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DOOR OPERATOR CONTROL

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2 Sheets-Sheet 1

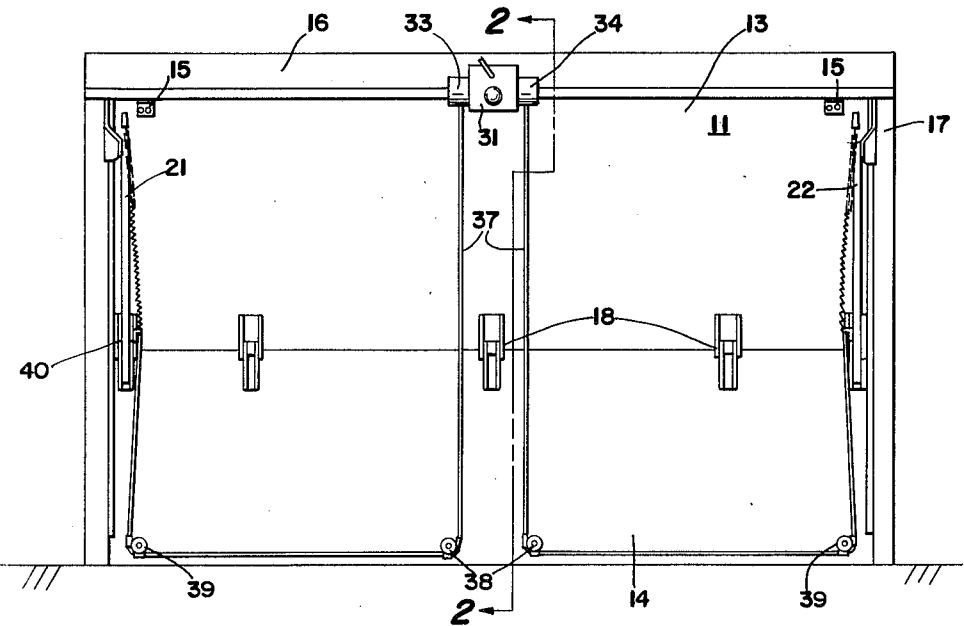


Fig. 1

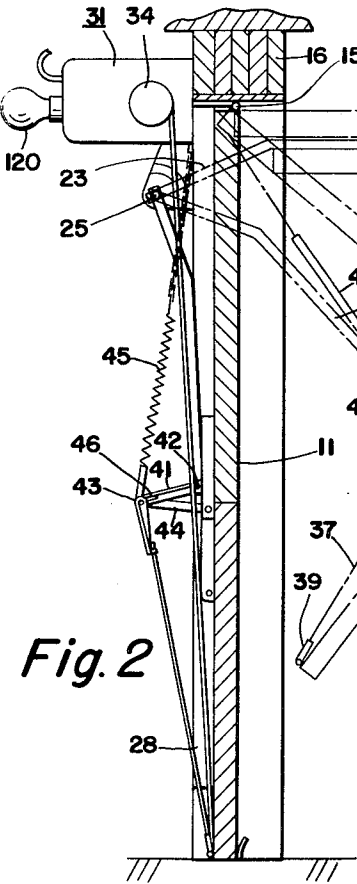


Fig. 2

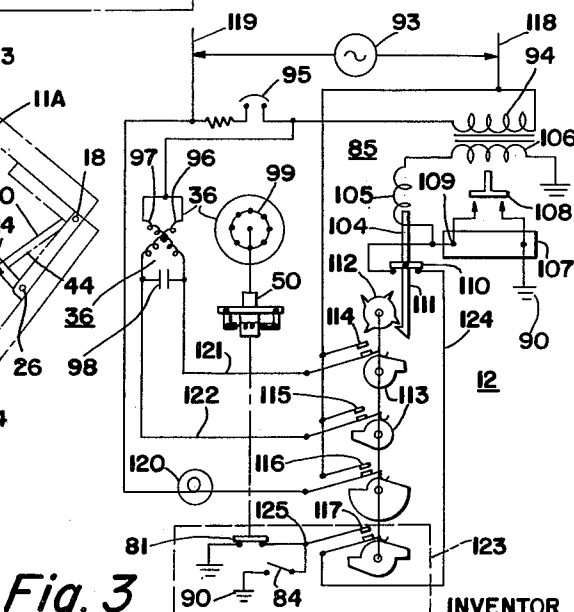


Fig. 3

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3,207,502

DOOR OPERATOR CONTROL

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13 Claims. (Cl. 268—74)

This application is a continuation-in-part of the Richard D. Houk applications Serial Number 190,858, entitled Door; Serial Number 190,869, entitled Garage Door and Operator; and Serial Number 190,877 entitled Door and Control System Therefor, all filed April 30, 1962.

