

March 1, 1966

J. C. CATLETT

3,237,932

AUTOMATIC DOOR OPERATOR

Filed Oct. 10, 1962

6 Sheets-Sheet 1

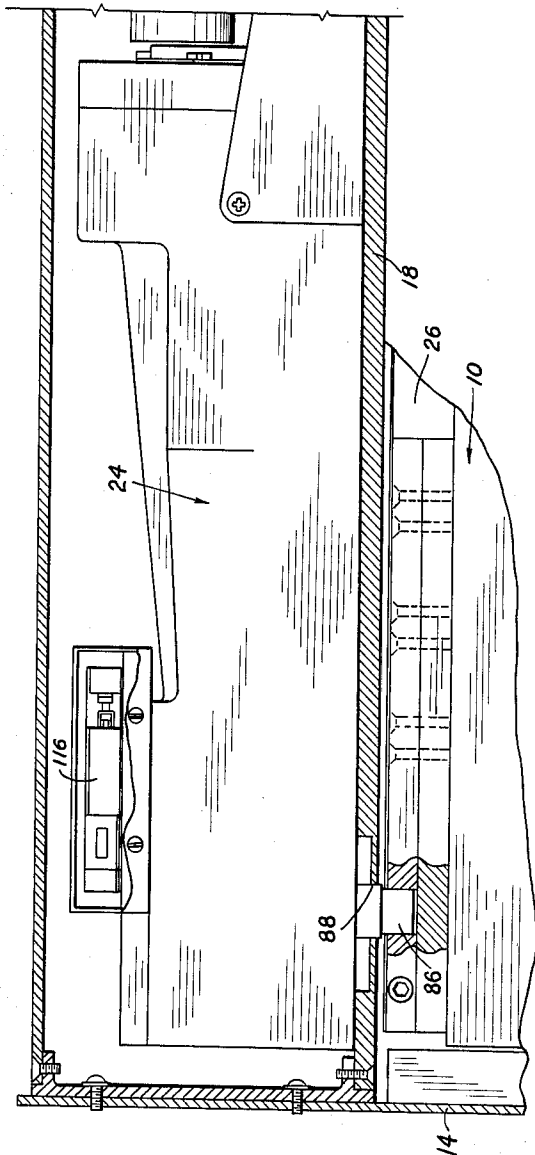


Fig. 1

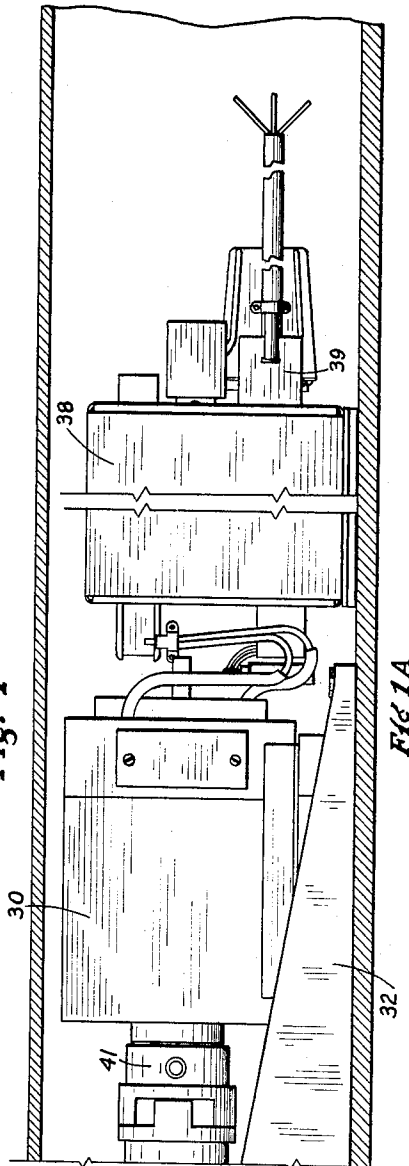


Fig. 1A

