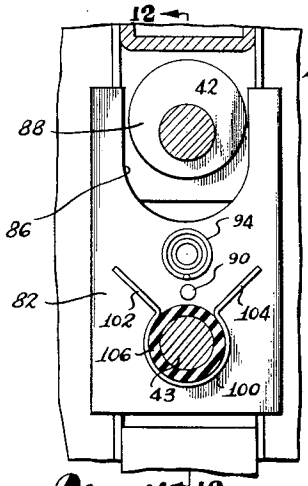

Fig. 11

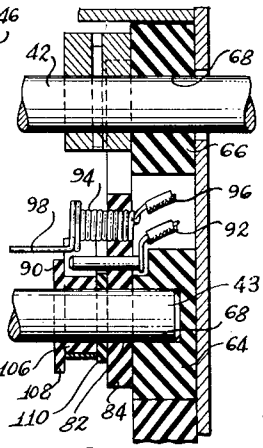

Fig. 12

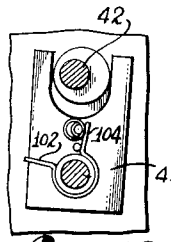

Fig. 13

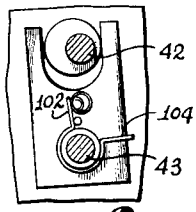

Fig. 14

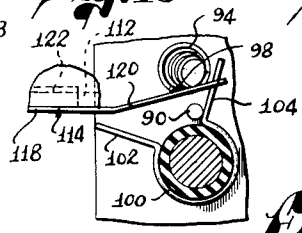

Fig. 15

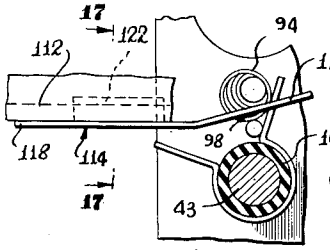

Fig. 16

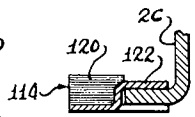

Fig. 17

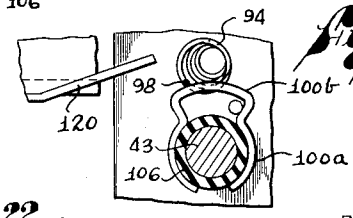

Fig. 18

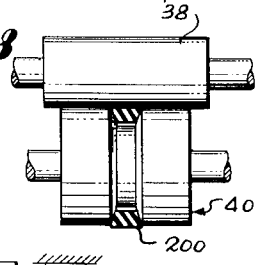

Fig. 21

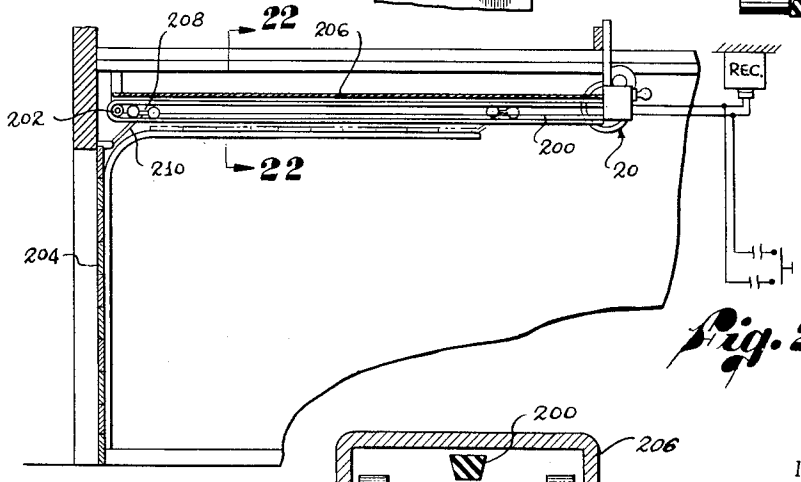

Fig. 20

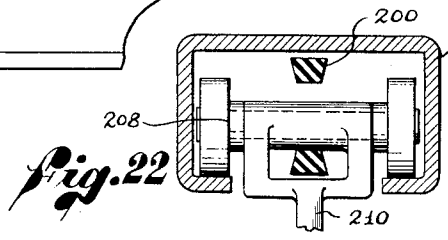

Fig. 22

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United States Patent Office 2,995,634 Patented Aug. 8, 1961

2,995,634

GARAGE DOOR OPERATOR

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Filed Oct. 28, 1957, Ser. No. 692,789
2 Claims. (Cl. 200—47)

This invention relates to automatic garage door operators and particularly to improvements in the operator disclosed in Patent No. 2,752,150, issued June 26, 1956, and entitled "Garage Door Operator."

Briefly, the patented garage door operator comprises an elongate channel member pivotally connected at one end to the door to be operated, and having its opposite end received between a pair of rollers in a drive mechanism. One of these rollers is freely rotatable to form an idler roller, while the other roller, comprising a friction roller, is coupled to a reversible motor in the driving mechanism. The idler roller is adjustable toward and away from the driving roller to enable a limited degree of frictional contact to be established between the driving roller and channel.

During operation of the patented door operator, which may be initiated either by closure of manual switch means or by radio control, the driving roller is turned in one direction to move the channel in a first longitudinal direction for opening the door and turned in the other direction to move the channel member in the opposite longitudinal direction to close the door. The spacing between the idler and drive rollers is so adjusted that the frictional contact between the latter roller and channel is just sufficient to permit driving of the channel in opposite directions during normal operation of the apparatus. The arrangement is such as to accommodate slippage between the channel and driving roller in the event the door encounters an obstruction during opening or closing thereof.

Embodied in the operator are certain safety switch means responsive to a change in speed of the idler roller relative to the drive roller, such as arises when slippage occurs between the channel and driving roller, for terminating operation of the drive motor. The garage door operator is, therefore, automatically stopped in response to the door meeting an obstruction. Also embodied in this prior garage door operator are certain limit and reversing switch means which effect automatic termination of the drive motor and conditioning of the latter for subsequent reversed direction of operation in response to movement of the door to its opened or closed position.

