

April 30, 1963

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3,087,720

AUTOMATIC DOOR OPERATOR

Filed Oct. 8, 1959

3 Sheets-Sheet 1

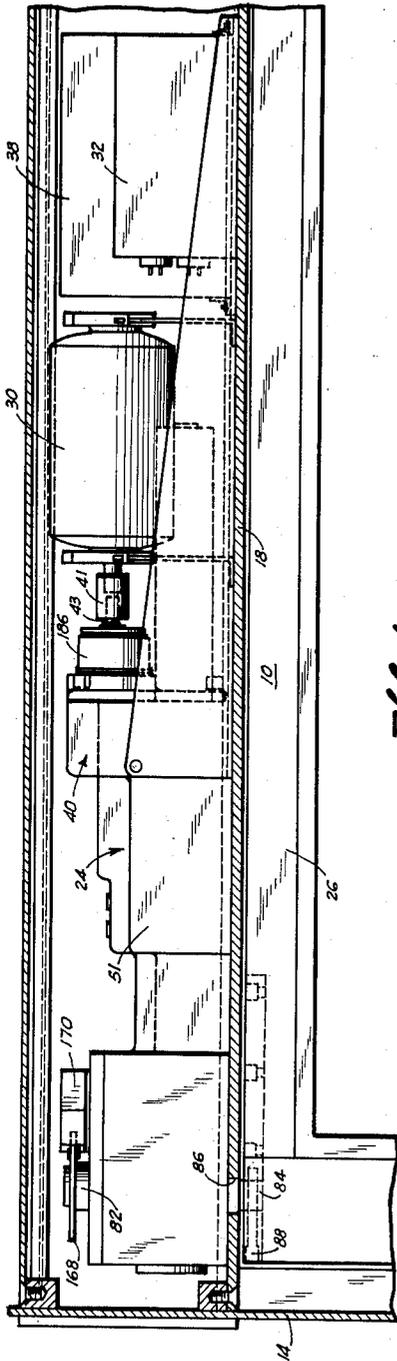


FIG. 1

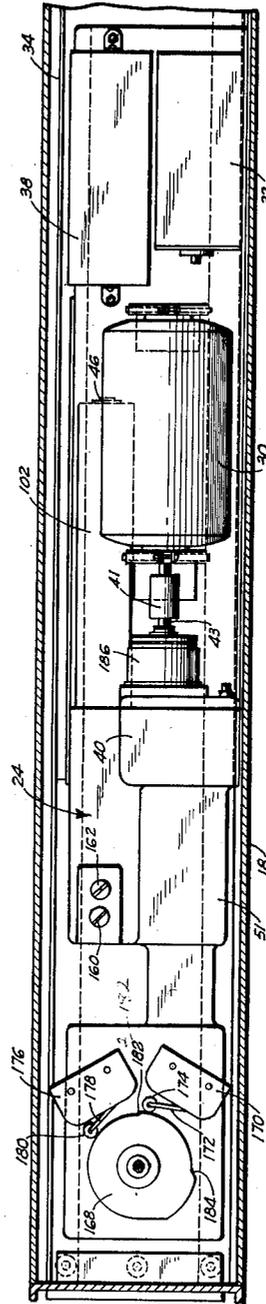


FIG. 2

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3 Sheets-Sheet 2

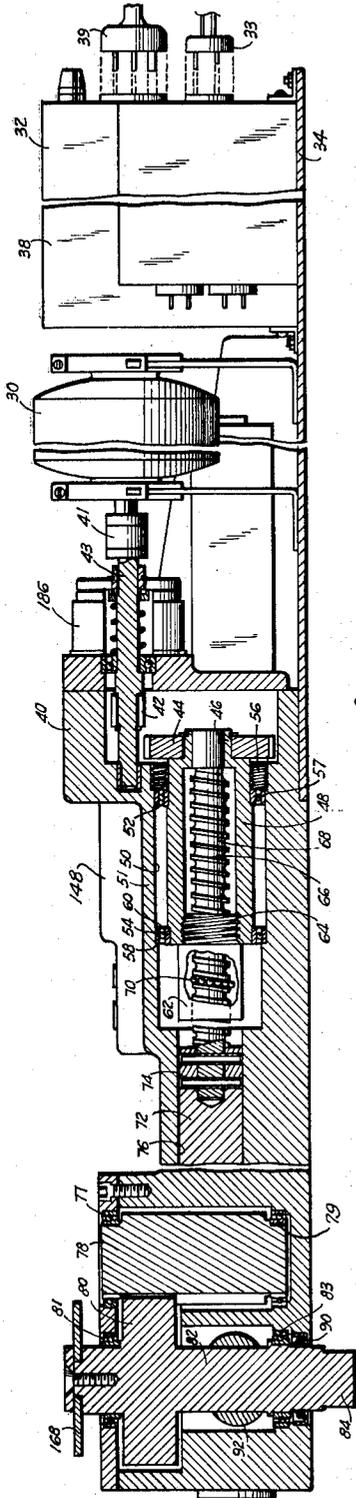


FIG. 3

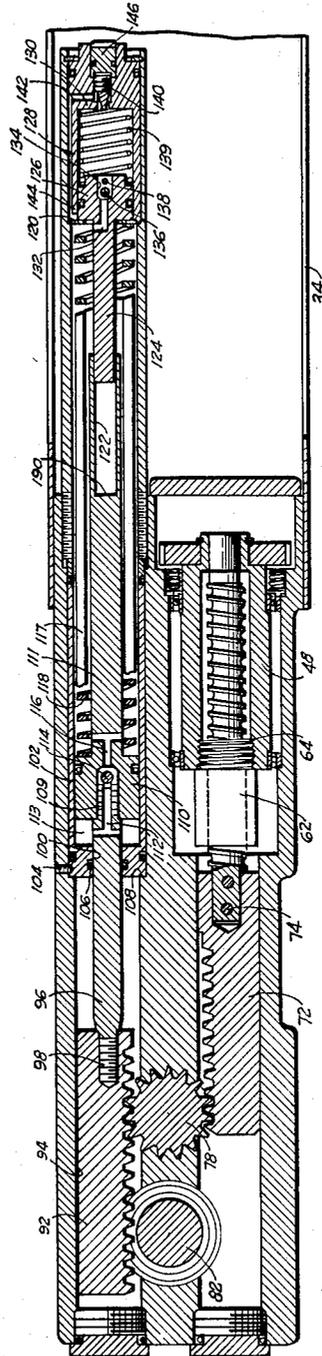


FIG. 4

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3 Sheets-Sheet 3