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6 Sheets-Sheet 2

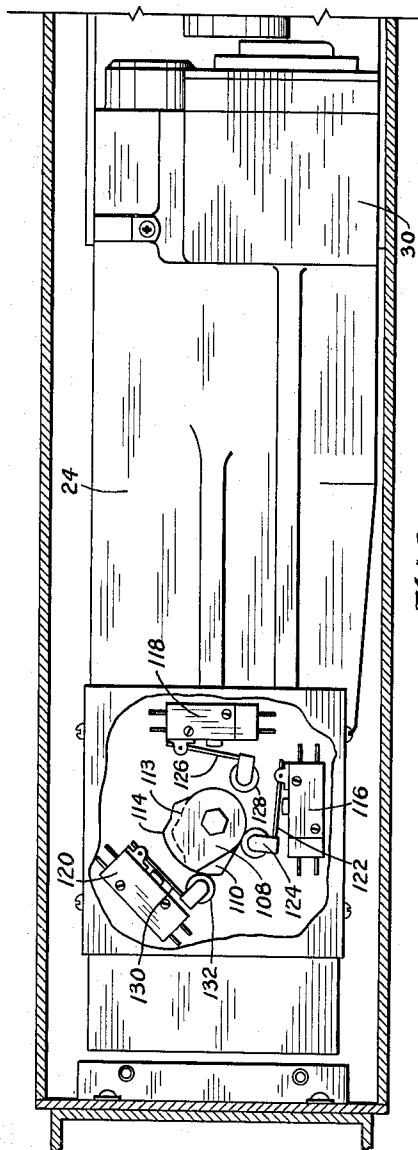


Fig. 2

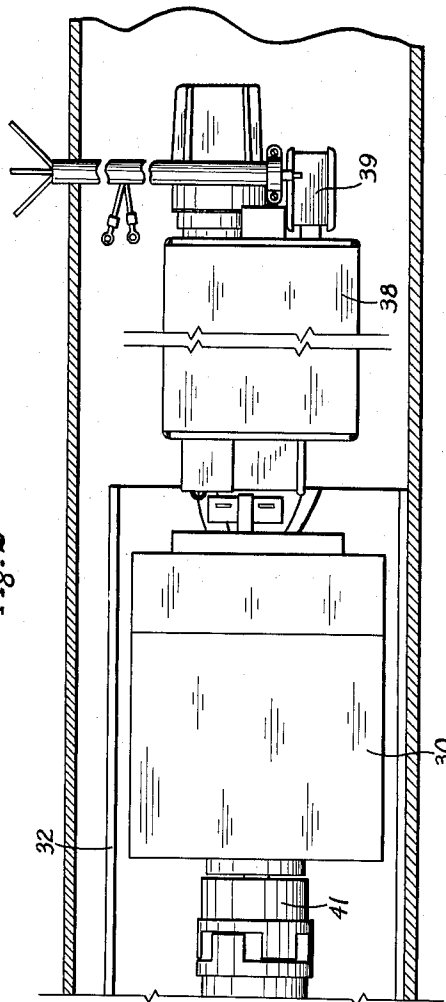


Fig. 2A

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6 Sheets-Sheet 3

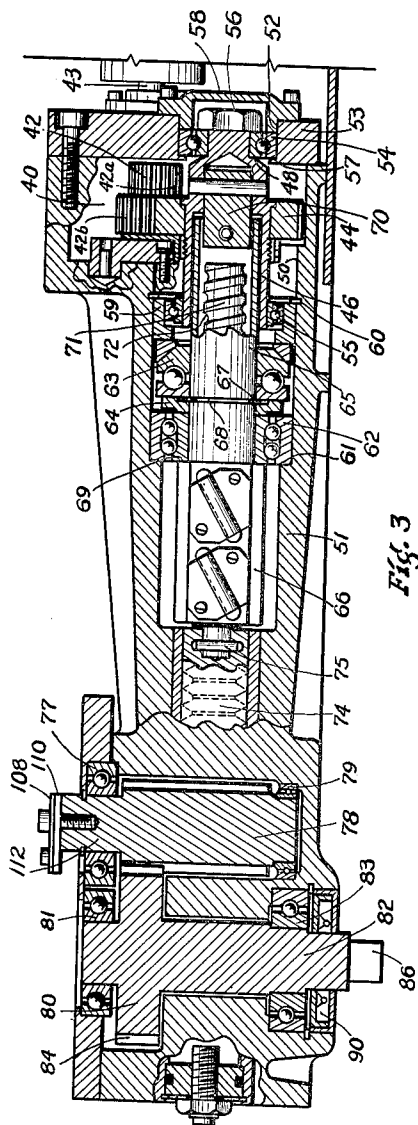


