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3,422,704

AUTOMATIC DOOR OPERATOR

Filed Jan. 31, 1967

Sheet 1 of 2

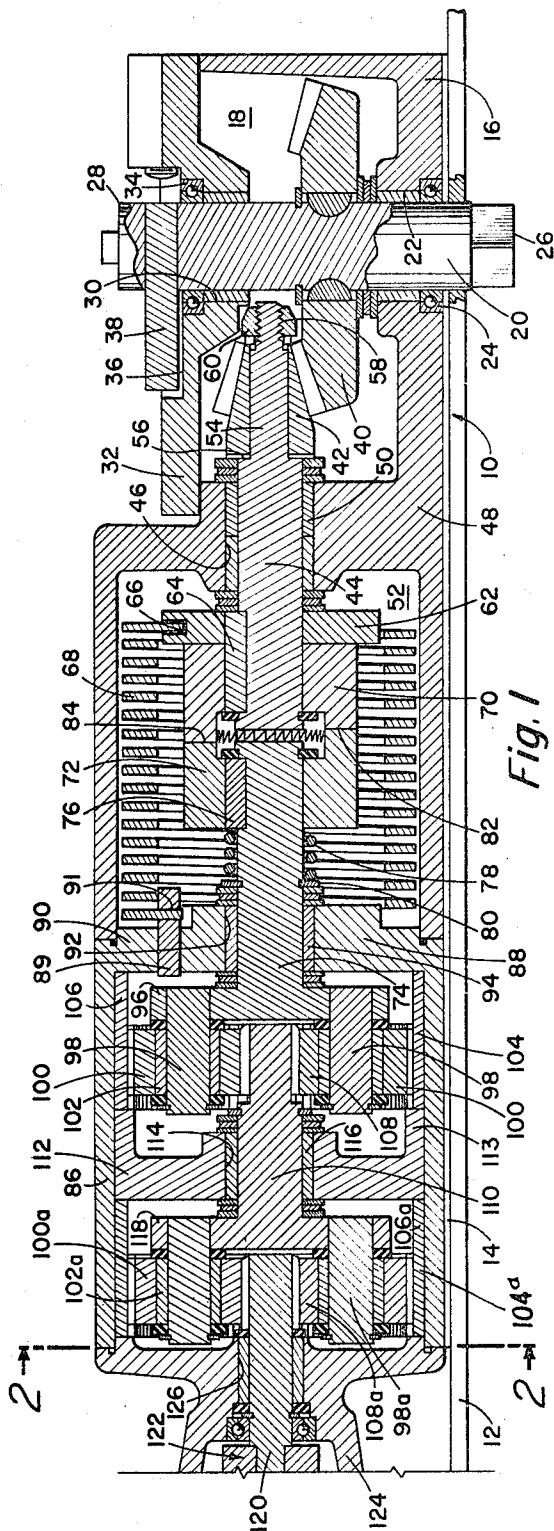


Fig. 1

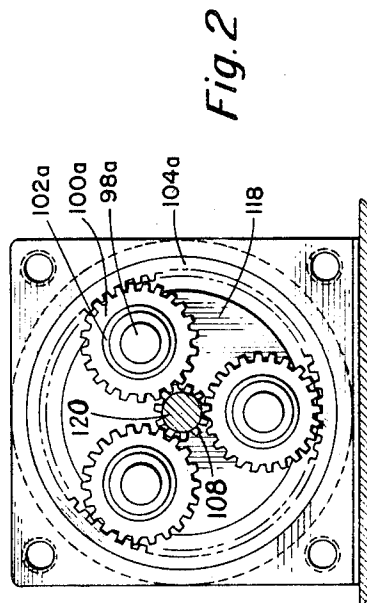


Fig. 2

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Sheet 2 of 2

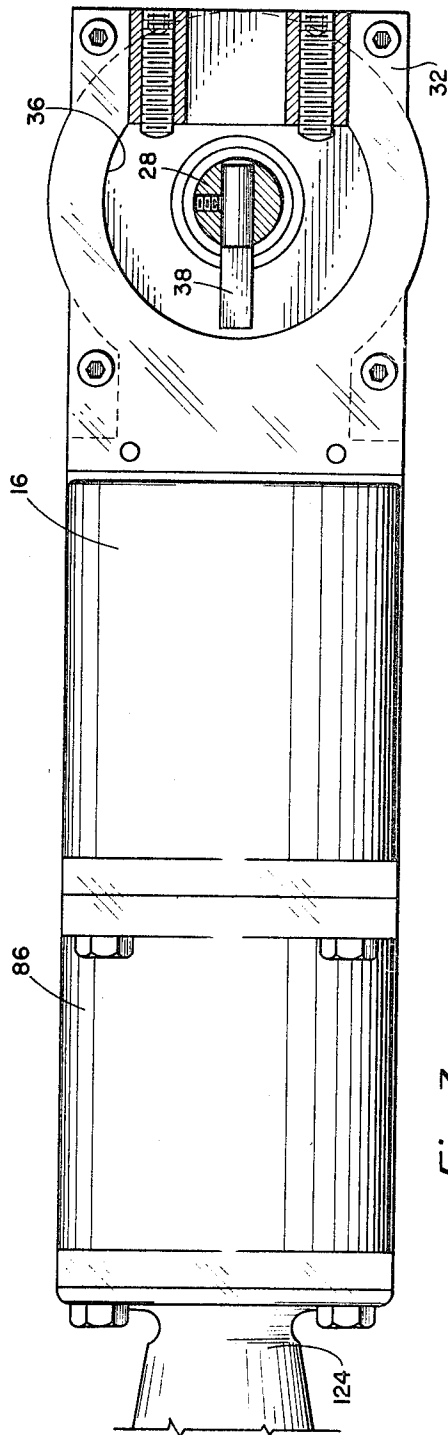


Fig. 3

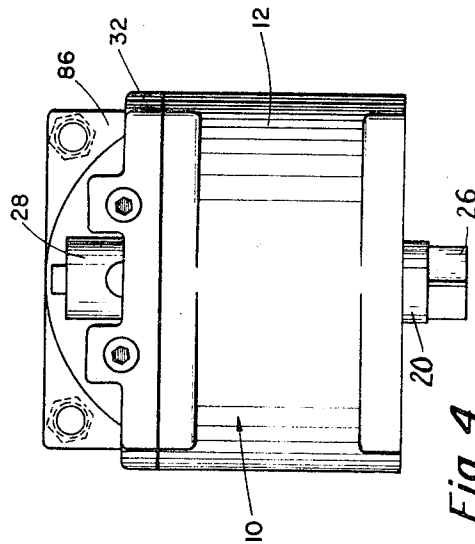


Fig. 4

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3,422,704

AUTOMATIC DOOR OPERATOR

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5 Claims

Int. Cl. F16h 1/46; E05f 15/20; E05f 15/00

This invention relates to improvements in automatic door operators, and more particularly, but not by way of limitation, to an automatic door operator particularly designed and constructed for eliminating the necessity of reciprocal operational members for transmitting rotation from a power source to a door axis during the opening and closing of the door.

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 are usually operated by means of a mechanism installed in the frame above the door, and the space limitations for these mechanisms or devices normally restrict the types of operational devices which may be utilized in transmitting rotation from the power source to the door. In most of the door operators in use today the rotational movement of the motor or power source is changed to a reciprocatory movement and the reciprocatory movement is ultimately changed back into a rotary movement which is applied to the axis of the door. The devices utilized for providing the reciprocal movement are usually very expensive and frequently require maintenance or repair to maintain an efficient functioning of the door operator.