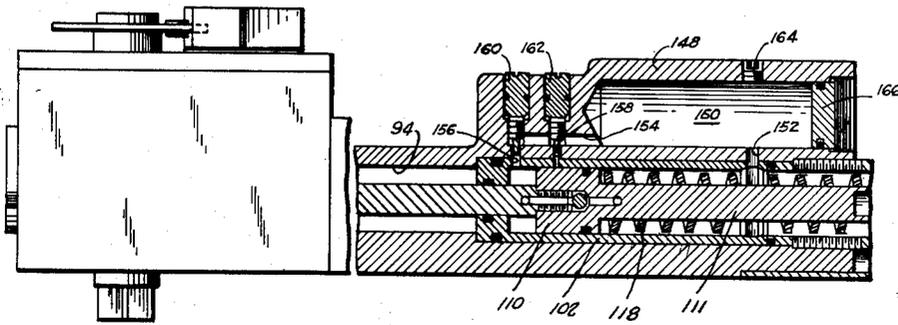


Fig. 5

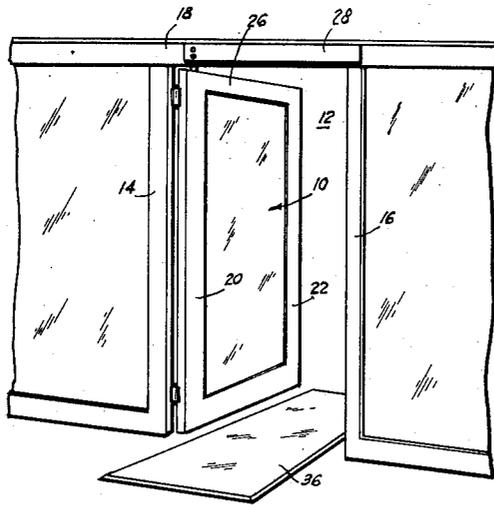


Fig. 6

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3,087,720

AUTOMATIC DOOR OPERATOR

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7 Claims. (Cl. 268-65)

This invention relates to improvements in a door operator, and more particularly, but not by way of limitation, to an electrically actuated door operator.

