Sept. 21, 1965 E. V. SCHNEIDER 3,207,501

DOOR OPERATOR MECHANISM

Filed June 12, 1963 2 Sheets-Sheet 1

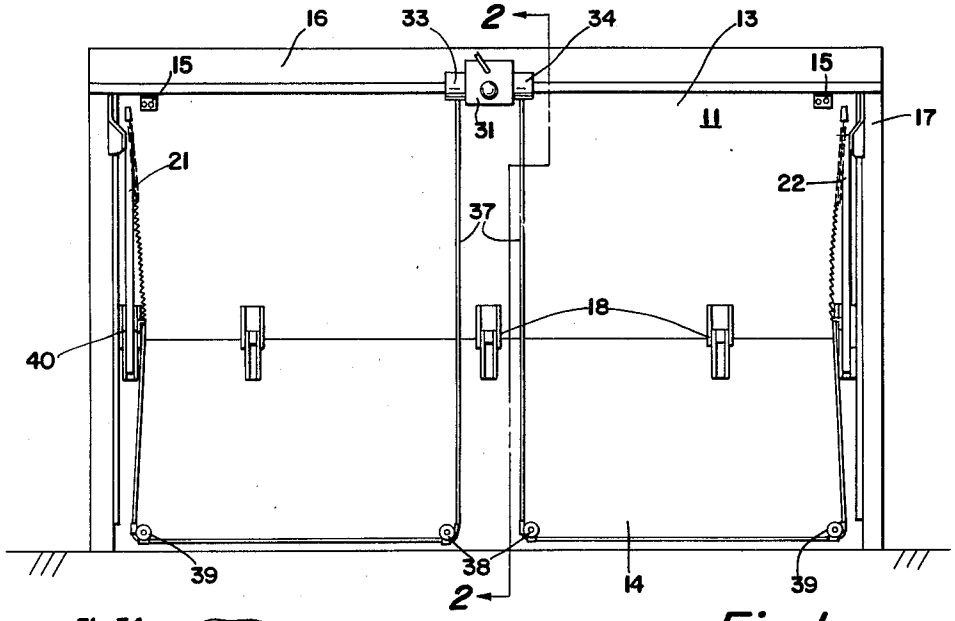


Fig. 1

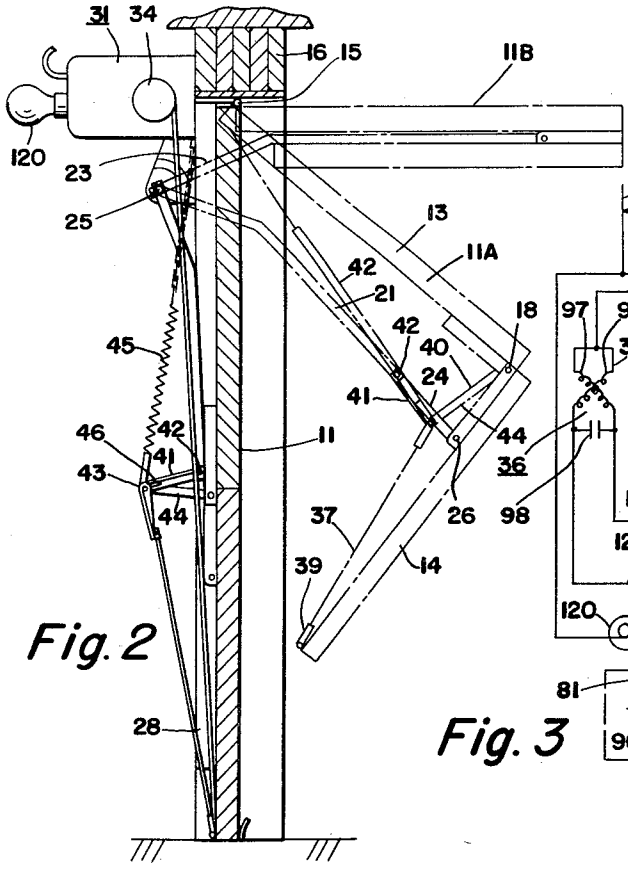


Fig. 2

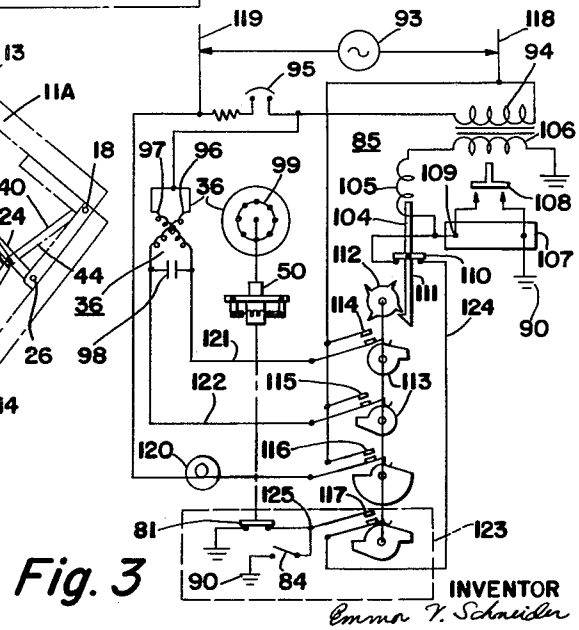


Fig. 3

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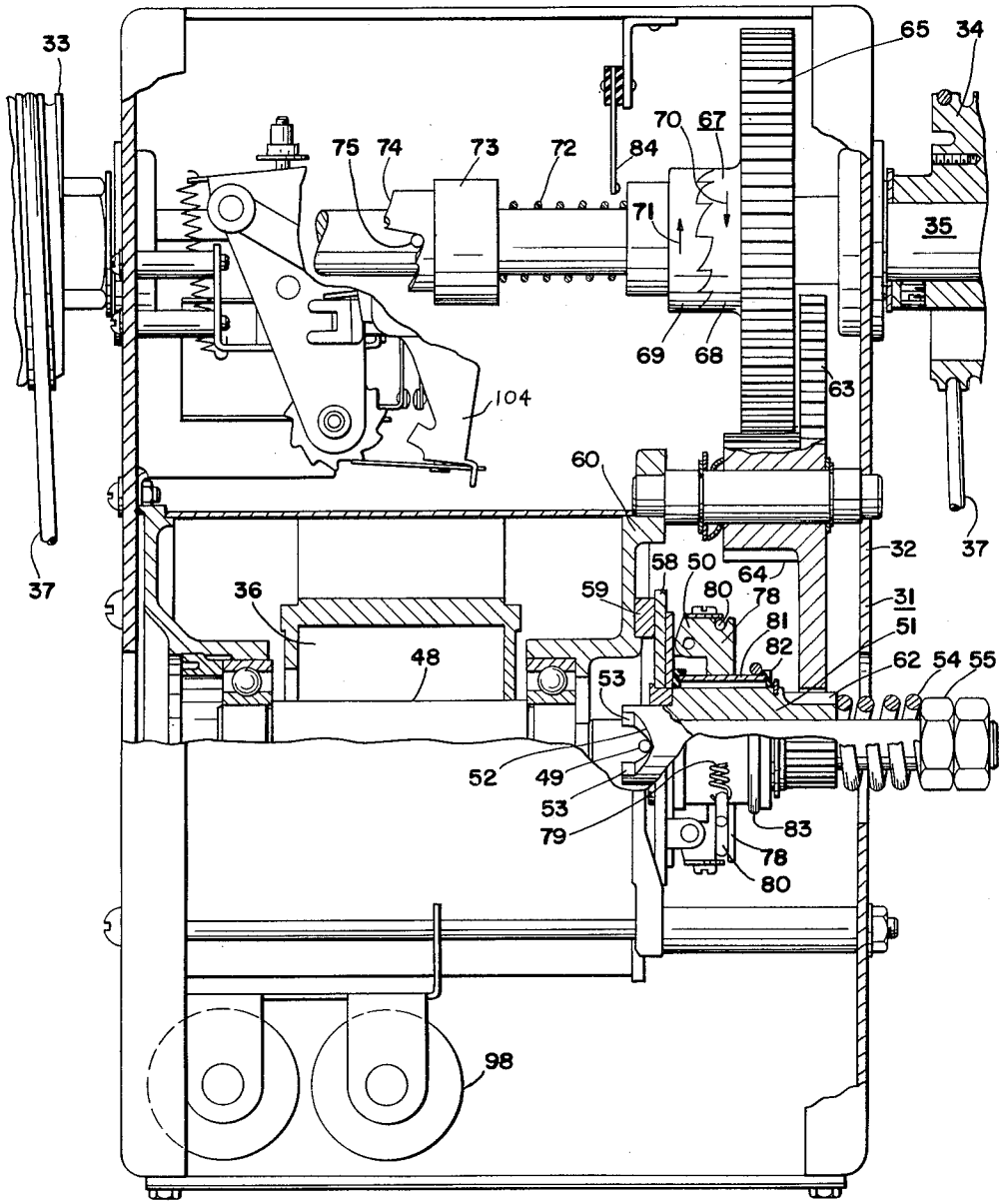


Fig. 4

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3,207,501

DOOR OPERATOR MECHANISM

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19 Claims. (Cl. 268—74)

The invention relates in general to a door operator mechanism and, more particularly, to an operator mechanism for a door which is to be opened and closed and which has an unbalanced force resisting either the opening or closing effort.

Many types of doors such as garage doors and the like have either a spring force or a gravitational force which tends to hold these doors in one position, for example a closed position. Many garage doors are upward acting or overhead door types wherein primarily a lifting force must be exerted on the door. Often, counterbalance weights or springs are used to aid any lifting effort on such a door. Where a motorized door operator is provided with the door, such counterbalance springs or weights are often retained.

Such counterbalance springs or weights may be adjusted to take less or more of the weight of the door so that there is an unbalanced force causing the door to either open or close, with the motor acting against such unbalanced force.

An object of the invention is to provide a door operator mechanism especially for use with an overhead type door which mechanism is simple and easy to construct and use.

Another object of the invention is to provide a door operator mechanism for use with a door having an unbalanced force thereon which resists one of the opening and closing movements of the door and wherein brake means is provided to control movement of the door under actuation by said unbalanced force.

Another object of the invention is to provide a door operator mechanism wherein two different types of brake means are provided either or both of which may be actuated during the closing movement of the door.

Another object of the invention is to provide a door operator mechanism for an overhead type door moved in opening and closing movements wherein two different brakes are used, one during the opening movement and another during the closing movement.

Another object of the invention is to provide a door operator mechanism with a slipping clutch which will slip under conditions of obstruction to door movement and this slipping clutch controls brake means for the door.

Another object of the invention is to provide a door operator mechanism wherein a motor drives a door through a one-way clutch for opening movement and the door drives the motor through the same one-way clutch for closing movement.

Another object of the invention is to provide a door operator mechanism wherein a motor drives through a one-way clutch to a door and upon slippage of the clutch, means is provided to stop the motor and brake the door.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is an interior elevational view of a door incorporating the door operator mechanism of the present invention;

FIGURE 2 is a sectional view on line 2—2 of FIGURE 1;

FIGURE 3 is a schematic electrical diagram of the control system; and,

FIGURE 4 is a sectional view through the operator.