A broad object of the present invention is the provision of an automatic garage door operator of the character described which presents certain improvements over the door operator of the above-mentioned patent.

A more specific object of the invention is the provision of an automatic garage door operator of the character described which embodies novel combination safety and limit switch means for terminating operation of the door operator in response to the door encountering an obstruction during its movement, as well as in response to movement of the door to its opened or closed position.

Another object of the invention is the provision of a garage door operator of the character described embodying new and improved reversing switch means for effecting alternately reversed direction of operation of the operator.

A further object of the invention is the provision of a garage door operator of the character described wherein improved and simplified bearing means for the idler and drive roller are provided, which permit a reduction in the complexity and cost of, as well as increased smoothness of operation of the operator.

Yet a further object of the invention is the provision of a garage door operator of the character described embodying a novel drive roller construction which is less prone to wear and deterioration and susceptible of less costly manufacture than existing drive rollers for this purpose.

The garage door operator of the abovementioned patent is especially designed for use with so-called overhead garage doors of the type commonly used in the western portion of the United States. Doors of this type comprise, in effect, a single rigid panel which is hinged for pivotal movement about a horizontal axis located intermediate the upper and lower edges of the door and spaced a distance from the plane thereof.

Garage doors in the eastern section of the United States, on the other hand, are often of the type embodying a plurality of sections or panels, adjacent ones of which are hinged along their edges for relative pivotal movement about horizontal axes. Each of these panels is provided at opposite ends with rollers which ride in curved tracks. During opening and closing of the door, these tracks guide the several panels for movement along an arcuate path between a closed position, wherein the panels are located in a common vertical plane closing the garage door opening, and an open position, wherein the several panels are located in a common horizontal plane, spaced a suitable distance above the garage floor.

Yet another object of the present invention is the provision of an automatic garage door operator which is so constructed as to enable it to be accommodated to use with either single panel or multiple hinged panel garage doors with a minimum of modification.

Still a further object of the invention is the provision of a garage door operator of the character described which is relatively simple in construction, easy to install, inexpensive to manufacture, and reliable in operation.

These and other objects and advantages of the invention are obtained in the primary illustrative embodiment thereof by the provision of a drive mechanism frame adapted for mounting in an overhead position in a garage. Journalled in this frame are a pair of horizontal rollers, one of which is freely rotatable in the frame and comprises an idler roller. The other roller, comprising a driving roller, mounts a sleeve of suitable friction material. This latter roller is coupled to a reversible drive motor and is formed with a circumferential groove.

When used with a conventional, single panel overhead garage door, the actuating channel extending from the door is received between these rollers, as previously mentioned. In those cases where the operator is to be used with a multiple hinged panel garage door, a hollow tubular channel or track is affixed at opposite ends to the operator frame and door frame. One wall of this channel is longitudinally slotted. Movable within the channel is a carriage which is attached to an endless belt. This belt passes over an idler roller at the door end of the channel and encircles the idler roller within its circumferential groove.

A link attached to the carriage projects through the slot in the channel and is secured to the upper panel of the door so that when the carriage is moved in one direction in the tubular channel, the door is pulled to an open position. When the carriage is moved in the opposite direction, the door is moved to a closed position. In either form of the apparatus, therefore, rotation of the drive roller in opposite directions effects opening and closing of the door.

The novel combination safety and limit switch means embodied in the operator comprises, in effect, means for continuously sensing the speed of rotation of the idler roller. These switch means are responsive to a change

in the idler roller speed, relative to that of the drive roller, such as occurs when the door encounters an obstruction either during closing or opening thereof, to terminate operation of the drive mechanism. This safety switch means includes a resilient contact element which is engageable by a pair of limit stops on the actuating channel, at opposite limits of movement of the latter, to terminate operation of the operator upon movement of the door to its open or closed position.

Unique reversing switch means embodied in the operator are responsive to two rotations of the driving shaft, during which the motor of the drive mechanism reaches a predetermined operating speed, to condition the operator for alternately reversed directions of operation. The apparatus involves various other novel features of construction, such as the previously mentioned bearings for the rollers, which will become readily apparent from the following detailed description taken in connection with the accompanying drawings, wherein:

FIGURE 1 is a perspective view of the present garage door operator;

FIGURE 2 shows the present apparatus, partially in section, installed in a garage equipped with a so-called overhead type garage door of single panel construction;

FIGURE 3 is an enlarged view looking in the direction indicated by the arrows on line 3—3 in FIGURE 2;

FIGURE 4 is an enlarged detail, partially in section, of a driving roller embodied in the present garage door operator;

FIGURE 5 is an enlarged view, partially in section, of the lower portion of FIGURE 3;

FIGURE 6 is a section taken along line 6—6 of FIGURE 5;

FIGURE 6A is a section taken along line 6A—6A of FIGURE 6;

FIGURE 7 is a section taken along line 7—7 of FIGURE 5;

FIGURES 8, 9 and 10 are views of certain reversing switch means embodied in the present door operator in three different positions of operation;

FIGURE 11 is an enlarged section taken along line 11—11 of FIGURE 5;

FIGURE 12 is a section taken along line 12—12 of FIGURE 11;

FIGURES 13 and 14 are views of certain combination safety and limit switch means embodied in the door operator showing the same in various positions of operation as a safety switch;

FIGURES 15 and 16 are enlarged views similar to FIGURES 13 and 14, showing the switch means of the latter figures in two different positions of operation as limit switch means;

FIGURE 17 is a section taken along line 17—17 of FIGURE 16;

FIGURE 18 shows an alternative form of the switch means of FIGURES 13–16;

FIGURE 19 is a schematic diagram of the electrical control circuit of the operator;

FIGURE 20 is a view, in reduced scale, illustrating the present garage door operator as applied to doors of the multiple-hinged panel construction;

FIGURE 21 is a view illustrating certain drive elements of the operator in FIGURE 20; and

FIGURE 22 is a section taken along line 22—22 of FIGURE 18.