The invention relates in general to door operator control systems and, more particularly, to a control system 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. With such a door operator, however, there is always the problem of providing a safe control system so that the door operator mechanism will properly cease its driving movement at the fully open and fully closed positions and also will have a means to stop the door movement should the door encounter some obstruction.

An object of the invention is to provide a door operator control system with a safety means to stop door movement upon the door encountering an obstruction.

Another object of the invention is to provide a door operator control system wherein a drive train is provided from an operator to a door and wherein lost motion means is provided in the drive train with control effected by actuation of the lost motion means.

Another object of the invention is to provide a door operator control system wherein a clutch is provided with a lost motion means in the clutch and upon actuation of the lost motion means a switch is actuated to control energization of the motor in the door operator.

Another object of the invention is to provide a door operator control system wherein a one-way clutch is provided permitting overrunning connection of the motor to the door in one direction with drive of the door in the other direction and with control means being effected by the overrunning condition of the clutch.

Another object of the invention is to provide a door operator control system wherein the door operator is de-energized upon the door meeting an obstruction during closing movement to permit slippage in a clutch in the drive train.

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 control 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

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with the door operator control system 12 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 11 is provided with a door operator 31 which 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 drum 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 control arm 21 and having a sliding pivotal connection of a pivot 43 in an elongated slot 46 in one end of a second lever 44. 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 49 is located. A centrifugal switch mechanism 50 is mounted on a hub 51 journaled on the output drive shaft 48. This hub 51 has a V cut 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.

A brake disc 58 is fixed on the hub 51 and 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 deenergized, the hub 51 is braked against rotation.

The hub 51 carries a drive pinion 62 driving a gear 63 having a pinion 64 in turn driving a gear 65 journaled 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 conducting 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 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 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 108 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 motor 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 FIG. 2.

The electrical control circuit 85 controls the door opening and closing movements. 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 1/4 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 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 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 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.

Alternatively, the door may be stopped at any time in the door opening movement by pressing the push button switch 108. This energizes the relay coil 105 to also ratchet the relay 104 from the second to the third position.

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 thus the first clutch part 68 is driven in the reverse direction, opposite to arrow 70. This 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 a door mechanism for a door to be opened and having an unbalanced force resisting such opening effort, a door operator comprising, in combination, a motor, a clutch having first and second parts, a drive train connecting said first clutch part to said motor and said second clutch part to said door, said clutch providing drive from said first to said second part in a first rotational direction and from said second to said first part in a second rotational direction, lost motion means in said clutch between said first and second parts with rotation of said first part in said second rotational direction, circuit means to connect said motor for drive of said clutch first part in said first rotational direction for door opening movements and for drive of said clutch first part in the opposite rotational direction for door closing movements with said unbalanced force on the door driving said second part in said opposite rotational direction with said motor acting as a retarding force, obstruction to closing movement of said door retarding said second part relative to said first part and thus causing actuation of said lost motion means therebetween, and means responsive to said lost motion means to effect cessation of driving of said first clutch part from said motor.
2. In a door mechanism for a door to be opened and having an unbalanced force resisting such opening effort, a door operator comprising, in combination, a motor, a clutch having first and second parts, a drive train connecting said first clutch part to said motor and said second clutch part to said door, said clutch construction providing positive drive from said first to said second part in a first rotational direction and from said second to said first part in a second rotational direction,