FIGURES 1 and 2 show a door **11** which may be used with the door operator mechanism **31** of the invention. This door **11** may include first and second panels shown as upper and lower panels **13** and **14**, respectively. The first panel is hinged at the upper edge thereof by first hinge means **15** to the header **16** of the door frame **17**. Second hinge means **18** hinges the upper edge of the lower panel **14** to the lower edge of the upper panel **13**. First and second control arms **21** and **22** are provided on each side of the door **11** and each has first and second ends **23** and **24**, respectively. The first end **23** is pivoted by third hinge means **25** to the door frame **17** and the second end **24** is pivoted at fourth hinge means **26** to the lower panel **14**. The third hinge means **25** is positioned a first vertical distance below the first hinge means **15** and is also positioned inwardly of a vertical plane passing through this first hinge means **15**. The fourth hinge means **26** is positioned a second given distance below the second hinge means **18** which second distance is substantially equal to said first given distance. The above construction provides a door **11** which is a bifold door and the control arms **21** and **22** establish movement of the lower panel **14** without using any guide track along the door frame **17** for a roller at the lower edge of the lower panel **14**. These control arms **21** and **22** establish that the door panels **13** and **14** hang substantially vertically in the closed position of the door and then the lower panel **14** swings inwardly and upwardly substantially against the inside of the upper panel **13** as this upper panel swings outwardly through substantially a 90 degree arc. The door **11**, in opening, passes through an intermediate position **11A** shown in phantom in FIGURE 2 to an open position **11B** also shown in phantom in FIGURE 2. In the closed position the panels **13** and **14** abut a door stop **28**.

In the open position it will be noted that the control arms **21** and **22** form a type of triangular brace to help support the door **11** and also in the closed position the weight of the door is supported on the first and third hinge means **15** and **25**.

The door operator mechanism **31** of the invention includes a case **32** mounted centrally on the inside of the door header **16**. This door operator case has extending from either side thereof cable drums **33** and **34** mounted on an output shaft **35**. A motor **36** is provided in the case **32** to drive the output shaft **35**. Cables **37** extend downwardly from the cable drums **33** and **34**, pass around cable sheaves **38** at the bottom of the door **11** and then extend generally horizontally to cable sheaves **39** near the lower corners of the door **11**. From this point the cables **37** extend upwardly to a lever lock system **40** shown in greater detail in the co-pending application of Richard D. Houk and John T. Kunkle entitled "Door Operator," Serial Number 287,418, filed concurrently herewith. This lever lock system **40** includes a first lever **41** pivoted at **42** to the centrol arm **21** and having a sliding pivotal connection to one end of a second lever **44** by means of a pivot **43** in lever **44** and an elongated slot **46** in lever **41**. The other end of this lever **44** is pivoted at the second hinge means **18**. The cable **37** is connected to the pivot **43**. This lever lock system **40** provides a type of toggle locking mechanism to lock the door in its closed position and also provides leverage to open the door, even though a wind force may be exerted on the exterior of the door **11**. Spring means **45** urges the levers **41** and **44** upwardly toward a locked position and the cable **37** pulls downwardly on pivot **43** upon a lifting force being exerted by the operator **31**.

FIGURE 2 shows the door **11** as closed against the door stop **28**, but with the lever lock system **40** not completely locked. The locked position is with the levers **41**

and 44 pulled upwardly by the spring 45 to a position of parallelism and disposed at an acute angle of about thirty degrees relative to the upper panel 13. In this locked position the second hinge means 18 and pivots 42 and 43 are substantially aligned to form a type of toggle locking mechanism.

FIGURE 4 better shows the internal construction of the door operator 31. The motor 36 is carried in the case 32. The motor has a drive shaft 48 in which a transverse double ended drive pin or cam 49 is located. A centrifugal switch mechanism 50 is mounted on a hub 51 journalled on the output drive shaft 48. This hub 51 has a V cut or cam follower 52 on the inner end to engage the drive pin 49. This V cut 52 has right angle shoulders 53 for positive drive engagement with the drive pin 49. A compression spring 54 is adjusted by a nut 55 threaded on the drive shaft 48 and urges the hub 51 into engagement with the drive pin 49.

Brake means is provided by a brake disc 58 fixed on the hub 51 which is adapted to frictionally engage a brake shoe 59 fixed on the frame 60 of the motor 36. Upon rotation in either direction of the motor drive shaft 48, the drive pin 49 cams against the V cut 52 to move the hub 51 to the right, as viewed in FIGURE 4, and thus disengage the brake disc 58 from the brake shoe 59. When the motor 36 is de-energized, the hub 51 is braked against rotation.

The hub 51 is on an axially movable member and carries a drive pinion 62 driving a gear 63 having a pinion 64 in turn driving a gear 65 journalled on the output shaft 35. A clutch 67 is disposed in the drive train between the gear 65 and the output shaft 35. This clutch 67 is shown as a one-way clutch as an example of a clutch having lost motion means therein. The clutch 67 has first and second parts 68 and 69, respectively, and the first part 68 will drive the second part 69 in a first rotational direction shown by the arrow 70. Conversely, the second part 69 will drive the first part 68 in the opposite rotational direction shown by arrow 71. The second clutch part 69 is keyed to the output shaft 35 and a compression spring 72 urges the clutch parts together. This compression spring 72 is adjusted in compressional force by an adjusting nut 73 having a cam surface 74 cooperating with a pin 75 in the output shaft 35.

The centrifugal switch mechanism 50 may be used as a torque switch and includes weights 78 pivotally carried on the brake disc 58. Spring means 79 acting through yokes 80 urge the weights 78 inwardly to engage a torque switch sleeve 81. This sleeve is electrically conductive but insulated at 82 from the hub 51. The sleeve 81 is held by a metal clamp 83 so that it is stationary and this clamp also provides electrical connection to the sleeve 81. When the weights 78 are in contact with the sleeve 81, this sleeve is grounded and at about half speed of the motor, the weights fly centrifugally outwardly out of engagement with the sleeve 81 for a switch open condition.