Referring to FIGURES 1 and 2, illustrating the present operator as applied to a single panel, overhead garage door, the numeral 20 denotes the drive unit of the operator. This unit is attached to a ceiling beam 22 of a garage in the manner shown. As is more fully described in the aforementioned patent, drive unit 20 is operatively connected to the garage door 24 through an actuating channel 26. One end of the channel 26 is hinged at 28 to the door 24. The opposite end of the channel 26 is operatively engaged with and moved in opposite longitudinal directions by the drive unit 20.

The general arrangement of the present garage door operator thus far described is substantially identical to that disclosed in the aforementioned patent, so that no further details of this general arrangement will be presented here. Suffice it to say, that movement of the actuating channel 26 in one longitudinal direction by the drive unit 20 effects movement of the door 24 from its solid line closed position of FIGURE 2 to its phantom line open position of that figure. Similary, movement of the actuating channel 26 in the opposite longitudinal direction by the drive unit 20 effects movement of the door from its phantom line open position of FIGURE 2 to its solid line closed position of that figure. As will presently be more fully discussed, operation of the present garage door operator may be initiated by closing of a manual switch 30 or by means of radio signals transmited from an automobile to a receiver 32.

The drive unit 20, illustrated in detail in FIGURES 3 through 17, is generally similar to the drive unit of the aforementioned patent while embodying certain unique structural features which will become clear as the description proceeds.

Thus, the drive unit 20 comprises a frame 34 to which is rigidly fixed a drive motor 36. Drive motor 36 is of the reversible type and embodies combination starting and reversing means, not shown, which are automatically cut out of the motor circuit upon the motor speed reaching a predetermined value. These reversing and starting means are selectively operable to condition the motor for one or the other direction of rotation, as will be hereinafter more fully described.

Indicated at 38 and 40 are a friction driving roller and an idler roller, respectively, between which the channel 26 is received, as illustrated in FIGURES 3, 5 and 7. The rollers 38 and 40 are journalled in the frame 34 as described below, the driving roller shaft 42 having one end extending exteriorly of the frame 34, as shown in FIGURES 3 and 5, and drivably coupled to the shaft of the motor 36 through the belt drive 44. The motor shaft mounts a relatively small pulley and the driving roller shaft 42 a relatively large pulley, as shown, to provide an appreciable speed reduction between the motor and the driving shaft.

Indicated generally at 46 are certain combination safety and limit switch means, to be presently described, which serve to terminate operation of the motor 36 in response to movement of the actuating channel 26 to an extreme open or closed position, and also in response to the change in speed of the idler roller 40, relative to the driving roller 38. As will be seen, such a change in speed results from an obstruction in the path of the door 24. Generally indicated at 48 are certain reversing switch means, to be presently described, which effect operation of the aforementioned reversing means within the motor 36. This occurs after the motor has reached a predetermined speed whereat the reversing means are cut out of the motor circuit and conditions the motor for reversed direction of rotation during the following operation of the door operator. The driving roller 38 and idler roller 40 are arranged to be relatively moved toward one another to effect a desired frictional engagement of the driving roller 38 with the actuating channel 26, by idler roller adjusting means generally indicated at 50. These adjusting means will also be presently described.

Briefly, operation of the present garage door operator is as follows. Assuming the door to be in its solid line closed position of FIGURE 2, operation of the manual switch 30 or receiver 32 initiates rotation of the drive motor 36 in a direction to move the actuating channel 26 to the right as viewed in FIGURES 1 and 2. The door is thereby moved toward its phantom line, open position of FIGURE 2. After the driving shaft 38 has made two full revolutions, during which the starting and

reversing means in the motor are cut out, the reversing switch means **48** is actuated to condition the motor **36** for reverse direction of rotation. Upon movement of the door **24**, and therefore the channel **26**, to the fully open position, the limit switch means **46** are actuated to terminate operation of the drive motor **36**. As mentioned above, the switch means **46** is also effective to terminate operation of the drive motor **36** in response to the door encountering an obstruction during the opening thereof, as well as during subsequent reclosing thereof.

The motor **36** is now conditioned for turning in a reverse direction, to move the actuating channel **26** to the left, as viewed in FIGURES 1 and 2, in response to the next operation of the manual switch **30** or receiver **32**, such reversed operation of the drive motor being terminated by the limit switch means **46** in response to movement of the door **24** to its fully closed position. During this closing of the door, the reversing switch means **48** are again actuated to condition the motor for reversed operation as before.

In the above brief description of operation, the general similarity between the present drive unit and that of the aforementioned patent will be apparent. The improvements of the present garage door operator over that of the prior patent reside in the unique construction of the switch means **46**, switch means **48**, the bearing means for the driving and idler rollers, and in the construction of the idler roller which enables the present garage door operator to be employed either with an actuating channel as just mentioned, or with a belt drive as will be described.

These unique features of construction of the present garage door operator will now be described in greater detail.

In the past, difficulty was encountered in fabricating the drive roller **38**. These difficulties are obviated in the present driving shaft construction, shown in FIGURE 4. As shown in this figure, the driving shaft **42** is formed intermediate its ends with raised longitudinal serrations **52** which extend for a distance lengthwise of the shaft, as shown. The friction driving roller **38** itself comprises two elements, namely, an inner soft metallic sleeve **54**, of aluminum or other suitable material, and an outer resilient, friction sleeve **56**, of rubber or the like, which is bonded to the metallic sleeve **54**.

The internal diameter of the metallic sleeve **54** is such that the driving shaft **42** is received in the sleeve with a tight friction fit, the serrations **52** biting into the soft metal of the sleeve **54** to effectively restrain the driving roller **38** against slippage on the shaft **42**. It has been found that this unique construction appreciably simplifies the manufacture and reduces the cost of the driving roller.