- lost motion means in said clutch between said first and second parts with rotation of said first part in said second rotational direction,
- circuit means to energize said motor for drive of said clutch first part in said first rotational direction for door opening movements and for drive of said clutch first part in the opposite rotational direction for door closing movements with said unbalanced force on the door driving said second part in said opposite rotational direction with said energized motor acting as a retarding force,
- obstruction to closing movement of said door retarding said second part relative to said first part and thus causing actuation of said lost motion means therebetween,
- switch means actuated by said lost motion means, and means connecting said switch means to said circuit means to effect cessation of driving of said first clutch part from said motor upon actuation of said switch means.
3. In a door operator mechanism for a door to be lifted by a motor and having an unbalanced weight resisting such lifting effort, a control circuit comprising, in combination, a drive train including a clutch having first and second parts, said first clutch part being connected to said motor, said second clutch part being connected to said door, said clutch construction providing positive drive from said first to said second part in a first rotational direction and from said second to said first part in a second rotational direction, lost motion means in said clutch between said first and second parts with rotation of said first part in said second rotational direction, spring means acting on said first and second clutch parts relatively urging said first clutch part in said first rotational direction toward said second clutch part to take up said lost motion means, circuit means to energize said motor for drive of said clutch first part in said first rotational direction for door lifting movements and for drive of said clutch first part 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 energized motor acting as a retarding force, obstruction to downward movement of said door retarding said second part relative to said first part against the urging of said spring means and thus causing actuation of said lost motion means therebetween, switch means actuated by said lost motion means, and means connecting said switch means to said circuit means to control the de-energization of said motor upon actuation of said switch means.
 4. In a door mechanism for a door to be opened and having an unbalanced force resisting such opening effort, a door operator comprising, in combination, a motor, a one-way clutch having first and second parts, a drive train connecting said first clutch part to said motor and said second clutch part to said door, drive through said clutch being from said first to said second part in a first rotational direction and from said second to said first part in a second rotational direction, circuit means to connect said motor for drive of said clutch first part in said first rotational direction for door opening movements and for drive of said clutch first part in the opposite rotational direction for door closing movements with said unbalanced force on the door driving said second part in said opposite rotational direction with said motor acting as a retarding force, obstruction to closing movements of said door retarding

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said second part relative to said first part and thus causing slippage therebetween,
and means responsive to said slippage of said clutch parts to effect cessation of driving of said first clutch part from said motor.

5 5. In a door mechanism for a door to be opened and having an unbalanced force resisting such opening effort, a door operator comprising, in combination, a motor, a one-way clutch having first and second parts, a drive train connecting said first clutch part to said motor and said second clutch part to said door, 10 drive through said clutch being from said first to said second part in a first rotational direction and from said second to said first part in a second rotational direction, 15 circuit means to energize said motor for drive of said clutch first part in said first rotational direction for door opening movements and for drive of said clutch first part in the opposite rotational direction for door closing movements with said unbalanced force on the door driving said second part in said opposite rotational direction with said energized motor acting as a 20 retarding force, obstruction to closing movement of said door retarding said second part relative to said first part and thus causing slippage therebetween, 25 switch means actuated by said slippage of said clutch parts, and means connecting said switch means to said circuit means to effect cessation of driving of said first clutch part from said motor upon actuation of said switch means. 30

6. In a door operator mechanism for a door to be lifted by a motor and having an unbalanced weight resisting such lifting effort, 35 a control circuit comprising, in combination, a drive train including a one-way clutch having first and second parts, said first clutch part being connected to said motor, said second clutch part being connected to said door, 40 drive through said clutch being from said first to said second part in a first rotational direction and from said second to said first part in a second rotational direction, circuit means to energize said motor for drive of said 45 clutch first part in said first rotational direction for door lifting movements and for drive of said clutch first part 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 energized motor acting as a retarding force, 50 obstruction to downward movement of said door retarding said second part relative to said first part and thus causing slippage therebetween, 55 switch means actuated by said slippage of said clutch parts, and means connecting said switch means to said circuit means to control the de-energization of said motor upon actuation of said switch means. 60

7. In a door operator mechanism for a door to be lifted by a motor and having an unbalanced weight resisting such lifting effort, 65 a control circuit comprising, in combination, a drive train including a one-way clutch of first and second parts, said first clutch part being connected to said motor, said second clutch part being connected to said door, drive through said clutch being from said first to said second part in a first rotational direction and from said second to said first part in a second rotational direction, 70 circuit means to energize said motor for drive of said clutch first part in said first rotational direction for door lifting movements, 75

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means to reversely energize said motor for rotation in said 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 retarding force, obstruction to downward movement of said door retarding said second part relative to said first part and thus causing slippage between said first and second clutch parts, switch means actuated by said slippage of said clutch parts, and means connecting said switch means to said circuit means to control the de-energization of said motor upon actuation of said switch means.

8. In a door operator mechanism for a door to be lifted by a motor and having an unbalanced weight resisting such lifting effort, a control circuit comprising, in combination, a drive train including a one-way clutch of first and second parts, said first clutch part being connected to said motor, said second clutch part being connected to said door, said first part capable of driving said second part in a first rotational direction and said second part capable of driving said first part in a second rotational direction, spring means urging said clutch parts into relative driving engagement, circuit 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 said 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 retarding force, obstruction to downward movement of said door retarding said second part relative to said first part against the urging of said spring means and thus causing slippage between said first and second clutch parts, switch means actuated by said slippage of said clutch parts, and means connecting said switch means to said circuit means to control the de-energization of said motor upon actuation of said switch means.