An electrical switch 84 is a resilient leaf blade insulatedly mounted on the case 32, and adapted to be contacted and grounded when engaged by the clutch part 69 upon movement to the left, as viewed in FIGURE 4.

FIGURE 3 shows schematically the electrical control circuit 85. The control circuit 85 is a grounded or single conductor system and, hence, the electrical contact is made between the leaf spring blade 84 and the clutch part 69 which is grounded.

The control circuit 85 is energized from a suitable voltage source such as an alternating voltage source 93. A control transformer 94 is energized through an overload protector 95. The electric motor 36 is also energized through this overload protector 95 and has first and second windings 96 and 97, respectively. This motor is a reversible capacitor induction motor having a capacitor 98. The motor 36 has a rotor 99 which drives the centrifugal switch mechanism 50. The torque switch sleeve 81 is adapted to be contacted by the weights 78 as part of the centrifugal mechanism 50 and this torque switch 81 is opened upon acceleration of the motor to about one-half speed.

The control circuit 85 also includes a ratchet relay 104 having a relay coil 105 energizable from a low voltage secondary 106 of the control transformer 94. One end of the secondary 106 is grounded for a grounded or single conductor control system and the other end of the relay coil 105 is connected to a terminal 109 on a terminal board 107. A push button switch 108 is connected across the terminals of the terminal board 107 to ground 90 to establish energization of the relay coil 105. This push button switch may be a manual switch such as an ordinary door bell push button operating on the low voltage secondary 106, for example 24 volts. Also, this push button switch 108 may be representative of a radio controlled switch closed by actuation of a radio transmitter in an automobile for remote operation of the door 11.

A relay armature position switch 110 is a normally closed switch connected to be actuated to the open position by energization of the relay coil 105 and, hence, actuation of the relay armature. The relay armature 111 actuates a ratchet 112 to rotate a plurality of cams 113 and, accordingly, actuate a series of relay contacts 114 to 117, inclusive, in a predetermined sequence. The relay contacts 114 to 117 are normally open contacts and are shown in the open position in FIGURE 3 which corresponds to the door closed position of the door 11. A conductor 118 of the voltage source 93 is connected to each of the contacts 114 to 116. A conductor 119 of the voltage source 93 is connected through a lamp 120 to the contacts 116. This lamp 120 may be mounted on the door operator 31 to illuminate the interior of the garage or other structure for which the door 11 is a closure. A conductor 121 connects motor winding 97 to the other side of contacts 114 and a conductor 122 connects the motor winding 96 to the other side of relay contacts 115.

The relay contacts 114–116 are power contacts to control energization to the motor 36 and lamp 120 and relay contacts 117 are control contacts forming part of a control circuit 123. A conductor 124 is connected from the relay armature position switch 110 through the relay contacts 117 to a terminal 125. The torque switch 81 and switch 84 are connected in parallel between terminal 125 and ground. As viewed in FIGURE 4, the switch 84 is open and the switch 81 is closed when the motor and the door are stopped.

Operation

As best shown in FIGURE 2, the door 11 is constructed to swing upwardly and outwardly in the door opening movement. The upper panel 13 swings from a generally vertical to a generally horizontal position and the lower panel 14 also moves from a generally vertical to a generally horizontal position but the second hinge means 18 and control arms 21 and 22 establish that the lower panel 14 moves approximately 180 degrees relative to the upper panel 13. The door 11 is supported substantially entirely in the closed position by the first and third hinge means 15 and 25. These two points of support plus the control arms 21 and 22 provide support and control means for the door 11 and support a majority of the weight throughout the entire door opening and door closing movement. Thus, it has been found that a 385 lb. door required only 110 lbs. total pull on the cables 37 throughout the entire opening movement. Thus, the door 11 requires no counterbalancing means because the motor 36 may easily supply the necessary power to open the door 11 in a normal time of 10–15 seconds. The motor 36 drives the output shaft 35 to wind the cables 37 on the respective cable drums 33 and 34, thus exerting a generally vertical lifting force on the bottom of the lower panel 14 and this moves the door 11 through the intermediate position 11A to the open position 11B shown in phantom in FIGURE 2.

The electrical control circuit 85 controls the door open-

ing and closing movement. When the push button switch **108** is depressed or the radio control switch is actuated across the same terminal board **107**, the relay coil **105** will be energized. FIGURE 3 shows the control circuit **85** in the de-energized position corresponding to the door closed or first position. Energization of relay coil **105** moves armature **111** to move the ratchet **112** and the cams **113** from the first to the second of four sequential positions. This second position corresponds to a door opening condition and closes contacts **114**, **116** and **117**. Contacts **116** energize the lamp **120** to illuminate the inside of the garage. Contacts **114** are closed to energize motor winding **97** directly and energize motor winding **96** through the capacitor **98** to rotate the rotor **99** in one direction for a door opening movement. Initial rotation of the motor **36** rotates the drive pin **49** against one side of the V cut **52** to cam the hub **51** to the right and release the friction brake **58–59**. Next, the drive pin **49** engages one of the right angle shoulders **53** for positive drive of the hub **51**. The drive train is through the gears **62–65** to the one-way clutch **67**, in the direction of arrow **70**, to drive the cable drums **33** and **34**, and thus exert a lifting force on the door panels **13** and **14**. During initial acceleration of the rotor **99**, the torque switch **81** is opened.