The driving roller **38** and idler roller **40** are journalled on the operator frame **34**, as follows. Firmly attached to opposite side walls **58** of the attachment frame **34** are a pair of L-shaped angle members **60** having flanges **62** thereof located in spaced parallel relationship and extending parallel to the common plane of the driving and idler roller shaft. These parallel flanges of the angles **60** on the two side walls extend inwardly of the frame **34** and toward one another, as shown.

Slideably received between the flanges **62** of each pair of angles **60** are a pair of movable nylon bearing blocks **64**. Also located between the flanges **62** of each pair of angles **60** is a stationary bearing block **66**.

The bearing blocks **64** and **66** are generally identical, and each comprises, as shown in FIGURE 6A, a generally rectangular member having a blind bore **68'**. The bore **68'** in the upper right hand bearing block **66**, however, extends entirely through the block. Driving shaft **42** has one end received in the blind bore **68** of the left hand bearing block **66**. The opposite end of this shaft is journalled in the through bore **68'** of the right hand bearing block **66** and extends through an enlarged opening in

the right hand frame wall **58** for mounting the large pulley engaged by the drive belt **44**, as previously discussed.

Opposite ends of the shaft of the idler roller **40** are journalled in the blind bores **68** of the intermediate bearing blocks **64**. Thus, the intermediate bearing blocks provide both journal and thrust bearings for the idler roller shaft.

The idler roller adjusting means **50** comprises a rod **72** having coaxial end portions, rotatably received in the blind bores **68** of the lower bearing block **64**, and an intermediate curved portion **74**. It will be seen, therefore, that the lower bearing blocks **64** also provide both journal and thrust bearings for the rod **72**. Extending radially from one end of the rod **72** is an elongate handle **76** by which the rod **72** may be rotated about the axis of its coaxial end portions.

Threaded in the lower panel **78** of the operator frame **34** is a bolt **80** aligned with the center of the curved rod portion **74** of rod **72**. It will be clear from the above description that when the curved rod **72** is in the angular position shown in FIGURE 5, rotation of the bolt **80** in one direction will exert a thrust on the idler roller shaft **43** through the rod **72** and the slideable bearing blocks **64**, to move the idler roller **40** toward the driving roller **38**. Rotation of the screw **80** in the opposite direction, of course, accommodates movement of the idler roller away from the driving roller.

In use of the present garage door operator, the screw **80** is so adjusted that when the parts are in the position illustrated in FIGURE 5, the pressure of the driving roller **38** against the channel **26** is sufficient to accomplish frictional driving of the channel from the driving roller to open and close the garage door **24** under normal conditions of operation. This pressure, however, is made sufficiently light to accommodate slippage between the channel and driving roller in response to an increase in the resistance to movement of the channel **26**, above that existing during normal opening and closing of the garage door **24**. Such an increase in resistance occurs, for example, when the door encounters obstruction. The driving roller **40** may be readily released for movement away from the pressure roller **38**, to release the channel **26**, so as to permit initial adjustment of the apparatus, for example, by rotation of the rod **72** from the position of FIGURE 5 to a plane normal to that position by means of the handle **76**. Rotation of the rod **72** back to the position of FIGURE 5, of course, effects movement of the idler roller **40** toward the driving roller **48** to the preset position determined by the adjustment of the screw **80**.

The combination safety and limit switch means **46**, shown in detail in FIGURES 11 through 17, is also generally similar to the safety switch means embodied in the garage door operator of the aforementioned patent. Thus, the safety and limit switch means **46** comprises a wobbler element **82** located adjacent the right hand frame wall **58**, as viewed in FIGURE 5. The wobbler is formed with a bore **84** adjacent its normally lower edge for rotatably receiving the idler roller shaft **43**. A generally U-shaped notch **86** is cut into the upper edge of the wobbler element **82** and receives an eccentric **88** fixed to the driving shaft **42** adjacent the right hand end thereof, as viewed in FIGURE 5. It is clear, therefore, that as the idler roller shaft **42** turns, the eccentric **88** works in the notch **86** of the wobbler element **82** to oscillate the latter in the manner illustrated in FIGURES 13 and 14.

Fixed in the wobbler element **82** and extending beyond the inner face thereof is a contact pin **90** to the outer end of which a lead **92** is secured. Also fixed to the wobbler element **82** and extending beyond the inner face thereof is a resilient contact element **94** to the outer end of which a second lead **96** is attached.

Resilient contact **94** is shown as comprising a coil spring formed at its inner end with an axially extending finger **98**. As shown in FIGURE 11, the pin **90**, coil spring

94 and idler roller shaft 43 have their centers located in a common plane, the contact pin 90 being located between the resilient contact spring 94 and the idler roller shaft 43.

As will be presently described, the leads 92 and 96 extend to a control circuit for the drive motor 36. This circuit includes a holding circuit for the motor 36 which is completed by establishment of an electrical circuit between the contact pin 90 and contact spring 94.

This electrical circuit is established between the contact pin and contact spring by means of the contact strip 100 having its intermediate portion bent into a generally circular configuration and its opposite ends 102 and 104 extending substantially perpendicular to one another and radially from the cylindrical portion of the contact strip. Tightly fitted on the idler roller shaft 43 is a nylon insulating sleeve 106 on which the cylindrical portion of the contact strip 100 is frictionally received. As shown in FIGURE 12, the sleeve 106 has a shoulder 108 for limiting axial movement of the contact strip 100 in one direction. Axial movement of the contact strip in the opposite direction is limited by a non-conductive washer 110 received on the idler roller shaft between the sleeve 106 and the wobbler element 82.