9. In a door operator mechanism for a door to be opened and closed and having an unbalanced force resisting one of said opening and closing movements. a control circuit comprising, in combination, a motor, a drive train including a one-way dog clutch of first and second intermeshing parts each having teeth with cam faces on one side, said first clutch part being connected to said motor, said second clutch part being connected to said door, circuit means to energize said motor for drive of said clutch first part in a first rotational direction for door opening movements and for drive of said clutch first part in the opposite rotational direction for door closing movements with one of said movements being effected by said unbalanced force driving said clutch second part in said opposite rotational direction, obstruction to said one of said door movements retarding said clutch second part relative to said first part and thus cammingly separate said first and second clutch parts in an axial direction. switch means actuated by said relative axial movement of said clutch parts, and means connecting said switch means to said circuit means to control the de-energization of said motor upon actuation of said switch means.

10. In a door operator mechanism for a door to be lifted and having an unbalanced weight resisting such lifting effort,

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a control circuit comprising, in combination, a motor,
 a drive train 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 first clutch part being connected to said motor,
 said second clutch part being connected to said door,
 spring means axially urging said clutch parts together,
 circuit means to energize said motor for drive of 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 retarding
 force,
 obstruction to downward movement of said door retard-
 ing said second part relative to said first part and
 thus cammingly separating said first and second
 clutch parts in an axial direction by moving said
 second clutch part axially,
 switch means actuated by said axial movement of said
 second clutch part,
 and means connecting said switch means to said circuit
 means to control the de-energization of said motor
 upon actuation of said switch means.

11. In a door operator mechanism for a door to be
 lifted and having an unbalanced weight resisting such lift-
 ing effort,
 a control circuit comprising, in combination, a motor,
 a drive train 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 first clutch part being connected to said motor,
 said second clutch part being connected to exert a lifting
 effort on said door,
 spring means axially urging said clutch parts together,
 circuit means to energize said motor for drive of 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
 clutch second part in said opposite rotational direc-
 tional with said reversely energized motor acting as
 a retarding force,
 obstruction to downward movement of said door retard-
 ing said second part relative to said first part and
 thus cammingly separate said first and second clutch
 parts in an axial direction by moving said second
 clutch part axially,
 an electrical switch actuated to a closed condition by
 said axial movement of said second clutch part,
 means connecting said electrical switch to said circuit
 means to control the de-energization of said motor
 upon closed actuation of said switch,
 and brake means actuated by the de-energization of
 said motor to brake said drive train and, hence, brake
 said door in said downward closing movement.

12. A door operator and control circuit for a door to
 be lifted and having an unbalanced weight resisting such
 lifting effort,
 said door operator and control circuit comprising, in
 combination, a motor having a frame and a rotatable
 shaft,
 a cable connecting said motor to lift said door,

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a drive train between said motor and cable including
 a one-way dog clutch of first and second intermesh-
 ing 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 rota-
 tional 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,
 obstruction to downward movement of said door re-
 leasing tension on said cable to slow said second part
 relative to said first part and thus cammingly sep-
 arate said first and second clutch parts in an axial
 direction by moving said second clutch part axially,
 an electrical switch actuated to a closed condition by
 said axial movement of said second clutch part,
 electrical circuit means controlling the de-energization
 of said motor upon closed actuation of said switch,
 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 engage-
 ment,
 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 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.

13. A door operator and control circuit for a door to
 be lifted and having an unbalanced weight resisting such
 lifting effort,
 said operator and control circuit comprising, in com-
 bination, a motor,
 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 intermesh-
 ing parts each having teeth with axially parallel faces
 on one side and angular faces on the other side,
 circuit means to energize said motor for drive of 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,
 obstruction to downward movement of said door re-
 leasing tension on said cable to slow said second
 part relative to said first part and thus cammingly
 separate said first and second clutch parts in an axial
 direction by moving said second clutch part axially
 an electrical switch actuated to a closed condition by
 said axial movement of said second clutch part,
 means connecting said electrical switch to said circuit
 means to control the de-energization of said motor
 upon closed actuation of said switch,
 and brake means actuated by the de-energization of
 said motor to brake said cable and, hence, brake said
 door in said downward closing movement.

No references cited.

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