Fig. 3

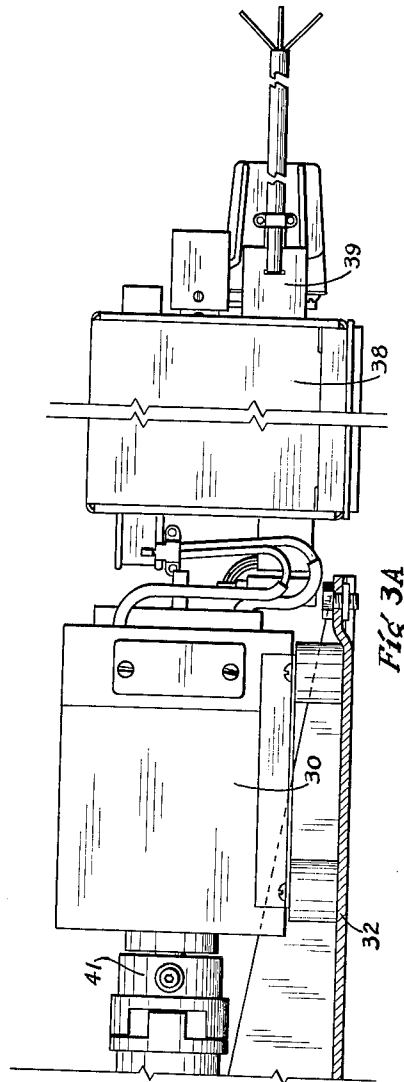


Fig. 3A

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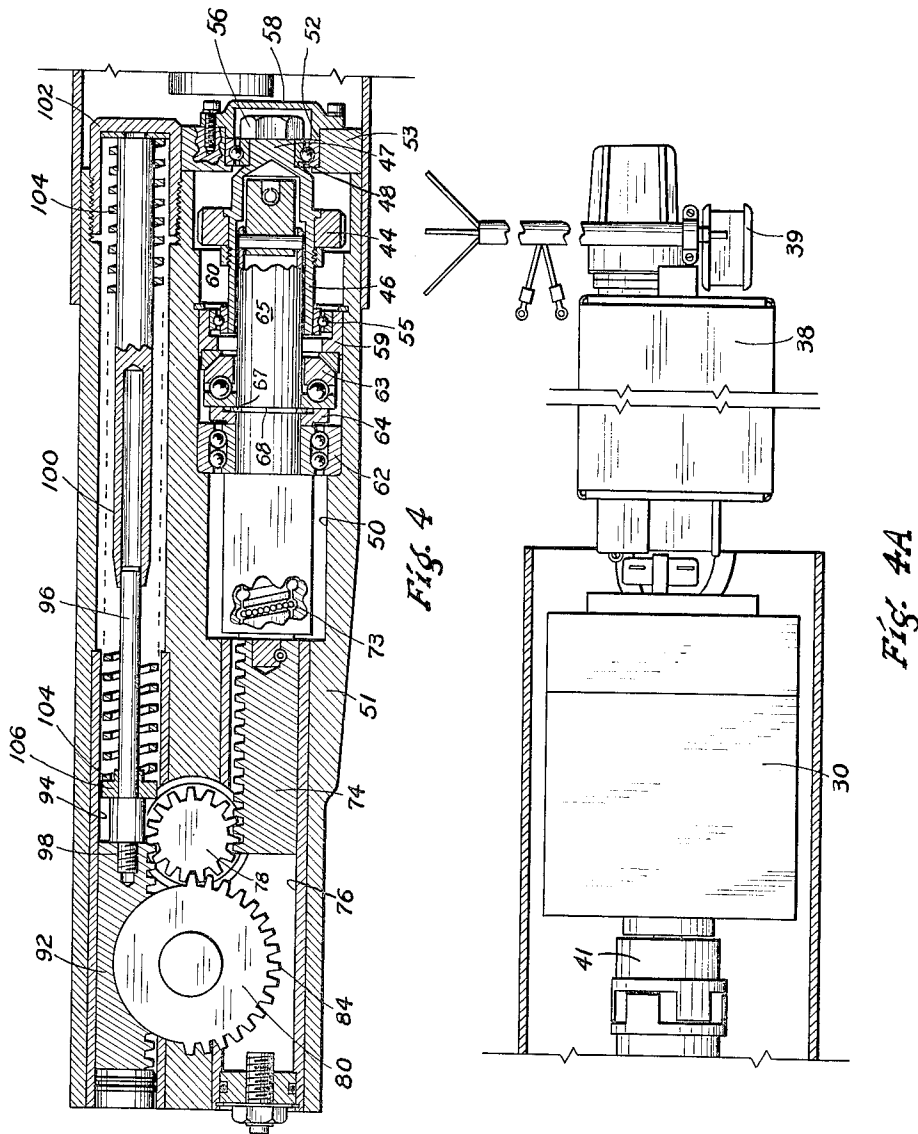
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AUTOMATIC DOOR OPERATOR