This occurs quickly after energization of the motor **36**, and thereafter push button switch **108** may be released to de-energize the relay coil **105** without other change in the circuit condition. The initial movement of the cables **37** pulls downwardly on the levers **41** and **44**, against the urging of spring means **45**, and this releases the toggle lock arrangement of these levers. It also exerts a force multiplied leverage on the door **11** at the second hinge means **18** to force the door outwardly, thus breaking the effective toggle of the previously vertically disposed door panels **13** and **14**. Once the second hinge means **18** is moved outwardly a few inches, the cables **37** exert an effective lifting force to open the door **11**. The spring means **45** may have a force of about 15 lbs. for example, but it has been found that only a slight excess of force, for example 20 lbs. force, is necessary on the cables **37** to commence the door unlocking and opening movement. The lever lock system **40** acts smoothly and with gradual change from a high to a lower ratio of force multiplication so that the door opens gradually without any sudden jumping movement away from the door stops **28**. FIGURE 2 shows the door **11** just starting its opening movement with levers **41** and **44** swung downwardly about thirty to forty degrees to better show the connections of these levers. This would be the condition with wind on the outside of the door holding the door against the stops **28** and with the pivot **43** sliding in the elongated slot **46** in lever **41**. The door continues in its opening movement through an intermediate position **11A** to the full open position **11B** shown in phantom in FIGURE 2. It is in the intermediate position **11A** at which the maximum lifting force must be applied to the cables **37** and this is only about 30–35% of the total weight of the door **11**. This light load means that an ordinary household motor such as ¼ h.p. may easily raise the door **11** without aid from any counterbalance means.

As the door approaches the full open position **11B**, the load on the cables is again reduced to only about 20–25 lbs. force for a door having a weight in the order of 400 lbs. This is because the control arms **21** and **22** in effect act as a triangular brace to support the door **11** in the open position and because the fourth hinge means **26** is approaching a high enough position relative to the first and second hinge means **15** and **18** to almost lock the door in the up position. If the fourth hinge means **26** is made to lie above the line joining the first and second hinge means **15** and **18**, then it is found that the door **11** will lock up in the full open position **11B**. It is not desired to achieve this locking up condition in this door mechanism because it is desired to have the door **11** close by gravity rather than being driven closed by the motor **36**.

When the door **11** reaches the full open position, the lower panel **14** is collapsed up against the upper panel **13** with the control arms **21** and **22** sandwiched therebetween and, thus, the lower panel **14** can go no higher. Accordingly, the motor **36** is stalled and the centrifugal switch mechanism **50** closes the torque switch **81**, which is the grounded weights **78** contacting sleeve **81**. This pulses or energizes the relay coil **105** through the then closed relay contacts **110** and **117**. The relay **104** is thus ratcheted from the second to the third position which is a door open position. In this door open position, only the relay contacts **116** remain closed to keep the lamp **120** illuminated.

In the door open position, the motor **36** is of course de-energized with a small amount of weight from the door **11** acting through the cables **37** to apply a small torque to the brake disc **58**. This torque is resisted by the brake shoe **59**, because the spring **54** causes engagement therebetween, inasmuch as the motor is now de-energized to no longer have drive pin **49** cammed into drive engagement with the shoulder **53**. Thus this brake holds the door in the open position **11B**.

The door closing movement is initiated by depressing the push button **108** or its counterpart radio control switch, not shown. This actuates the relay coil **105** to ratchet the cams **113** from the third to the fourth position which is a door closing condition. This fourth position closes contacts **115**, **116** and **117** with contacts **116** again keeping the lamp **120** illuminated. Closing of the contacts **115** energizes the motor winding **96** directly and motor winding **97** through the capacitor **98** for reverse rotation of the rotor **99**. This is a door closing direction and the unbalanced force of gravity on the door drives clutch part **69** in the reverse direction according to arrow **71**, and this drives clutch part **68**, with the energized motor acting as a retarding force or brake means on the door. This reverse energization of the motor **36** does not push the door closed but does pay out the cables **37** because gravity acting on the door **11** is an unbalanced force urging the second clutch part **69** in the said reverse rotational direction as shown by arrow **71**. This maintains drive engagement from the second clutch part **69** to the first clutch part **68**. The spring **72** aids this engagement, and does give a slight driving force from clutch part **68** to part **69**, in case it is needed because of wind force or the like on the door **11**. Since the induction motor **36** is essentially a constant speed device, the door closing speed is approximately the same as the opening speed, with the motor **36** acting as a brake or retarding force.

During the door closing movement the door moves from position **11B** through position **11A** to the solid line position shown in FIGURE 2. As the door becomes closed, the motor continues to pay out the flexible cables and, thus, the spring means **45** urges the levers **41** and **44** upwardly. The toggle lever arrangement of these levers continually increases the force multiplication to pull the door **11** tightly closed against the door stops **28** despite any wind force which might be exerted through an open window on the inside of the door **11**. Also, the lever lock system **40** locks the door in the closed position as the levers cease movement by abutting each other when parallel for a stop means therebetween. Continued motor rotation beyond this point releases tension in the cable and the one-way clutch **67** slips. This cams the second clutch part **69** to the left as a lost motion means to actuate switch **84** by grounding same on the clutch part **69**. This energizes the relay coil **105** through the then closed relay contacts **117** and **110**. The relay **104** is thus ratcheted to return from the fourth to the first position which is the door closed condition. In this position, all contacts **114–117** are open and, hence, the motor **36** is de-energized. The door is locked at the two sides near the second hinge

means **18** to prevent unauthorized entry into the garage. It will be noted that the exterior of the door **11** presents a smooth appearance with no external handles and, thus, nothing may be grasped to aid forcible entry into the garage.