There are many types of hinged doors available today adapted to open automatically upon the approach of a person desiring to pass therethrough. These doors are normally actuated by means of an electric eye, an electronic wave impulse, or by switch type mats which initiate the opening of the door upon being interrupted or activated by the person approaching the door. These doors have many disadvantages in that they are usually of a complicated construction requiring special auxiliary electrical circuits. In addition, repair of the operating mechanism is frequently tedious and costly, as well as time consuming.

The present invention contemplates a novel electric door operator particularly designed and constructed of a compact size whereby the mechanism may be installed in the frame above the door. The novel door operator may be actuated by the normal or standard commercial house power of 110-115 volts, and does not require any special auxiliary electrical circuits outside of the unit itself. A small electric motor may be utilized for powering the unit, and a small size braking unit may be provided for controlling the operating force to hold the door in a locked open position. The door may also be readily opened manually in the event of a power failure. The simple design of the structure provides for maintenance thereof without the need for specialized training, and the entire unit may be quickly and easily removed from the door frame for replacement in a minimum of time to provide for getting the automatic door back into operation as quickly as possible in the event of any interruption of service.

It is an important object of this invention to provide a novel electric door operator for a hinged or swinging type of door.

It is another object of this invention to provide an electric door operator particularly designed and constructed of a compact size for facilitating the installation thereof in the frame above the door.

Another object of this invention is to provide an electric door operator designed for utilization of commercial house power without any auxiliary electrical circuits.

A further object of this invention is to provide an electric door operator having a substantially frictionless drive mechanism whereby the door may be readily opened and closed mechanically in the event of a power failure.

A still further object of this invention is to provide an electric door operator having a minimum number of operating parts for facilitating the maintenance thereof.

An additional object of this invention is to provide an electric door operation which is simple and efficient in operation and economical and durable in construction.

Other objects and advantages of the invention will be evident from the following detailed description, read in

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conjunction with the accompanying drawings, which illustrate my invention.

In the drawings:

FIGURE 1 is a side elevational view of a door operator embodying the invention and in association with a door operated thereby, depicting portions in section for purposes of illustration.

FIGURE 2 is a plan view of the novel door operator disposed in a door frame.

FIGURE 3 is a sectional elevational view of the novel door operator with portions shown in elevation for clarity.

FIGURE 4 is a sectional plan view of the novel door operator with portions thereof omitted for clarity.

FIGURE 5 is an elevational view partly in section depicting a portion of the hydraulic closer mechanism of the novel door operator.

FIGURE 6 is a perspective view of a door operated by the novel door operator and depicting the door in an open position.

Referring to the drawings in detail, and particularly FIGS. 1 and 6, reference character 10 refers in general to a door disposed in the usual doorway 12 having vertical door jambs 14 and 16 and an upper door frame 18. The door 10 is provided with the normal vertical stiles 20 and 22, and the stile 20 is preferably hingedly secured to the door jamb 14 in any well known manner, as clearly shown in FIG. 6. A door operator unit, generally indicated at 24, is disposed in the upper door frame 18 above the upper door leaf 26 for opening and closing the door 10, as will be hereinafter set forth. A suitable plate member 28 may be removably secured to the door frame 18 in any suitable manner (not shown) to provide accessibility for the operator unit 24 for facilitating installation thereof.