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6 Sheets-Sheet 4



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6 Sheets-Sheet 5

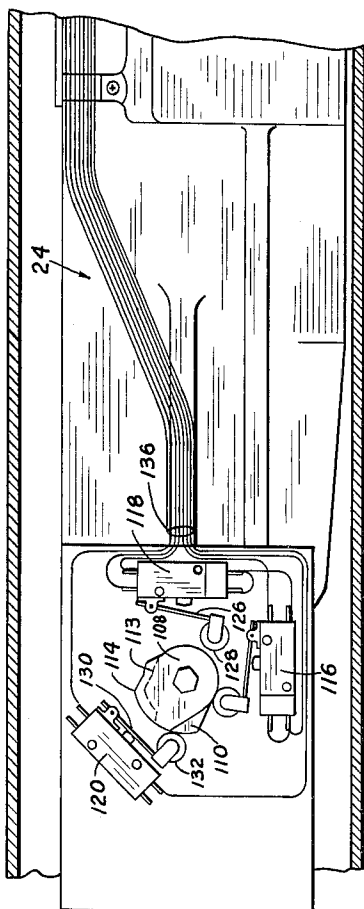


Fig 5

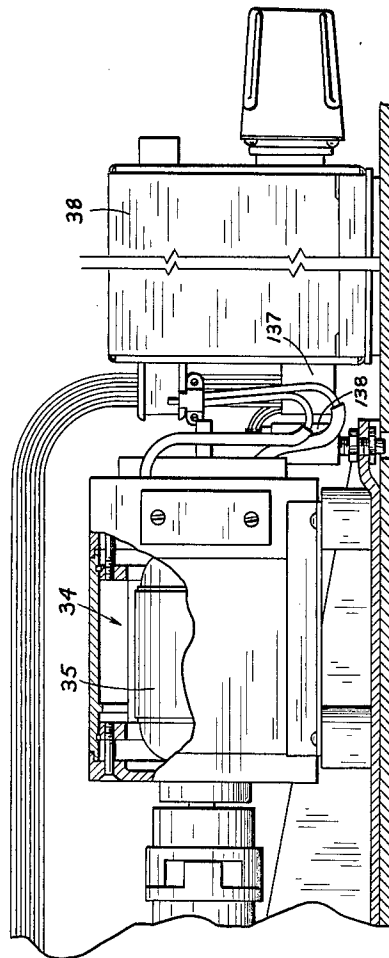


Fig 5A

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6 Sheets-Sheet 6

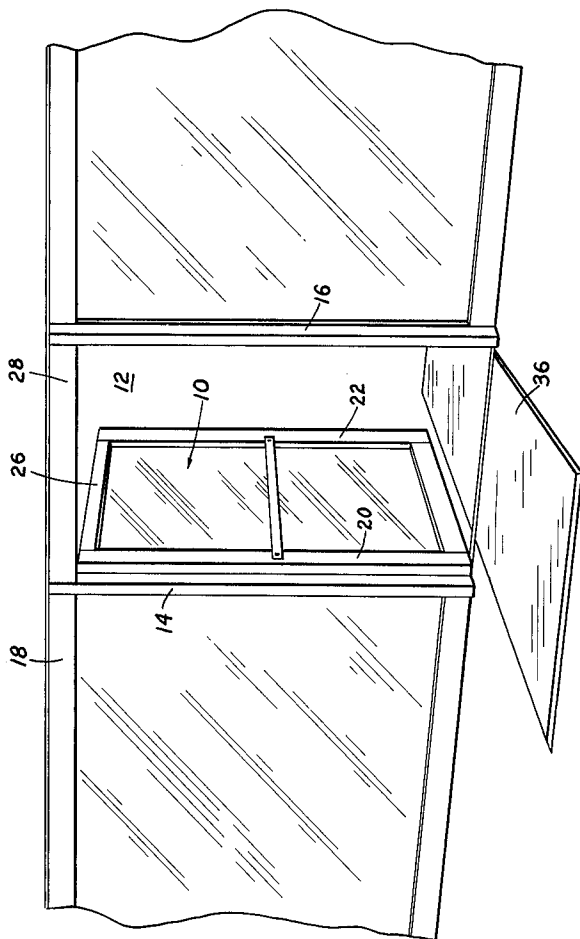


Fig. 6

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1

3,237,932

AUTOMATIC DOOR OPERATOR

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Filed Oct. 10, 1962, Ser. No. 229,542
10 Claims. (Cl. 268—65)

This application is a continuation-in-part of my co-pending application Serial No. 845,144, filed October 8, 1959, and entitled "Automatic Door Operator" now Patent No. 3,087,720.

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, the 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. The novel door operator is an improvement over that disclosed in my aforesaid pending application in that the unit is powered by an electrical motor having a permanent magnetic field whereby the opening of the door, holding of the door in the open position, and closing speed of the door may be controlled by the motor, thus eliminating the necessity of providing additional braking devices, or dampening mechanism. There are many advantages to the utilization of such a motor, namely, the constant speed control of the door closing is accomplished without variations due to temperature and viscosity of the fluid in the hydraulic dampening device. The present structure also eliminates the necessity of providing oil seals, pistons and check valves which are required in the mechanism using a hydraulic dampening or speed control method. In addition, a constant closing speed for the door is maintained in accordance with the door closing speed set at the site of manufacture of the unit since any time an increased force is applied to the door these forces will, in turn, try to rotate the motor faster, and in so doing, the motor will generate more current, thereby creating a stronger repelling force. Thus, even though the external forces on the door may vary, the closing speed of the door will be maintained substantially constant.