The present invention contemplates a novel door operator for automatic doors, or the like, wherein a gear train is interposed between the motor and the door axis which eliminates the need for any reciprocating members for transmitting rotation to the door axis. The novel door operator includes a gear reduction arrangement connected with the power source for directing rotational movement to the door axis through a clutch member. The gear reduction comprises two planetary gear structures in series whereby a minimum of space is required for installation. A torsional spring is utilized in lieu of the usual compression spring, and the torsional spring is wound up upon the opening of the door in such a manner that when the motor or power source is deactivated the spring will unwind, thus causing the door to return to the closed position thereof. A direct drive is provided from the clutch to the door axis through a bevel gear arrangement. The entire chain of movement from the power source to the door axis is rotation, thus completely eliminating the need for any reciprocal members.

It is an important object of this invention to provide a novel automatic door operator particularly designed and constructed for the elimination of reciprocating members between the power source and the axis of the door.

It is another object of this invention to provide a novel automatic door operator which is of an economical construction.

Another object of this invention is to provide a novel door operator of an economical construction which may be installed in a minimum of space.

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:

FIGURE 1 is a sectional elevational view of a door

operator embodying the invention, with the power source broken for purposes of illustration.

FIGURE 2 is a sectional view taken on line 2—2 of FIGURE 1.

FIGURE 3 is a plan view of a door operator embodying the invention.

FIGURE 4 is an end view of a door operator embodying the invention.