The operator unit 24 comprises a motor 30 having the usual motor capacitor 32, both of which are mounted or secured to a channel member 34 in any suitable manner. The capacitor 32 is electrically connected with the commercial 110 v. power by the usual connector member 33. The motor 30 is preferably a small electrical motor of approximately 3,000 r.p.m., and with a rated torque of two inch pounds, but not limited thereto. The motor 30 is actuated by an electronic switch or switch type floor mat 36 (FIG. 6) through a series of electrical relays (not shown) located in an electrical control box 38, which is secured to the channel 34 in the proximity of the motor 30. The control box 38 is electrically connected to the switch mat 36 in any suitable manner, such as the connection member 39. The switch mat 36 is actuated when a person steps on the mat, as is well known. The motor 30 is connected to a gear reduction unit 40 by a suitable flexible coupling member 41 and shaft 43. Upon actuation of the motor 30, the shaft 43 is rotated whereby the gear 42 in the gear reduction unit 40 is simultaneously rotated for transmitting rotation to the gear 44 through a suitable gear train (not shown), as is well known.

The gear 44 is rigidly secured to the reduced neck portion 46 of a sleeve 48 in any well known manner. The sleeve 48 is disposed within a bore 50 provided in a housing 51 which is secured to the channel 34 and extends longitudinally therefrom, as clearly shown in FIG.

3. The sleeve 48 is journaled in the bore 50 by a plurality of spaced bearing members 52 and 54 whereby the sleeve 48 may rotate freely upon rotation of the gear 44. A suitable retainer ring 56 may be threadedly secured in the bore 50 for contacting the bearing 52 to cooperate with an outwardly directed shoulder 57 on the sleeve 48 for precluding longitudinal movement of the sleeve 48 in one direction. An inwardly directed circumferential shoulder 58 is provided in the bore 50 and spaced from the ring 56 for receiving the bearing member 54 thereagainst. An outwardly directed circumferential shoulder 60 provided on the sleeve 48 receives the bearing 54 thereagainst for cooperation with the shoulder 58 to preclude longitudinal movement of the sleeve 48 in an opposite direction. Thus, the sleeve 48 may rotate freely in the bore 50, but cannot move in a longitudinal direction therein.

An apertured ball nut 62 is threadedly secured to the sleeve 48 at 64 and rotates simultaneously therewith. A ball bearing screw shaft 66 extends longitudinally through the ball nut 62 and into the sleeve 48. A continuous spiral groove 68 extends longitudinally along the outer periphery of the shaft 66 for cooperation with a plurality of balls 70 contained within the ball nut 62 to preclude rotational movement of the shaft 66, and transform the rotational movement of the ball nut 62 into longitudinal movement of the shaft 66. Rotation of the sleeve 48 in one direction will rotate the ball nut 62 in a direction for moving the shaft 66 longitudinally in a left hand direction as viewed in FIGS. 3 and 4.

A rack member 72 is secured to the outer extremity of the shaft 66 in any suitable manner, such as by a plurality of transverse pins 74, whereby movement of the shaft 66 is transmitted to the rack 72. The rack 72 is disposed in a longitudinally extending bore 76 and reciprocated therein during the operation of the door operator unit 24, as will be hereinafter set forth. The rack 72 meshes with a gear 78 which is journaled in the housing 51 by suitable spaced bearings 77 and 79 in such a manner that the longitudinal axis thereof is at right angles with respect to the plane of the rack 72. The gear 78 in turn meshes with a gear 80 which is integral with or secured to a pivot shaft 82, the axis of which is substantially parallel with the axis of the gear 78. The shaft 82 is suitably journaled within the housing 51 by a plurality of spaced bearing members 81 and 83.

The lower extremity 84 of the pivot shaft 82 extends downwardly from the housing 51 and through an aperture 86 (FIG. 1) in the door frame 18 for connection with the upper portion of the door 10 in any suitable manner, such as a pin 88, whereby the door 10 will be pivoted to alternate open and closed positions upon rotation of the pivot shaft 82 in alternate directions, as will be hereinafter set forth. A suitable packing member 90 (FIG. 3) may be disposed around the shaft 82 below the bearing 83 to seal the interior of the housing 51 from dust or other foreign debris.

A second rack member 92 is slidably disposed in a longitudinally extending bore 94 provided in the housing 51 spaced from and substantially parallel to the bore 76. The rack 92 meshes with the gear 78 diametrically opposed from the rack 72 as clearly shown in FIG. 4, and responds to rotational movement of the gear 78 for reciprocal movement within the bore 94. A stem member 96 is threadedly secured to the rack 92 at 98 for reciprocal movement simultaneously therewith. The stem 96 extends through a bore 100 provided in a sectional cylindrical housing 102 which is rigidly secured within the bore 94 by a set screw 104. A suitable liquid (not shown) is disposed or provided within the housing 102 for a purpose as will be hereinafter set forth. The stem 96 is slidable within the bore 100, and a suitable packing ring 106 is provided in the bore adjacent the stem 96 to preclude leakage of fluid therebetween. The housing 102 is disposed adjacent an inwardly directed shoulder 108 pro-

vided in the bore 94 to preclude longitudinal movement of the housing 102 therein.