Owing to the frictional engagement between the contact strip 100 and the nylon sleeve 106, which, as just mentioned, is fixed to the idler roller shaft 43, the contact strip tends to rotate with the idler roller shaft. Thus, for example, when the idler roller shaft rotates in a counterclockwise direction, as viewed in FIGURE 13, the contact strip 100 turns with the idler roller shaft until the end 104 of the strip engages the contact pin 90 whereupon further rotation of the strip with the idler roller shaft is prevented, the nylon sleeve 106 merely slipping within the contact strip.

As shown in FIGURES 11 and 13, the diameter of the contact spring 94 is such that the end 104 of the contact strip engages the contact spring 94 prior to engaging the contact pin 90. The contact spring is thereby deformed slightly to accommodate movement of the end 104 into engagement with the contact pin 90. Thus, in the limiting position of FIGURE 13, the end 104 of the contact strip engages both the contact pin 90 and contact spring 94 to establish an electrical circuit between these parts.

A similar action occurs when the idler roller shaft turns in the opposite, or clockwise, direction, as viewed in FIGURE 14. That is, the contact strip 100 turns with the idler roller shaft until its end 102 engages the contact pin 90 whereupon the nylon sleeve 106 merely turns within the cylindrical portion of the contact strip. In this latter limiting position of the parts, as shown in FIGURE 14, the end 102 of the contact strip engages both the contact pin 90 and spring contact 94 to establish an electrical circuit therebetween.

The operation of the switch means 46, when functioning as a safety switch, is similar to that described in the aforementioned patent. Thus, during normal operation of the apparatus, the driving roller shaft 42 and idler roller shaft 43 rotate in opposite directions during opening and closing of the door. Rotation of the driving roller shaft 42 imparts oscillation to the wobbler element 82 through the eccentric 88 working in the wobbler element notch 86. The contact strip 100 and the contacts 90 and 94, which oscillate with the wobbler element 82, may be regarded as sensing means whose behavior is governed by movement of both the driving roller and idler roller shafts in such manner that the ratio of the idler roller shaft speed to the driving roller shaft speed is continuously sensed.

Thus, referring to FIGURE 13, and assuming the idler roller shaft 43 to be turning in a counterclockwise direction and the driving roller shaft 42 to be turning in a clockwise direction, it will be seen that the end 104 of the contact strip 100 is continuously urged against the contact pin 90 and contact spring 94, due to the frictional coupling between the contact strip and the idler roller shaft. In the position of FIGURE 13, the wobbler element 82 is at the right hand limit of its stroke, and the contact strip 100 is stationary and merely slipping on the idler roller shaft 43 as the latter turns.

During continued rotation of the idler roller and driving shafts, the wobbler element 84 is rocked toward the left, as viewed in FIGURE 13, to the left-hand limit of its stroke. During this rocking of the wobbler element, the contacts 90 and 94 are also moved to the left, thereby releasing the contact strip 100, for rotation with the idler roller shaft 43. The end 104 of the strip, therefore, moves with and is continuously urged against the contacts 90 and 94 as the latter move to the left. Engagement between the strip and the contacts is thus maintained. Upon reaching the left-hand limit of its strike, the wobbler element 82 is again rocked to the right-hand limiting position of FIGURE 13, during which the contact strip 100 is turned slightly in a clockwise direction on the idler roller shaft. The same action occurs with reference to the end 102 of the contact strip during reversed rotation of the shafts, as illustrated in FIGURE 14.

Thus, during normal operation of the apparatus, one or the other of the ends 102 or 104 of the contact strip will be maintained in engagement with the contacts 90 and 94, as the wobbler element 82 oscillates. As will be presently described, the energizing circuit of the drive motor 36 is thereby maintained.

It will be apparent, however, that if the speed of the idler roller shaft 43 is decreased or reduced to zero, such as occurs when the actuating channel 26 is held stationary against the frictional resistance of the driving roller 38, the wobbler element 82 will continue to oscillate while the contact strip remains stationary with the idler roller 43, or turns at the reduced angular velocity of the idler roller. Eventually during one or the other of the strokes of the wobbler element 82, at least the fixed contact pin 90 will be moved out of engagement with the contact strip thereby breaking the electrical circuit between the contact pin 90 and contact spring 94. This interrupts the hereinafter discussed holding circuit for the drive motor 36. The motor therefore is deenergized.

It will also be clear that this action occurs in both directions of rotation of the idler roller shaft and driving roller shaft, and, therefore, during both opening and closing of the door 24. Thus, if the door encounters an obstruction while being opened or closed, the increased resistance to movement transmitted to the actuating channel 26 causes slippage between the channel and the driving roller 38. This effects operation of the switch means 46 in the manner just described to terminate opening or closing of the door, as the case may be, until the obstruction is removed and the operator reenergized.

As previously mentioned, the switch 46 serves not only as a safety switch but also as a limit switch means. To this end, the actuating channel 26 is formed along the edge thereof approximately to the switch means 46 with a flange 112 to which a pair of spring clips 114 and 116 are releasably secured. These clips are of similar construction, each being a mirror image of the other.

Each of the clips 114 and 116 comprises a strip 118, one end of which is bent away from the channel flange 112 at an angle to the latter, as shown at 120 in FIGURES 7, 15 and 16. One side of the strip 118 bears against the underside of the flange 112. The strips 118 have tabs 122 punched therefrom which overlie the flange 112 so that each of the clips 114 and 116 is frictionally secured to the flange 112. The frictional engagement between the clips and the flange is sufficient to restrain the clips against axial movement along the flange under normal conditions and yet accommodate axial repositioning of the clips on the flange for reasons to be presently seen.

The clips **114** and **116** have their inclined ends **120** extending away from one another, as shown, and aligned with the axial finger **98** on the spring contact **94**.

The finger **98** on the contact spring **94** is so located relative to the plane of movement of the clips **114** and **116** that when the actuating channel **26** is moved to its forward limiting position, corresponding to the closed position of the garage door **24**, the spring contact finger **98** is engaged by the normally upper surface of the inclined end **120** of the clip **114** which is located adjacent the rear end of the actuating channel **26**. Finger **98** is cammed upwardly by this inclined end, as shown in FIGURE 15. The spring contact **94** is thereby deflected out of engagement with the end **104** of the contact strip **100** to break the electrical circuit between the spring contact and the contact pin **90**. This, of course, terminates operation of the drive motor **36** for reasons previously mentioned and hereinafter more fully discussed.