Still another advantage of the present door operator design is that, once the door closing speed has been set, there is no need for adjustment thereof in the field, or under actual use conditions to provide a constant closing speed over a wide range of door weights, or wind forces and temperature variances. The novel door operator requires considerably less maintenance than normally necessary with presently available door operators of this type wherein the door closing speed is controlled through hydraulic means, and this, in effect, reduces the upkeep costs, and prolongs the useful life of the unit. Furthermore, the design of the electrical circuit of the unit makes use of semi conductors whereby it is possible to

2

rotate the motor in the normal direction in which it is powered to turn by manually opening the door, and in this direction of motor rotation, there is no braking action. This permits the door to be operated manually in the event of power failure, and in addition, since no external source of power is required to regulate the closing speed of the door, the present apparatus provides for manual opening of the door and automatic control of the closing speed thereof.

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.

It is a still further object of this invention to provide a novel electric door operator powered by a motor having a permanent magnetic field whereby the motor functions for both opening of the door and controlling the closing speed thereof eliminating the necessity of providing separate dampening systems in conjunction therewith.

And still another object of this invention is to provide a novel electric door operator wherein the motor provides a braking action therefor to maintain the door in the open position until persons moving through the open doorway have cleared the door area, thus eliminating the need for separate braking devices.

It is still another object of this invention to provide a novel electric door operator which may be opened manually in the event of power failure, and still have the closing speed thereof automatically controlled.

It is yet another object of this invention to provide an electric door operator which is simple and efficient in operation and economical and durable in construction.

Other and further objects and advantageous features of the present invention will hereinafter more fully appear in connection with a detailed description of the drawings in which:

FIGURES 1 and 1A are left and right portions, respectively, of 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.

FIGURES 2 and 2A are left and right hand portions, respectively, of a plan view of the novel door operator disposed in a door frame.

FIGURES 3 and 3A are left and right hand portions, respectively, of a sectional elevational view of the novel door operator with portions shown in elevation for clarity.

FIGURES 4 and 4A are left and right hand portions, respectively, of a plan view of the novel door operator with portions thereof omitted for clarity.

FIGURES 5 and 5A are left and right hand portions,

respectively, of a plan view of the novel door operator disposed in a door frame and including wiring details illustrating the generating effect of the motor for controlling the closing speed of the door.

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 FIGURES 1, 1A 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 or pivotally secured adjacent thereto in any well known manner, as clearly shown in FIGURE 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.

Referring now to FIGURES 3, 3A, 4 and 4A in addition to FIGURES 1, 1A and 6 the operator unit 24 comprises a motor 30 mounted or secured to a channel member 32 in any suitable manner. The motor 30 is preferably an electric motor of approximately 3,000 r.p.m., with a rated torque of five to seven inch pounds, but not limited thereto, and is provided with a permanent type magnet 34 (FIGURE 5A) built therein in any suitable manner. The magnet 34 may be a single circular magnet surrounding the motor armature 35, or may comprise a plurality of circumferentially spaced magnets disposed around the armature 35 to provide a permanent magnetic field for the motor 30. The motor 30 is actuated by an electronic switch or switch type floor mat 36 (FIGURE 6) through a series of electrical relays (not shown) located in an electrical control box 38, which is secured to the base plate 18 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 activated 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, a portion of which is indicated by the gears 42a and 42b in FIGURE 3.

The gear 44 is keyed or otherwise suitably rigidly secured to the outer periphery of a sleeve 46 having a reduced neck portion 47 at one end thereof providing an annular shoulder 48 therearound. The sleeve 46 is disposed within a bore provided in a housing 51 which is secured to the channel 32 and extends longitudinally therefrom, as clearly shown in FIGURE 3. The neck portion 47 of the sleeve 46 extends through a bore 52 provided in the cover member 53 of the gear reduction unit 40, and is rotatably supported therein by a suitable bearing member 54. The opposite end of the sleeve 46 is rotatably supported in the bore 50 by a suitable bearing 55 whereby the sleeve 46 is freely rotatable upon the rotation of the gear 44.

A suitable retainer nut 56 may be threadedly secured to the outer extremity of the reduced neck portion 47 for contacting the bearing 54 and cooperating with the outwardly directed shoulder 48 for retaining the bearing 54 in position around the neck portion 47. The outer race of the bearing 54 is disposed between an inwardly directed shoulder 57 provided on the inner end of the bore 52 and a bearing lock cover 58 which is removably secured to the cover member 53. In this manner longitudinal movement of the sleeve 46 is precluded without interference

with the free rotation thereof during rotation of the gear 44.

The bearing 55 is supported by a flanged ring 59 which is held against movement in a right hand direction, as viewed in FIGURE 3, by a suitable lock washer 60. An inwardly directed circumferential shoulder 61 is provided in the bore 50 and spaced from the flanged ring 59 for receiving a self-aligning bearing 62 and a thrust bearing 63 therebetween. A suitable spacer ring 64 is interposed between the bearing 62 and 63 for a purpose as will be hereinafter set forth. It will be readily apparent that the shoulder 61 and lock washer 60 cooperate for retaining the bearings 62 and 63 and the flanged ring 59 securely in position within the bore 50 and preclude longitudinal movement thereof.