The stem 96 is threadedly secured within a bore 109 of the piston head 110 of a piston stem 111 which is slidably disposed within the housing 102. A substantially T-shaped passageway 112 is provided in the stem 96 to provide communication between the bore 109 and a chamber 113 in the interior of the housing 102 at the left of the piston head 110. A ball 114 is disposed within the bore 109 in the proximity of the open end of the passageway 112 therein and cooperates with a second T-shaped internal passageway 116 to provide a check valve for a purpose as will be hereinafter set forth. The T-shaped internal passageway 116 is provided in the piston stem 111 to provide communication between the bore 109 and a chamber 117 on the opposite side of the piston head 110. A closure spring 118 is disposed around stem 111 and has one end anchored against the piston head 110 and the opposite end anchored against an annular ring 120 secured within the housing 102 and spaced from the shoulder 108. The spring 118 constantly urges the piston head 110 in a left hand direction as viewed in FIG. 4.

A longitudinally extending bore 122 is provided in the outer end of the piston stem 111 for slidably receiving a rod 124. The rod 124 extends through the annular ring 120 and is provided with an enlarged head portion 126 which is slidably disposed within an inner sleeve 128. The movement of the head 126 in a left hand direction, as viewed in FIG. 4, is limited by the annular ring 120, and the right hand movement thereof is limited by the closed end 130 of the inner sleeve 128. An angled passageway 132 is provided in the piston stem 124 and head 126 to provide communication between the outer periphery of the stem and the interior of the sleeve 128. The passageway 132 is enlarged at 134 to receive a ball member 136 therein. The ball 136 is retained within the enlarged bore 134 by a transversely extending pin 138 and cooperates with the passageway 132 to provide a check valve for the piston 124. A spring 139 is disposed within the sleeve 128 for constantly urging the piston head 126 in a left hand direction as viewed in the drawings.

A bore 140 is provided in the closed end portion 130 of the sleeve 128 and is in communication with a radially extending passageway 142, which in turn is in communication with an angled passageway 144 to provide communication between the opposed ends of the sleeve 128 for a purpose as will be hereinafter set forth. A suitable needle valve 146 is threadedly secured within the bore 140 to regulate the flow of fluid through the passageways 142 and 144, as is well known.

Referring now to FIG. 5, the housing 51 is enlarged at 148 and is provided with an oil or liquid reservoir chamber 150 therein. The chamber 150 is in communication with the interior of the housing 102 through a bore or aperture 152 to assure an adequate supply of liquid within the housing 102 at all times. A longitudinally extending passageway 154 extends from the chamber 150 into communication with a pair of spaced apertures or ports 156 and 158 which also extend into communication with the interior of the housing 102, spaced from the port 152. Suitable check valves 160 and 162 are disposed in the ports 156 and 158, respectively, for regulating the flow of fluid therethrough upon operation of the door operator 24, as will be hereinafter set forth. A suitable filler plug 164 is provided in the enlarged housing portion 148 to permit filling of the chamber 150, and a suitable access plug 166 is threadedly secured to the chamber 150 for access to the chamber 150 when it is desired for any reason.

Referring now to FIGS. 1, 2 and 3, a switch cam 168 is rigidly secured to the pivot shaft 82 oppositely disposed from the lower extension portion 84. A motor and brake switch member 170 is secured to the housing 51 in the

proximity of the cam 168 and is provided with an arm member 172 having a roller member 174 adapted to ride along the outer periphery of the cam 168. A safety switch member 176 similar to the motor and brake switch 170 is also secured to the housing 51 adjacent the cam 168 and is provided with an arm 178 having a roller 180 adapted to roll or ride along the outer periphery of the cam 168. A plurality of outwardly extending shoulders, such as 182 and 184, are provided on the outer periphery of the cam 168 for actuation of the switches 170 and 176, as will be hereinafter set forth.