The clip **114** is so located along the actuating channel **26** that the spring contact is thus disengaged from the contact strip **100** just prior to the door being moved to its solid line closed position of FIGURE 2. The momentum of the parts of the operator and the door carry the actuating channel **26** to the left, as viewed in FIGURE 15, to a position wherein the finger **98** is located beyond the right-hand end of the clip **114**. Contact **94** is thus released by the clip for reengagement with the contact strip **100**. As will be described, the holding circuit for the motor **36** will be deenergized in response to this momentary interruption thereof, so that the motor will not reenergize upon reengagement of the spring contact with the contact strip **100**.

When the garage door operator is again activated to open the garage door **24**, the actuating channel **26** will be moved to the right, as viewed in FIGURE 16. During initial right-hand movement of the actuating channel, the spring contact finger **98** is engaged by the undersurface of the inclined end **120** of clip **114**. The spring contact is thereby cammed downwardly into increased electrical contact with the contact strip **100**, as shown in FIGURE 16. The energizing circuit of the motor **36** thus remains intact.

Upon movement of the actuating channel **26** to a position just prior to its fully opened position, the left-hand clip **116**, as viewed in FIGURE 7, engages the contact finger **98**. The spring contact **94** is again cammed upwardly by the inclined end **120** of the latter clip out of engagement with the contact strip **100** to deenergize the motor **36**. The inertia of the parts carries the actuating channel **26** to the right, as viewed in the drawing, to a position wherein the contact finger **9B** is located to the left of the clip **116** and contact **94** is released to reengage the contact strip **100**.

Here again, the holding circuit for the motor **36** is momentarily interrupted and, therefore, the motor **36** remains deenergized until the operator is again activated. Upon this reactivation of the operator, the actuating channel **26** is again moved to the left, as viewed in the drawings, the inclined end **120** of the forward clip **116** acting to cam the spring contact **94** downwardly into firmer electrical engagement with the contact strip so that the energizing circuit of the motor **36** is maintained.

It is clear from the foregoing description, therefore, that the switch means **46** is operative to terminate driving of the motor **36** in response to an increased resistance to movement of the actuating member **26**, due to an obstruction in the path of the door, as well as in response to movement of the door **24** to its fully opened or fully closed position. Switch **46**, therefore, operates as a combination safety switch and limit switch means, as mentioned.

The contact **100** may have a slightly modified construction, as shown at **100A** in FIGURE 18. Here the strip **100A** is bent, as shown, to provide a generally circular portion for frictionally receiving the sleeve **106** and a

cylindric portion **100B** having its center at the axis of shaft **43**. Arms **100C** and **100D** connect this cylindric portion **100B** to the circular portion **100A**.

Operation of the safety and limit switch means with this modified contact is substantially identical to that just described, except that the spring contact **94** engages the cylindric portion **100B** of the contact, as shown, rather than the arms **100C** and **100D**, as in the previous switch means.

As previously indicated, motor **36** is of the reversible type comprising starting and reversing means which are cut out of the motor circuit in response to the motor attaining a predetermined speed. These reversing means within the motor **36** are in electrical circuit with a toggle switch **124** which, as shown in FIGURES 5 and 7, is fixed to an upper horizontal panel **126** of the operator frame **34**. Switch **124** has its stem **128** projecting downwardly beyond the underside of this upper panel **126** and toward the driving shaft **42**.

The stem **128** terminates somewhat short of the shaft **42** and is located substantially in a vertical plane passing through the axis of the shaft. As will shortly be described, the toggle switch **124** so connected in the energizing circuit of the motor **36** that when the actuating stem **128** is in the right-hand position of FIGURE 8, the motor **36** is conditioned for driving in a direction to move the actuating channel **26** toward the right, as viewed in FIGURE 2. Similarly, when the toggle switch stem **128** is in its left-hand position of FIGURE 10, the motor **36** is conditioned for driving in a direction to move the actuating channel **26** to the left, as viewed in FIGURE 2. This toggle switch **124** actually serves to reverse the connections of a starting and reversing coil, embodied in the motor **36**.

In order to avoid arcing in the motor, it is necessary that the connections to the starting and reversing coil of the motor not be reversed until such coil is cut out of the motor circuit in response to the motor reaching the aforesaid predetermined speed. It has been found that in the present operator, such predetermined motor speed is obtained prior to rotation of the driving roller shaft **42** through two revolutions by the motor **36**. The switch means **48**, therefore, are arranged and uniquely constructed to actuate the stem **128** only after the driving roller shaft **42** has been rotated through two revolutions by the motor **36**.

To this end, the switch means **48** comprises a series of three strips **132**, **134** and **136** (FIGURE 5) each formed, as shown most clearly in FIGURES 8, 9 and 10, with a generally cylindrical portion which is frictionally received on one of three nylon sleeves **138**. These sleeves are fixed to the driving shaft **42** adajacent the left-hand end thereof, as viewed in FIGURE 5, and are formed at one end with shoulders **140** which limit movement of the strips **132**, **134** and **136** axially of the driving roller shaft.

The two outer strips **132** and **136** have opposite divergent ends **132'** and **136'**, respectively, which extend radially from the driving shaft **42**. The center strip **134** has only one radially extending end **134'** to which is fixed a pin **142**. Pin **142** extends transversely of the strip end **134'** and has its opposite ends located in the path of rotational movement of the ends **132'** and **136'** on the strips **132** and **136**, as shown most clearly in FIGURE 5. Also as shown in this latter figure, the stem **128** of the toggle switch **124** is located in and movable in the plane of the center strip **134**.