The bearings 62 and 63 are disposed around the outer periphery of the sleeve portion 65 of a suitable apertured ball nut 66. The ball nut 66 is held against longitudinal movement by a lock washer 67 carried by the spacer ring 64 and disposed in an annular groove 68 provided on the outer periphery of the sleeve 65. The lock washer 67 cooperates with an annular shoulder 69 on the ball nut 66 for securing the ball nut to the inner race of the bearing 62, thus precluding longitudinal movement of the ball nut 66. The sleeve 65 extends longitudinally into the sleeve 46 and is rigidly secured thereto in any suitable manner, such as by the universal member 70, for simultaneous rotation therewith. Thus, the ball nut 66 may rotate freely upon rotation of the gear 44, but is held securely against longitudinal movement within the bore 50.

A corresponding ball bearing screw shaft 71 extends longitudinally through the apertured ball nut 66 and sleeve 65 as clearly shown in FIGURE 3. A continuous spiral groove 72 extends longitudinally along the outer periphery of the shaft 71 for cooperation with a plurality of balls 73 (FIGURE 4) contained within the ball nut 55 to transform the rotational movement of the ball nut 66 into longitudinal movement of the shaft 71. Rotation of the sleeve 46 in one direction will rotate the ball nut 66 in a direction for moving the shaft 71 longitudinally in a left hand direction, as viewed in FIGURES 3 and 4.

A rack member 74 is secured to the outer extremity of the shaft 71 in any suitable manner, such as by a plurality of transverse pins 75, whereby movement of the shaft 71 is transmitted to the rack 74. The rack 74 is disposed in a longitudinally extending bore 76 (FIGURE 4) and reciprocated therein during the operation of the door operator unit 24, as will be hereinafter set forth. The rack 74 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 74. The gear 78 in turn meshes with a gear 80 which is integral with or secured to a pivot shaft 82 (FIGURE 3), 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 gear 80 may be provided with the usual gear teeth 84 which extend completely around the circumference or outer periphery thereof, if desired, or with the teeth 84 extending only around substantially one-half the circumference thereof, as shown in FIGURE 4. If the latter is preferred, it will be apparent that rotation of the gear 80 by the gear 78 will be through an arc of substantially 180 degrees, whereas if the gear 80 is provided with the teeth 84 extending completely therearound, rotation thereof may be through an arc of 360 degrees.

The lower extremity 86 of the pivot shaft 82 extends downwardly from the housing 51 and through an aperture 88 (FIGURE 1) provided in the door frame 18 for connection with the upper portion of the door 10 in any suitable manner 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-

5

URE 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 74 as clearly shown in FIGURE 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 longitudinally from the rack 92 and is slidably disposed in a support sleeve 100 disposed in the bore 94 and spaced from the rack member 92. The sleeve 100 may be carried by an end cap member 102 which is threadedly secured in one end of the bore 94, as clearly shown in FIGURE 4. A closure spring 104, depicted partially in broken lines in FIGURE 4, is disposed around the sleeve 100 and stem 96 and has one end anchored in the end cap 102 and the opposite end anchored against a retainer member 106 secured around the stem 96 and spaced slightly from the rack member 92. The stem 96 and sleeve 100 provide a guide for the spring 104, and the spring 104 is preloaded at substantially any desired strength for opposing the movement of the rack gear 92.

Referring now to FIGURES 1, 2, 3 and 5, a pair of superimposed switch cams 108 and 110 are rigidly secured to an upper extension 112 of the gear 78. The cams 108 and 110 may be individual members, as shown herein, or may be a unitary disc, or the like, so machined as to provide the desired outer configuration therefor. It is preferable that the cams 108 and 110 be provided with outwardly extending shoulders, such as 113 and 114, on the outer periphery thereof for actuation of the switches 116, 118, and 120, as will be hereinafter set forth. The switch 116 is a motor switch and is secured to the housing 51 in the proximity of the cam 108 and is provided with an arm member 122 having a roller 124 adapted to roll or ride along the outer periphery of the cam 108.

The switch 118 is a safety switch and is actuated by the cooperation between the cam 108 and the arm 126 and roller 128 carried thereby whereby upon opening of the door 10 to a predetermined angular disposition thereof, the safety switch is energized and cooperates with the switch mat 36 for holding the door in this open position until the person passing therethrough has safely cleared the doorway 12. In addition, the motor switch 116 is electrically connected to an external switch (not shown) which, when energized, will cause the door to open and with the door in the open position the motor switch reduces the voltage to the motor 30 and because of insufficient power, the motor will stall with just enough driving force to securely retain the gear 78 in a stationary position to preclude operation of the rack and gear means. 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, including the stalled current to the motor 30, and the door 10 will begin to close.