The safety switch 176 is actuated by the cooperation between the cam 168 and the arm 178 whereby upon opening of the door 10 to a predetermined angular disposition thereof, the safety switch is energized and cooperates with the switch mat for holding the door in this open position until the person passing therethrough has safely cleared the doorway 12. In addition, the brake and motor switch 170 is electrically connected in any suitable manner (not shown) with a magnetic type brake apparatus 186 whereby actuation of the brake 186, simultaneously with a stoppage of the motor 30, will securely hold the door in an open position thus adding an additional holding feature to the door. When the switch 170 is turned on by the cooperation between the cam 168 and the arm 172, the magnetic brake is energized, and the switch mat 36 is deenergized, or out of operation.

To avoid the possibility of having the door 10 open against someone, such as a child or person standing at the exterior of the door or in the way of the opening of the door, the exterior switch (not shown) of the mat 36 is preferably set up on a special circuit to operate as a safety switch. When a person stands on the mat at the exterior of the door, this exterior switch closes a relay in the electrical control box 38 and causes the opening switch (not shown) of the mat 36 to cease to function, thus precluding accidental opening of the door against a person. The door 10 will then remain closed until the person or obstruction clears the exterior switch. As soon as the obstruction clears the exterior switch, the normal operation of the door may be resumed.

Operation

The door operator unit 24 is preferably installed in the door frame 18 above the upper door leaf 26 as hereinbefore set forth. The unit 24 is installed in such a manner that the pivot shaft 82 is rigidly connected with the door 10 whereby the door may be pivoted or swung to alternate positions of opened and closed upon rotation of the pivot shaft. The door remains in a normally closed position until the operator 24 is activated or energized for opening of the door.

The door 10 is preferably adapted to open in one direction only, and when a person approaches the door 10 for passing therethrough, he steps onto the switch mat 36 on the side of the door from which it may be opened. It will be apparent that any suitable type of remote electrical switch may be utilized in lieu of the switch mat, if desired. The switch mat 36 is thus activated for starting the operation of the motor 30 through the electrical relays contained within the box 38. The motor 30 rotates the gear 44 through the gear reduction unit 40, whereby the rotatable sleeve 48 is rotated freely within the bore 50. The rotation of the sleeve 48 is transmitted to the ball nut 62 whereupon the ball bearing shaft 66 is moved longitudinally by the cooperating balls 70 and the spiral groove 68. Of course, one inherent feature of the ball nut 62 and cooperating ball bearing shaft 66 is the substantially frictionless drive therebetween, which results in what is known as a free wheeling motion or drive. The motor 30 rotates the gear 44 in such a direction that the shaft 66 moves in a left hand direction as viewed in FIGS. 3 and 4.

The left hand movement of the shaft 66 moves the rack 72 in a left hand direction to transmit a clockwise rota-

tion to the gear 78. The gear 78 in turn meshes with the gear 80 to provide a counterclockwise direction of rotation for the pivot shaft 82 and lower extension member 84. The door 10 is thus moved toward an open position.

The clockwise rotation of the gear 78 causes the rack 92 to move in a right hand direction in the bore 94, carrying the stem 96 with it. The stem 96 transmits the right hand movement to the piston head 110 and stem 111 and moves the piston against action of the spring 118. The fluid in the chamber 117 is forced into the passageway 116 by the movement of the piston, whereby the check valve 114 opens and the fluid moves through the bore 109 into the passageway 112 and is discharged into the chamber 113.

A continued right hand movement of the stem 111 brings the end 190 (FIG. 4) of the bore 122 into contact with the rod 124, and moves the rod in a right hand direction. The movement of the rod moves the piston head 126 in a right hand direction against the action of the spring 139 and forces the fluid in the housing 128 out through the needle valve 146. The fluid moves through the passageways 142 and 144 since the check valve 136 is closed during the right hand movement of the piston head 126. With the piston head 126 moved to a position in the proximity of the closed end 130 of the housing 128, the fluid is discharged from the passageway 144. The quantity of fluid moving through the needle valve may be regulated by adjusting the needle valve, as is well known, thus providing for a regulation of the speed of movement of the piston head 126. The housing 128 in cooperation with the fluid therein acting against the piston head 126 provides a back check during the opening of the door 10, and the adjustment of the needle valve provides for regulation to compensate for a variety of door sizes and operating conditions.