As just mentioned, the three strips **132**, **134** and **136** are frictionally engaged with the sleeves **138** which, in turn, are rigid on the driving roller shaft **42**. Thus, the strips **132**, **134** and **136** tend to rotate with the driving roller shaft but may be held stationary whereupon nylon sleeves **138** merely slip within the three strips.

When the garage door operator is in its normal inoperative condition with the actuating channel in the left-hand limit of its longitudinal movement, the strips **132**,

134 and 136 and the toggle switch stem 128 will be located in the positions shown in FIGURE 8. Upon actuation of the door operator, driving shaft 42 is rotated in the direction indicated in FIGURE 8, to move the actuating channel 26 toward the right and thereby open the door 24. In these positions of the parts, it will be observed that the pin 142 trails, relative to the direction of rotation of the driving shaft 42, the trailing ones of the ends 132' and 136' of the strips 132 and 136.

The three strips 132, 134 and 136 rotate with the shaft 42 owing to the frictional coupling therebetween. Upon rotation of the driving shaft and the strips to the position of the driving shaft and the strips to the position of FIGURE 9, wherein the pin 142 on the center strip 134 engages the stem 128 of toggle switch 124, the center strip is restrained against further rotation with the driving shaft 42. The frictional engagement between the center strip 134 and its respective bearing sleeve 138 is made sufficient to effect the above-described movement of the center strip with the driving shaft, but not so great as to cause tripping of stem 128.

During rotation of the parts beyond the position of FIGURE 9, the center strip 134 is held stationary and slips on the shaft 42 while the two outside strips 132 and 136 rotate with the shaft to the position of FIGURE 10 wherein they engage the pin 142 on the center strip.

Continued rotation of the driving shaft 42 after this contact of the two outside strips with the cross pin 142 produces an increased thrust on the stem 128 of the toggle switch 124. The frictional engagement of the outside strips with their respective nylon sleeves 138 is made somewhat greater than that of the center strip 134 with its sleeve 138 and sufficient to actuate the toggle switch stem 128 to its left-hand position of FIGURE 10. It will be seen, therefore, that the toggle switch stem is tripped after two revolutions of the driving shaft 42.

As mentioned above, the starting and reversing means embodied in the motor 36 is cut out of the motor circuit at this time so that tripping of the toggle switch 124 conditions the motor for reversed direction of rotation without instantly effecting the operation of the motor. Upon driving of the actuating channel 26 to its right-hand limiting position, the motor is stopped as previously discussed, whereupon the starting and reversing means are cut back into the motor circuit to condition the motor for subsequent operation in the reverse direction in response to the next activation of the operator.

Referring now to the schematic circuit diagram of FIGURE 19, the numeral 144 indicates an A.C. power supply having terminals to which two power leads 146 and 148 are connected. Lead 146 is connected to one end of the running winding 36A of the motor 36 through a first set of normally open contacts 150A of a relay 150. The other A.C. power lead 148 connects to the other end of the running winding 36A through a fuse 152.

Also connected across the power leads 146 and 148 is the receiver 32, although this component may derive its power from any other convenient source if desired. The reversing toggle switch 124 is shown, in FIGURE 19, as comprising a double pole-double throw switch, its two positions being indicated by the solid and dotted arrows, respectively.

In the solid line position, the switch 124 connects the power leads 146 and 148 to two leads 154 and 156, the former of which is connected to one end of a starting and reversing coil 36B in the motor 36 through a second set of contacts 150B in the relay 150. The other lead 156 connects to the other end of the starting coil 36B. Coil 36B comprises the aforementioned starting and reversing means of the motor 36.

In the solid line position of the toggle switch 124 then, the motor 36 is conditioned to drive in one direction. When the position of the toggle switch 124 is reversed to its dotted line position, the connection of the A.C. power leads 146 and 148 to the starting coil 36B are reversed and the motor 36 is conditioned to drive in the reverse direction.

Indicated generally at 158 are switch means responsive to the speed of the motor 36 for opening the energizing circuit of the starting coil 36B. It will be clear that when switch means 158 are open, upon the motor reaching a predetermined speed, starting coil 36B is disconnected from the A.C. power supply 144. As previously mentioned, switch means 158 are thus opened prior to operation of a toggle switch from one position to the other by the reversing switch means 48.

Normally open relay contacts 150A and 150B are operated by a solenoid 150C in a circuit designated by I in FIGURE 19. Indicated at 160 is a transformer having its primary connected across the leads 154 and 156, as shown, and its secondary in the abovementioned energizing circuit I for the relay 150C.

It will be observed that transformer 160 is energized whenever the A.C. supply 144 is energized and the toggle switch 124 is in either of its two positions. Relay coil 150C is initially energized from the transformer 160, to close the relay contacts 150A and 150B and thereby initiate operation of the motor 36, by closure of a manual switch means 30 or switch means 32' operated by the receiver 32. These switch means 30 and 32' are shunt connected in series with the relay coil 150C, as shown.

Closure of the relay contacts 150B, in response to this initial energizing of the relay coil 150C delivers electrical power to a second transformer 162 in a holding circuit, designated by II in FIGURE 19, for the relay coil 150C. The aforedescribed combination safety and limit switch means 46 are connected in series with the transformer 162 and the relay coil 150C, so that when the relay contacts 150B close, coil 150C is locked in energized condition if the switch means 46 are closed.

It will be clear that since manual switch means 30 and switch means 32', operated by the receiver 32, are only momentarily closed to initiate actuation of the operator, relay coil 150C is energized only so long as the safety switch means 46 remain closed. As previously mentioned, switch means 46 are opened in response to the door 124 encountering an obstruction during opening and closing thereof, or in response to the door being moved to its fully opened or fully closed position. This opening of the switch means 46 interrupts the holding circuit II for the relay coil 150C, and the latter deenergizes and remains deenergized until the manual switch means 30 or radio control switch means 32' are again operated. Relay contacts 150A and 150B, therefore, also remain open, and the operator remains inactive.