The third switch 120 is also disposed in the proximity of the cams 108 and 110 and is provided with an arm 130 having a roller 132 carried thereby for riding on the outer periphery of the cam 110. When the switch 120 is activated by the cooperation between the cam 110 and the arm 130, the resistance thereof is changed for altering the moving speed of the door. This permits the magnetic braking action of the motor 30, as will hereinafter be set forth, to close the door 10 at one speed from the fully open position to approximately 15 degrees from the fully closed position, and at this point the speed of the door closing will be reduced through the last 15 degrees to the closed position.

As shown in FIGURES 5 and 5A, the switches 116

6

and 118 are connected with a suitable connector member 137 by a plurality of suitable wiring members 134, which may be encased within a protective sleeve 136, if desired. The connector 137 is also in electrical connection with a suitable circuit breaker 138, as is well known.

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 time delay circuit 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 one-half second later, or at any designated time delay as desired for safety.

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 circuits contained within the box 38. The motor 30 rotates the gear 44 through the gear reduction unit 40, whereby the rotatable sleeve 46 is rotated freely within the bore 50. The rotation of the sleeve 46 is transmitted to the ball nut 66 whereupon the ball bearing shaft 71 is moved longitudinally by the cooperating balls 73 and the spiral groove 72. Of course, one inherent feature of the ball nut 66 and cooperating ball bearing shaft 71 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 71 moves in a left hand direction as viewed in FIGURES 3 and 4.

The left hand movement of the shaft 71 moves the rack 74 in a left hand direction to transmit a clockwise rotation to the gear 78. The gear 78 in turn meshes with the gear 80 to provide a counter-clockwise 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 and spring stop member 106 with it. The stem 96 is thus moved in a right hand direction within the sleeve 100 and against the force of the spring 104 and the spring is compressed between the spring stop 106 and end cap 102. When the pivot shaft 82 is rotated through a sufficient angle for opening the door to substantially any desired predetermined position, the cam disc 108, which rotates simultaneously with the gear 78, moves to a position whereby the shoulders 113 and 114 move the arms 122 and 126, respectively, for activating the safety switch 118 and motor switch 116. With these switches activated, the motor 30 is stopped whereby rotation of the gear 44 is ceased. The motor switch reduces the voltage to the motor 30, and because of in-

sufficient power, the motor will stall with just enough driving force to securely retain the gear 44 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, including the stalled current to the motor 30, and the door will begin to close.

Upon the interruption or stoppage of the electric power the closure spring 104, compressed between the end cap 102 and stop member 106, will urged the stop member 106 in a left hand direction as viewed in FIGURE 4, which causes the stem 96 and rack member 92 to move in a left hand direction. The left hand movement of the rack 92 rotates the gear 78 in a counter-clockwise direction, and 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 counter-clockwise rotation of the gear 78 also moves the rack 74 in a right hand direction for restoring the ball bearing shaft 71 to a position for opening of the door upon the next operation thereof.

The moving of the ball bearing shaft 71 in the right hand direction causes the ball nut 66 to rotate in an opposite direction from the opening rotational direction. The ball nut 66 transmits this reverse rotation to the sleeve 46 through the connection therebetween, which causes the gear train to rotate the armature of motor 30 in a direction opposite to its normal drive. By having the permanent magnets 34 built into the motor 30, the motor acts as a generator when the armature is turned in the direction opposite to its normal rotation under power as a result of the mechanical force or pressure of the closure spring 104. By use of suitable semi-conductors (not shown) the generated current is shorted out, which in turn creates an opposing magnetic force in the armature and fights the magnetic field of the permanent magnets. This, in turn, causes a braking action which is used for controlling the speed at which the door closes. A suitable resistor (not shown) is utilized to regulate the degree of speed, and the third switch 120, located in the proximity of the cams 108 and 110, changes the resistance at a predetermined point in the position of the door during the closing thereof to change the moving speed of the door. This allows the magnetic braking action in the operator 24 to close at one speed from the fully opened position of the door to approximately 15 degrees from the closed position, or any other preselected position prior to the closing of the door, and then to be slowed down to a still slower speed from the said 15 degree position to the fully closed position.

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 74 and gear 78. The reduction of current to the motor 30 upon the full opening of the door causes the motor to stall sufficiently to securely hold the door in the open position until the person has cleared the doorway 12 and has stepped off of the mat 36. As soon as the person has moved off of the mat 36, the door starts to close through the action of the closure spring 104 and the rack 94 and gear 78. The reverse action of the rack and gear means causes the motor to rotate in a direction opposite to its normal drive, and sets up a magnetic braking action for regulating or controlling the speed of the door closing. In addition, the substantially frictionless or free wheeling action of the ball nut and ball bearing screw permits easy manual opening of the door upon any power failure, and the closing of the door is identical, regardless of whether or not electrical power is in operation.

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 opera-

tion 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.