The above description shows that the torque switch **81** is that which stops the motor in the full open position and the switch **84** is a lost motion means that stops the motor in the full closed position. The control circuit **85** also provides important safety features. One of these safety features is that at any point in the upward opening or downward closing movements of the door, the door may be stopped if a person notices that it needs to be stopped for any reason. This may be accomplished by simply depressing the push button switch **108** or the radio control switch, not shown, in parallel therewith. This push button switch **108** will actuate the relay coil **105** to index the relay **104** to the next position which is a motor and door stopped condition.

The switch **84** provides still another safety feature, namely, to stop the door in the downward direction whenever the door closing movement is obstructed. For example, if some obstruction is under the door in the intermediate position **11A** of FIGURE 2, then this releases cable tension to cause slippage of the clutch **67** to actuate the switch **84** and stop the motor and the door **11**. Upon de-energization of the motor **36**, the brake **58–59** is engaged by spring **54**, to brake and hold the door in any such intermediate position. In the intermediate position **11A** of FIGURE 2, the spring means **45** is acting generally parallel to the lever **41**, hence does not exert much force on the cable **37**. The lever **44** is that which effectively anchors the cable **37** to the door, and it is generally parallel to the door in this intermediate position **11A**. Accordingly, any obstruction to downward door movement quickly results in loss of cable tension without necessity for the levers **41** and **44** to swing through any arc, and accordingly, the motor **36** and door **11** are promptly stopped.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,
- a door operator comprising, in combination, a motor,
- a drive train between said motor and door and including a rotatable shaft and a one-way clutch,
- brake means for said rotatable shaft,
- said motor driving through said clutch for door movement in one direction,
- said unbalanced force on said door causing door movement in the opposite direction and driving through said clutch to said rotatable shaft,
- and means to actuate said brake means during drive of said rotatable shaft from said unbalanced force.

2. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,
- a door operator comprising, in combination, a motor,
- a drive train between said motor and door and including a rotatable shaft,
- brake means for said rotatable shaft,
- spring means urging at least part of said brake means toward engagement,
- cam and cam follower means acting on at least part of said brake means to release same upon rotation of said rotatable shaft,
- said motor driving through said drive train for door movement in one direction,
- said unbalanced force on said door causing door movement in the opposite direction and driving through said drive train to said rotatable shaft.
- means to actuate at least part of said brake means during drive to said rotatable shaft from said unbalanced force.

3. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,
- a door operator comprising, in combination, a motor,
- a drive train between said shaft and door and including a rotatable shaft and a one-way clutch,
- said motor driving through said clutch for door movement in one direction,
- said unbalanced force on said door causing door movement in the opposite direction and driving through said clutch to said rotatable shaft,
- brake means for said rotatable shaft,
- means to actuate said brake means during drive of said rotatable shaft from said unbalanced force,
- and stopping of said motor causing said spring means to engage said brake means to brake said door in said opposite direction of movement.

4. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,
- a door operator comprising, in combination, a motor,
- a drive train between said shaft and door and including a rotatable shaft and a one-way clutch,
- brake means for said rotatable shaft,
- spring means urging said brake means toward engagement,
- cam and follower means acting on said brake means to release same upon rotation of said rotatable shaft,
- said motor driving through said clutch for door movement in one direction,
- said unbalanced force on said door causing door movement in the opposite direction and driving through said clutch to said rotatable shaft,
- and stopping of said motor causing said spring means to engage said brake means to brake said door in said opposite direction of movement.

5. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,
- a door operator comprising, in combination, a motor,
- a drive train between said motor and door and including a rotatable shaft and a one-way clutch,
- brake means for said rotatable shaft,
- spring means urging at least part of said brake means toward engagement,
- cam and cam follower means acting on at least part of said brake means to release same upon rotation of said rotatable shaft,
- said motor driving through said clutch for door movement in one direction,
- said unbalanced force on said door causing door movement in the opposite direction and driving through said clutch to said rotatable shaft,
- means to actuate at least part of said brake means during drive of said rotatable shaft from said unbalanced force,
- and stopping of said motor causing said spring means to engage at least part of said brake means to brake said door in said opposite direction of movement.

6. In combination with a door to be opened anl closed and having an unbalanced force resisting one of such movements,
- a door operator comprising, in combination, a motor,
- a rotatable shaft driven from said motor,
- a drive train between said shaft and door and including a one-way clutch,
- an axially movable member in said drive train,
- brake means for said rotatable shaft acting on said axially movable member,

spring means urging said brake means toward engagement,
a cam on said rotatable shaft,
a cam follower on said axially movable member engageable with said cam to move said axially movable member axially against the urging of said spring means to release said brake means upon rotation of said rotatable shaft,
said motor driving through said clutch for door movement in one direction,
said unbalanced force on said door causing door movement in the opposite direction and driving through said clutch to said rotatable shaft,
means to actuate said brake means during drive of said rotatable shaft from said unbalanced force,
and stopping of said motor causing said spring means to engage said brake means to brake said door in said opposite direction of movement.

7. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,
a door operator comprising, in combination, a motor,
a rotatable shaft driven from said motor,
a drive train between said shaft and door and including a one-way clutch,
said motor driving through said clutch for door movement in one direction,
said unbalanced force on said door causing door movement in the opposite direction and driving through said clutch to said motor,
an axially movable member in said drive train,
brake means for said motor acting on said axially movable member,
spring means urging said brake means toward engagement,
a cam on said rotatable shaft,
a cam follower on said axially movable member engageable with said cam to move said axially movable member axially against the urging of said spring means to release said brake means upon rotation of said rotatable shaft,
and de-energization of said motor causing said spring means to engage said brake means to brake said door in said opposite direction of movement.

8. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,
a door operator comprising, in combination, a motor,
a rotatable shaft driven from said motor,
a drive train between said shaft and door and including a one-way clutch with first and second parts,
said motor driving said clutch first part in a non-slipping first rotational direction for door movement in one direction,
means to reversely energize said motor for rotation in the opposite rotational direction for door movement in the opposite direction with said unbalanced force on the door driving said second clutch part in said opposite rotational direction with said reversely energized motor acting as a brake,
an axially movable member in said drive train,
brake means for said motor acting on said axially movable member,
spring means urging said brake means toward engagement,
a cam on said rotatable shaft,
a cam follower on said axially movable member engageable with said cam to move said axially movable member axially against the urging of said spring means to release said brake means upon rotation of said rotatable shaft,
and de-energization of said motor causing said spring means to engage said brake means to brake said door in said opposite direction of movement.

9. A door operator for a door to be opened and closed and having an unbalanced force resisting one such movement,
said operator comprising, in combination, a motor,
a rotatable shaft driven from said motor,
a cam on said shaft,
a drive train from said shaft to said door and including an axially movable member on said shaft and a one-way clutch,
a cam follower on said axially movable member engageable with said cam,
stop means cooperating with said cam and cam follower for positive drive engagement from said shaft to said axially movable member,
brake means for said motor acting on said axially movable member,
spring means urging said axially slidable member toward engagement of said brake means,
means to energize said motor to cause said cam to move said axially movable member axially against the urging of said spring means to release said brake means upon rotation of said motor shaft for door movement in one direction,
means to reversely energize said motor for rotation in the opposite rotational direction for door movement in the opposite direction,
and de-energization of said motor causing said spring means to engage said brake means to brake said door.

10. A door operator for a door to be opened and closed and having an unbalanced force resisting one such movement,
said operator comprising, in combination, a motor having a frame and a rotatable shaft,
an axially slidable member journalled on said motor shaft,
a cam on said motor shaft,
a cam follower on said axially sliding member engageable with said cam to axially move said member upon rotation of said motor shaft,
an axially parallel drive shoulder on said axially slidable member adjacent said cam follower for positive drive engagement with said cam,
brake means for said motor acting between the motor frame and said axially slidable member,
spring means urging said axially slidable member toward said frame to engage said brake means,
a drive train between said motor and door including said axially slidable member and a one-way clutch,
means to energize said motor to cause said cam to move said axially slidable member axially against the urging of said spring means to release said brake means upon rotation of said motor shaft for door opening movements,
means to reversely energize said motor for rotation in the opposite rotational direction for door closing movements,
and de-energization of said motor causing said spring means to engage said brake means to brake said door.

11. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,
a door operator comprising, in combination, a motor having a frame and a rotatable shaft,
a drive train between said motor and door and including a one-way clutch with first and second parts,
said motor driving said clutch first part in a non-slipping first rotational direction for door movement in one direction,
means to reversely energize said motor for rotation in the opposite rotational direction for door movement in the opposite direction with said unbalanced force of the door driving said second clutch part in said opposite rotational direction with said reversely energized motor acting as a brake,

brake means for said motor acting between the motor frame and an axially movable member of said drive train,

spring means urging said brake means toward engagement,

a drive pin on said motor shaft,

a drive V on said axially movable member engageable with said drive pin to move said axially movable member axially against the urging of said spring means to release said brake means upon rotation of said motor shaft,

and de-energization of said motor causing said spring means to engage said brake means to brake said door in said opposite direction of movement.

12. In combination with a door to be opened and closed and having an unbalanced force resisting one of such movements,

a door operator comprising, in combination, a motor having a rotatable shaft,

a cable connecting said motor to move said door,

a drive train between said motor and cable including a one-way clutch,

means to energize said motor to drive said clutch first part in a first rotational direction for door movement in one direction,

means to reversely energize said motor for rotation in the opposite rotational direction for door movement in the opposite direction,

and said unbalanced force of the door driving said second part in one of said rotational directions with said energized motor acting as a brake.

13. In combination with a door to be opened and having an unbalanced force resisting such opening effort,

a door operator comprising, in combination, a motor having a frame and a rotatable shaft,

a cable connecting said motor to open said door,

a drive train between said motor and cable including a one-way clutch,

means to energize said motor to drive said clutch first part in a first rotational direction for door opening movements,

means to reversely energize said motor for rotation in the opposite rotational direction for door closing movements with said unbalanced force of the door driving said second part in said opposite rotational direction with said reversely energized motor acting as a brake,

brake means for said motor acting between the motor frame and an axially sliding member of said drive train,

spring means urging said brake means toward engagement,

a drive pin on said motor shaft,

a drive V on said axially sliding member engageable with said drive pin to move said axially sliding member axially against the urging of said spring means to release said brake means upon rotation of said motor shaft,

and de-energization of said motor causing said spring means to engage said brake means to brake said cable and, hence, brake said door in said closing movement.

14. A door operator for a door to be opened and closed and having an unbalanced force resisting one such movement,

said operator comprising, in combination, a motor having a frame and a rotatable shaft,

a drive pin on said motor shaft,

an axially slidable gear journalled on said motor shaft,

a drive V on said axially sliding gear engageable with said drive pin,

an axially parallel drive shoulder on said axially slidable gear adjacent said drive V for positive drive engagement with said drive pin,

spring means urging said drive V of said gear toward said drive pin,

brake means for said motor acting between the motor frame and said axially slidable gear and urged into engagement by said spring means,

a cable connected to said door,

a drive train between said motor and cable including said axially slidable gear and a one-way dog clutch of first and second parts intermeshing in a first rotational direction of said first part and each having teeth with axially parallel faces on one side and angular faces on the other side,

means to energize said motor to move said axially slidable gear axially against the urging of said spring means to release said brake means upon rotation of said motor shaft for drive of said clutch first part in said first rotational direction for door opening movements,

means to reversely energize said motor for rotation in the opposite rotational direction for door closing movements,

and de-energization of said motor causing said spring means to engage said brake means to brake said cable and, hence, brake said door.