When the pivot shaft 82 is rotated through a sufficient angle for opening the door to substantially any desired predetermined position, the cam disc 168, which rotates simultaneously with the pivot shaft, moves to a position whereby the shoulders 182 and 184 move the arms 172 and 180, respectively, for activating the safety switch 176 and the motor and brake switch 170. With these switches activated, the motor 30 is stopped whereby rotation of the gear 44 is ceased. The braking mechanism 186 securely retains the gear 42 in a stationary position to preclude operation of the gear train. Thus, the door 10 is securely retained in the predetermined open position until the traffic has cleared the doorway 12. When the person moves off of the mat 36, all electric power is cut off to the door operator unit 24, whereby the braking apparatus 186 is released, and the door 10 begins to close.

The spring 118 urges the piston head 110 in a left hand direction, and simultaneously the spring 139 urges the piston head 126 in a left hand direction. The fluid in the chamber 113 cannot move into the chamber 117 because the check valve 114 is closed as the piston head 110 moves in a left hand direction. Thus, the fluid is forced through the check valves 160 and 162, and through the passageway 154 into the oil reservoir chamber 150. The speed of the movement of the piston head 110 is regulated by the movement of the fluid through the valves 160 and 162, thus cushioning the closing of the door 10. The left hand movement of the piston head 110 moves the rod 96 in a left hand direction, which, in turn, moves the rack 92 in a left hand direction. The left hand movement of the rack 92 rotates the gear 78 in a counterclockwise direction. The counterclockwise rotation of the gear 78 rotates the gear 80 in a clockwise direction for a simultaneous clockwise rotation of the pivot shaft 82, thus rotating the door 10 toward a closed position. The counterclockwise rotation of the gear 78 also moves the rack 72 in a right hand direction for restoring the ball bearing shaft 66 to a position for opening of the door upon the next operation thereof.

The left hand movement of the piston head 126 opens

the check valve 136 whereby fluid may flow through the passageway 132 into the housing 128 for recharging thereof to assist in the back checking of the next door opening operation.

By way of summary, the motor 30 is activated when a person steps on the switch mat 36 to immediately start the door opening operation through the rack 72 and gear 78. The fluid in the housing 128 cooperates with the piston head 126 for checking the opening of the door as the door approaches the full opened position. As soon as the person has cleared the doorway 12 and has stepped off of the mat 36, the door starts to close through the cooperation of the rack 92 and the gear 78. The fluid in the chamber 113 cooperates with the piston head 110 for regulating the speed of the closing of the door to assure a smooth and efficient operation thereof.

From the foregoing, it will be apparent that the present invention provides a novel door operator unit for opening and closing a door through activation by a remote electronic signal. The opening and closing of the door 10 is accomplished through a mechanical operation whereby the door may be readily manually opened and automatically closed in the event of a power failure, or the like. The opening and closing of the door is maintained smooth and efficient, and a safety feature is provided for holding the door in an open position until the doorway has been cleared. The novel door operator unit is simple and efficient in operation and economical and durable in construction.

Changes may be made in the combination and arrangement of parts as heretofore set forth in the specification and shown in the drawings, it being understood that any modification in the precise embodiment of the invention may be made within the scope of the following claims without departing from the spirit of the invention.

I claim:

1. A door operator for opening and closing a door and comprising a motor, gear means rotated by the motor, a reciprocal rack member, free wheeling means for translating the rotational movement of the gear means to the reciprocal movement of the rack member, second gear means actuated by the rack member upon movement thereof in one direction for opening of the door, second rack means for actuation of the second gear means independently from the first rack means, spring biased means providing for reciprocal movement of the second rack means in one direction for actuation of the second gear means to close the door, and hydraulic damping means cooperating with said last mentioned means for controlling the speed of closing of the door.