What is claimed is:

1. A door operator for opening and closing a door and comprising a motor having a permanent magnetic field, and a rotatable armature, means for connecting said motor to said door including gear means rotated by the motor, rack and gear means, free wheeling means for translating the movement from the first gear means to the rack and gear means for movement thereof in one direction to open the door, means actuated upon opening of the door for stalling the motor to retain the door in the full opened position for a predetermined time period, resilient means cooperating with the rack and gear means for movement thereof in an opposite direction for closing the door upon deenergization of the motor, said free wheeling means and first gear means actuated by the said rack and gear means in the opposite movement thereof for rotating the motor in a reverse direction, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action to the closing of the door.

2. A door operator for opening and closing a door as set forth in claim 1 wherein means is provided for actuation during the closing of the door to provide at least a two speed control for the closing of the door.

3. A door operator for opening and closing a door and comprising a motor having a permanent magnetic field, and a rotatable armature, means for connecting said motor to said door including 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, a 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 upon deenergization of the motor, means actuated by the opening of the door for stalling the motor to securely retain the door in the fully opened position, said gear means actuated during the closing of the door for a reverse rotation of the motor, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action to the closing of the door.

4. A door operator for opening and closing a door and comprising a motor having a permanent magnetic field and a rotatable armature, means for connecting said motor to said door including gear means rotated by the motor, reciprocal rack means, free wheeling 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 actuated by the opening of the door for stalling the motor to provide a braking action for retaining the door

in the fully opened position throughout a predetermined time period, 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 upon deenergization of the motor, and said first gear means rotated in an opposite direction upon closing of the door for rotating said motor in a reverse direction, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action to the closing of the door.

5. A door operator for opening and closing a door and comprising a motor having a permanent magnetic field and a rotatable armature, means for connecting said motor to said door including gear means rotated by the motor, reciprocal rack means, free wheeling 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 actuated upon opening of the door for stalling the motor for temporarily retaining the door in an open position, second rack means reciprocated in one direction by the second gear means, 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 upon deenergization of the motor, said first gear means rotated in an opposite direction during closing of the door for rotating the motor in a reverse direction, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action for controlling the closing speed of the door, and means actuated during closing of the door to provide for at least a two speed control for the closing of the door.

6. A door operator for opening and closing a door and comprising a motor having a permanent magnetic field and a rotatable armature, means for connecting said motor to said door including 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 actuated by the opening of the door for stalling the motor for temporarily retaining the door in the open position, means for urging the second rack member in an opposite direction from said last mentioned direction upon deenergization of the motor 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, said motor being rotated in a reverse direction during closing of the door, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action to the closing of the door.

7. A door operator for opening and closing a door and comprising a motor having a permanent magnetic field and a rotatable armature, means for connecting said motor to said door including rotatable gear means rotated by said motor, 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 and oppositely disposed from the first rack member, said second rack member moved in one direction by the rotation of the gear member, means actuated upon opening of the door for stalling the motor to temporarily retain the door in the opened position, means for urging the second rack member in an opposite direction from said last mentioned direction upon interruption of the supply of power to the motor 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, said motor being rotated in a reverse direction during the closing of the door, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action to the closing of the door.

8. 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, first rack means cooperating with the gear means for rotation thereof in one direction for opening of the door, second rack means cooperating with the gear means for movement thereby in one direction during the opening of the door, spring means for urging the second rack means in an opposite direction for rotation of the gear means in an opposite rotational direction for closing the door, motor means having a permanent magnetic field and a rotatable armature for providing power for operation of the said first rack means in the direction for opening the door, said second rack means being moved in said opposite direction by said spring means upon deenergization of the motor, means responsive to opening of the door for stalling the motor means to temporarily retain the door in the open position, said motor being rotated in a reverse direction during the closing of the door, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action to the closing of the door.

9. 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, first rack means cooperating with the gear means for rotation thereof in one direction for opening of the door, means for moving the first rack means reciprocally in a direction for rotating the gear means for opening of the door, second rack means cooperating with the gear means for movement thereby in one direction during the opening of the door, spring means for urging the second rack means in an opposite direction for rotation of the gear means in an opposite rotational direction for closing of the door, motor means having a permanent magnetic field and a rotatable armature providing power for actuation of the first rack moving means, said spring means being operable to move said second rack means upon deenergization of the motor, means responsive to opening of the door for stalling the motor means for temporarily retaining the door in an open position, said motor being rotated in a reverse direction during the closing of the door, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action to the closing of the door.

10. A door operator for opening and closing a door, and comprising a motor having a permanent magnetic field and a rotatable armature, means for connecting said motor to said door including free wheeling means for translating rotational motion from the motor to longi-

11

tudinal motion, double rack and gear means actuated in one direction by the free wheeling means for opening of the door, spring urged means for actuating the double rack and gear means in an opposite direction for closing of the door upon interruption of the power supply 5 to the motor, means responsive to opening of the door for stalling the motor to temporarily retain the door in the open position, said motor being rotated in a reverse direction during the closing of the door, rotation of said armature with respect to said permanent magnetic field in said reverse direction creating an opposing magnetic force in said armature to provide a braking action 10 to the closing of the door.

12

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