Operation of the present automatic garage door operator is believed to be clear from the foregoing description. Thus, assuming the garage door to be in its closed position, the toggle switch stem 128 will be in its right hand position, of FIGURE 8, and the safety and limit switch means will be in their closed position, as previously described.

When the manual switch 30 or radio control switch 32' are closed, relay coil 150C is energized to close its normally open contacts 150A and 150B. Motor 36 is thereby energized to move the actuating channel to the right, as viewed in FIGURE 2, and the transformer 162 in the holding circuit II for the relay coil 150C is energized to lock the latter relay coil in energized condition. Motor 36, therefore, continues to drive the actuating channel toward the right until the garage door is open, or encounters an obstruction, whereupon the safety and limit switch means 46 are opened to break the holding circuit II of the relay coil 150C and deenergize the latter.

As previously discussed, the toggle switch stem 128 is tripped from its right hand position of FIGURE 8 to its left hand position of FIGURE 10, to reverse the connections to the motor starting winding 36B, after the driving shaft 42 has been rotated through two revolu-

tions and subsequent to opening of the switch means **158** to cut the starting winding **36B** out of the motor circuit. Upon termination of operation of the operator in response to movement of the door to its open position, therefore, motor **36** is conditioned for subsequent driving in the reverse direction to close the garage door.

Accordingly, when the manual switch means **30** or radio control switch means **32'** are subsequently operated to energize the relay coil **150C** and close its normally open contacts **150A** and **150B**, motor **36** drives in a direction to move the actuating channel toward the left, as viewed in FIGURE 2, and thereby move the garage door to its closed position. Upon the garage door reaching its closed position or encountering an obstruction, switch means **46** are again opened to break the holding circuit II for the motor **36** and thereby deenergize the latter.

As previously mentioned, the present operator may also be used with multiple hinged panel doors of the type commonly used in the Eastern section of the United States. In such installations, as shown in FIGURES 20, 21 and 22, the drive mechanism **20** is supported from a beam in the ceiling of a garage, as before. In lieu of the actuating channel **26** of FIGURES 1 through 17, however, a friction drive belt **200** is passed around the idler roller **40**, within a circumferential groove formed in the idler roller, as shown in FIGURE 21, and about a pulley **202** secured to a ceiling beam located above the hinged panel garage door **204**.

Belt **200** and pulley **202** are enclosed in a hollow guide channel or track **206** which is secured at its forward end to the forward ceiling beam and in its rear end to the drive mechanism **20**. Located in this track **206** and secured to the belt **200** is a movable carriage **208**. Secured at one end to this carriage **208** and at the other end to the upper edge of the garage door **204** is a link **210** which extends through a longitudinal slot **212** in the lower wall of the track **206**. It will be clear from this description that when the belt is driven in one direction, carriage **208** is moved to the right in the track **206** to move the door **204** from its solid line closed position of FIGURE 20 to its phantom line open position. Similarly, when the belt is driven in the opposite direction, the carriage is moved toward the left, as viewed in FIGURE 20, to move the door from its phantom line open position to its solid line closed position.

As shown in FIGURE 21, belt **200** passes between the idler roller **40** and drive roller **38** so as to be driven in one direction or the other by rotation of the driving roller **38**. The idler roller **40** is so positioned relative to the driving roller **38** as to establish sufficient frictional contact therebetween to enable driving of the belt and yet accommodate slippage between the rollers in the event the door encounters an obstruction. Any other form of belt may, of course, be employed.

Operation of this latter form of the invention is generally similar to that previously described. Thus, assuming the door **204** to be in its closed position, closure of the manual switch means **30** or radio control switch means **32'** effects energizing of the motor **36** to move the carriage **208** from its left-hand solid line position of FIGURE 18 to its right-hand phantom line position of that figure to open the door **204**. Upon the door reaching its fully open position, the resistance to movement of the carriage **208** to the right is increased.

This increased resistance is transmitted to the belt **200** with resultant slippage between the belt and driving roller **38**. Switch means **46** is operative in response to this slippage between driving roller **38** and the belt **200** to interrupt the holding circuit II for the relay **150C**, as before, and thereby terminate operation of the operator.

The connections to the motor starting winding **36B**, at this time, will have been reversed in the manner previously described. Upon subsequent closure of the manual switch means **30** or radio control switch means **32'**, therefore, the motor **36** will drive in a reverse direction to move the garage door **204** to its closed position. Upon reaching its closed position, further movement of the carriage **208** is prevented and slippage occurs between the driving roller **38** and the belt **200**. Switch means **46** is thereby again opened to deactivate the operator.

It will be obvious that the above-described grooved roller around which the belt is trained may be driven directly rather than from a friction drive roller, as just discussed.

It will be apparent, therefore, that there has been described and illustrated an automatic garage door operator which is fully capable of obtaining the objects and advantages preliminarily set forth. While certain preferred embodiments of the invention have been described and illustrated, they are purely illustrative in nature, it being apparent that numerous modifications in design and arrangement of parts are possible within the scope of the following claims.

I claim:

1. A delayed action switching device, comprising a rotary shaft, means for turning the shaft in either direction of rotation, a plurality of cylindrically curved strips frictionally fitted on said shaft side by side so that each strip is driven in rotation from the shaft with a given frictional driving force, means interconnecting the strips which permits limited relative rotation of the strips, a switch to be operated by said strips including an actuating member which is movable between first and second positions in response to a force on the member which is less than the sum of the individual frictional driving forces on all of the strips but greater than the sum of the individual driving forces on less than all of the strips, and one strip having a radially extending end engageable with said member to move the later to one of its positions upon rotation of said one strip in one direction to a given angular position and to its other position upon rotation of said strip in the other direction to a given angular position.

2. The subject matter of claim 1 wherein the remaining strips also have radially extending ends, and said interconnecting means comprises a stop on one strip located in the paths of said extending ends of the other strips.

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