2. A door operator for opening and closing a door and comprising a motor, gear means rotated by the motor, reciprocal rack means, ball bearing screw means interposed between the gear means and the rack means for translating the rotational motion of the gear means to the reciprocal movement of the rack means, second gear means rotated in one direction by the rack means for opening the door, second rack means reciprocated in one direction by the second gear means, means cooperating with the second rack means for checking the opening of the door, hydraulically damped spring means for urging the second rack means in an opposite direction from the last mentioned direction for rotating the second gear means in a direction for closing of the door, and valve means for controlling the speed of movement of the second rack means in said opposite direction for controlling the speed of closing of the door.

3. A door operator for opening and closing a door and comprising a motor, gear means rotated by the motor, reciprocal rack means, free wheeling screw means interposed between the gear means and the rack means for translating the rotational motion of the gear means to the reciprocal movement of the rack means, second gear means rotated in one direction by the rack means

for opening the door, means for temporarily retaining the door in an open position, second rack means reciprocated in one direction by the second gear means, means cooperating with the second rack means for checking the opening of the door, hydraulically damped spring means for urging the second rack means in an opposite direction from the last mentioned direction for rotating the second gear means in a direction for closing of the door, and hydraulic valve means for controlling the speed of movement of the second rack means in said opposite direction for controlling the speed of closing of the door.

4. A door operator for opening and closing a door and comprising a motor, gear means interconnected to the motor for rotation thereby, a ball nut rotated by the gear means, a ball bearing screw shaft reciprocated in one direction by the rotation of the ball nut, a rack member carried by the shaft for movement therewith, a gear member rotated in one direction by the rack member, a second rack member meshing with the gear member and oppositely disposed from the first rack member, said second rack member moved in one direction by the rotation of the gear member, means for checking the movement of the second rack in said direction, means for urging the second rack member in an opposite direction from said last mentioned direction whereby the second rack rotates the gear member in an opposite direction from the first rotational direction thereof, means cooperating between the gear member and the door for opening the door in one direction of rotation of the gear member and closing the door in the opposite direction of rotation thereof, and means for regulating the speed of the movement of the second rack member in said opposite direction for controlling the speed of the closing of the door.

5. A door operator for opening and closing a door and comprising rotatable gear means, a ball nut rotated by the gear means, a ball bearing screw shaft reciprocated in one direction by the rotation of the ball nut, a rack member carried by the shaft for movement therewith, a gear member rotated in one direction by the rack member, a second rack member meshing with the gear member and oppositely disposed from the first rack member, said second rack member moved in one direction by the rotation of the gear member, means for checking the movement of the second rack in said direction, means for urging the second rack member in an opposite direction from said last mentioned direction whereby the second rack rotates the gear member in an opposite direction from the first rotational direction thereof, means cooperating between the gear member and the door for opening the door in one direction of rotation of the gear member and closing the door in an opposite direction of rotation thereof, means for temporarily retaining the door in an open position, and means for regulating the speed of the movement of the second rack member in said opposite direction for controlling the speed of the closing of the door.

6. A door operator for opening and closing a door, and comprising a pivotal shaft secured to the door for opening and closing thereof, gear means cooperating with the shaft for rotation thereof, rack means cooperating with the gear means for rotation thereof in one direction for opening of the door, means for temporarily holding the door in an open position, second rack means cooperating with the gear means for movement thereby in one direction during the opening of the door, hydraulically damped spring means for urging the second rack means in an opposite rotational direction for closing of the door, and valve means for regulating the speed of movement of the second rack means in said opposite direction for controlling the speed of the closing of the door.

7. A door operator for opening and closing a door, and

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comprising a pivotal shaft secured to the door for opening and closing thereof, gear means cooperating with the shaft for rotation thereof, rack means cooperating with the gear means for rotation thereof in one direction for opening of the door, means for moving the rack means reciprocally in a direction for rotating the gear means for opening of the door, means for temporarily holding the door in an open position, second rack means cooperating with the gear means for movement thereby in one direction during the opening of the door, means cooperating with the second rack means for checking the opening of the door, hydraulically damped spring means for urging the second rack means in an opposite direc-

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tion for rotation of the gear means in an opposite rotational direction for closing of the door, and hydraulic valve means for regulating the speed of movement of the second rack means in said opposite direction for controlling the speed of the closing of the door.

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