15. A door operator for a door to be opened and closed and having an unbalanced force resisting such opening effort,

said operator comprising, in combination, a motor having a frame and a rotatable shaft,

a drive pin on said motor shaft,

an axially slidable gear journalled on said motor shaft,

spring means urging said gear toward said drive pin,

brake means for said motor acting between the motor frame and said axially slidable gear,

a drive V on said axially sliding gear engageable with said drive pin to move said axially slidable gear axially against the urging of said spring means to release said brake means upon rotation of said motor shaft,

a drive train between said motor and door including said axially slidable gear and a one-way dog clutch of first and second parts intermeshing in a first rotational direction of said first part and each having teeth with axially parallel faces on one side and angular faces on the other side,

an axially parallel drive shoulder on said axially slidable gear adjacent said drive V for positive drive engagement with said drive pin,

means to energize said motor for drive of said clutch first part in said first rotational direction for door opening movements,

means to reversely energize said motor for rotation in the opposite rotational direction for door closing movements with said unbalanced force of the door driving said second part in said opposite rotational direction with said reversely energized motor acting as a brake,

and de-energization of said motor causing said spring means to engage said brake means to brake said door.

16. In combination with a door to be lifted and having an unbalanced weight resisting such lifting effort,

a door operator comprising, in combination, a motor having a frame and a rotatable shaft,

a cable connecting said motor to lift said door,

a drive train between said motor and cable including a one-way dog clutch of first and second intermeshing parts each having teeth with axially parallel faces on one side and angular faces on the other side,

means to energize said motor to drive said clutch first part in a first rotational direction for door lifting movements,

means to reversely energize said motor for rotation in the opposite rotational direction for door closing

movements with the weight of the door driving said second part in said opposite rotational direction with said reversely energized motor acting as a brake,

brake means for said motor acting between the motor frame and an axially sliding gear of said drive train,

spring means urging said brake means toward engagement,

a drive pin on said motor shaft,

a drive V on said axially sliding gear engageable with said drive pin to move said axially sliding gear axially against the urging of said spring means to release said brake means upon rotation of said motor shaft,

and de-energization of said motor causing said spring means to engage said brake means to brake said cable and, hence, brake said door in said downward closing movement.

17. A door operator for a door to be lifted and having an unbalanced weight resisting such lifting effort,

said operator comprising, in combination, a motor having a frame and a rotatable shaft,

a drive pin on said motor shaft,

an axially slidable gear journalled on said motor shaft,

spring means urging said gear toward said drive pin,

brake means for said motor acting between the motor frame and said axially slidable gear,

a drive V on said axially sliding gear engageable with said drive pin to move said axially slidable gear axially against the urging of said spring means to release said brake means upon rotation of said motor shaft,

a cable connected to said door,

a drive train between said motor and cable including said axially slidable gear and a one-way dog clutch of first and second parts intermeshing in a first rotational direction of said first part and each having teeth with axially parallel faces on one side and angular faces on the other side,

means to energize said motor for drive of said clutch first part in said first rotational direction for door lifting movements,

means to reversely energize said motor for rotation in the opposite rotational direction for door closing movements with the weight of the door driving said second part in said opposite rotational direction with said reversely energized motor acting as a brake,

an axially parallel drive shoulder on said axially slidable gear adjacent said drive V for positive drive engagement with said drive pin,

and de-energization of said motor causing said spring means to engage said brake means to brake said cable and, hence, brake said door.

18. A door operator for a door to be lifted and having an unbalanced weight resisting such lifting effort,

said operator comprising, in combination, a motor having a frame and a rotatable shaft,

a cable connecting said motor to lift said door,

a drive train between said motor and cable including a one-way dog clutch of first and second intermeshing parts each having teeth with axially parallel faces on one side and angular faces on the other side,

said motor driving said clutch first part in a first rotational direction for door lifting movements,

means to reversely energize said motor for rotation in the opposite rotational direction for door closing movements with the weight of the door driving said second clutch part in said opposite rotational direction with said reversely energized motor acting as a brake,

brake means for said motor acting between the motor frame and an axially sliding gear of said drive train,

spring means urging said brake means toward engagement,

a drive pin on said motor shaft,

a drive V on said axially sliding gear engageable with said drive pin to move said axially sliding gear axially against the urging of said spring means to release said brake means upon rotation of said motor shaft,

and de-energization of said motor causing said spring means to engage said brake means to brake said cable and, hence, brake said door.

19. A door operator for a door to be lifted and having an unbalaneed weight resisting such lifting effort,

said operator comprising, in combination, a motor having a frame and a rotatable shaft,

a cable connected to lift said door,

a drive train between said motor and cable including an axially sliding gear and a one-way dog clutch of first and second parts intermeshing in a first rotational direction of said first part and each having teeth with axially parallel faces on one side and angular faces on the other side,

means to energize said motor for drive of said clutch first part in said first rotational direction for door lifting movements,

means to reversely energize said motor for rotation in the opposite rotational direction for door closing movements with the weight of the door driving said second clutch part in said opposite rotational direction with said reversely energized motor acting as a brake,

brake means for said motor acting between the motor frame and said axially sliding gear of said drive train,

spring means urging said brake means toward engagement,

a drive pin on said motor shaft,

a drive V on said axially sliding gear engageable with said drive pin to move said axially sliding gear axially against the urging of said spring means to release said brake means upon rotation of said motor shaft in either direction,

and de-energization of said motor causing said spring means to engage said brake means to brake said cable and, hence, brake said door.

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