Referring to the drawings in detail, reference character 10 generally indicates a door operator comprising an outer housing 12 providing a support structure for the working elements of the device 10. A support plate 14 may be removably secured within the housing 12, in any suitable manner, and a first housing 16 may be secured to the plate 14 in any well known manner (not shown). The housing 16 is provided with a first chamber 18 having a shaft 20 extending therethrough. The shaft 20 extends through an aperture 22 provided in the housing 16 and may be journaled therein in any suitable manner, such as by a bearing 24. One end 26 of the shaft 20 extends outwardly from the casing 12 and is provided with a contour complementary to the upper end of a door pivot axis (not shown) for engagement therewith in order to provide simultaneous rotation between the door axis and the shaft 20. The opposite end 28 of the shaft 20 extends through an aperture 30 provided in a cover plate 32 which closes the chamber 18. The upper end 28 of the shaft 20 may be journaled in the aperture 30 in any suitable manner, such as a bearing 34, as is well known. A recess 36 may be provided in the cover 32 surrounding the aperture 30 for receiving a cam member 38. The cam 38 is secured to the upper end 28 of the shaft 20 for rotation simultaneously therewith for a purpose as will be hereinafter set forth.

A first miter gear 40 is disposed within the chamber 18 and is secured around the shaft 20 in any suitable manner for simultaneous rotation therewith. A second miter gear 42 engages the first miter gear 40 as is well known, and is carried by a shaft 44 which is disposed substantially perpendicularly with respect to the shaft 20. The shaft 44 extends through an aperture 46 provided in an upstanding wall 48 disposed in the housing 16. The wall or partition 48 may be integral with the housing 16 and forms one side of the chamber 18. The shaft 44 may be journaled in the aperture 46 in any suitable manner, such as by a plurality of bushing sleeves 50, and extends into a second chamber 52 provided in the housing 16 and separated from the chamber 18 by the wall 48. The shaft 44 is reduced in diameter at 54 to provide an annular shoulder 56 for receiving the gear 42 thereagainst. The outer end of the reduced portion 54 is preferably threaded at 58 for receiving a suitable lock nut 60 or the like for securing the gear 42 on the shaft 44 for simultaneous rotation therebetween.

A spring retainer ring or annular plate 62 is disposed in the chamber 52 and secured around the shaft 44 in any suitable manner, such as by a key member 64 for providing simultaneous rotation therebetween. An inwardly directed radial bore 66 is provided on the outer periphery of the ring 62 for receiving one end of a spring 68 therein. The spring 68 may be of any suitable type and is preferably a torsional spring for a purpose as will be hereinafter set forth. The spring 68 is disposed within the chamber 62 and the opposite end thereof is anchored in the proximity of the left end of the housing 16 as viewed in FIGURE 1 in a manner as will be hereinafter set forth.

One member or element 70 of a clutch mechanism is disposed around the shaft 44 and secured thereto in any suitable manner, such as by the key 64 for simultaneous rotation therewith. The second member 72 of the clutch is secured around a shaft 74 in any suitable

manner, such as by a key member 76 for simultaneous rotation therebetween. The shaft 74 is disposed in substantially axial alignment with the shaft 44 in a manner as will be hereinafter set forth.

A clutch spring 78 is disposed around the shaft 74 and interposed between the clutch element 72 and an annular lock ring 80 for urging the clutch element in a direction toward the clutch element 70. In this manner the mating inwardly directed faces 82 and 84 of the clutch elements 70 and 72 are maintained in a normally engaged position. The faces 82 and 84 are serrated or provided with complementary mating radially extending teeth having at least one substantially straight side whereby rotation is transmitted between the clutch elements 70 and 72 upon rotation of either the shaft 74 or the shaft 44 for a purpose as will be hereinafter set forth.

A gear reducer housing 86 may be secured to the support plate 14 in any suitable manner (not shown) and is disposed adjacent to the first housing 16, as clearly shown in FIGURE 1. The housing 86 is closed at one end by a wall or partition 88 having a reduced portion 90 which extends into the open end of the housing 16. Of course, the housing 86 may be removably secured to the housing 16 in any well known manner, if desired. In addition, an O-ring (not shown), or the like, may be interposed between the wall 88 and the end of the housing 16 for providing a seal at the juncture therebetween. A pin 89 is secured to the partition 88 in any suitable manner and extends longitudinally outwardly therefrom into the chamber 52. An aperture or bore 91 is provided in the pin 89 for receiving the left hand end (as viewed in FIGURE 1) of the spring 68 therein. Thus, both ends of the spring 68 are anchored, with the left end being anchored in a stationary connection with the pin 89, and the right end being anchored to the rotatable ring 62 for a purpose as will be hereinafter set forth.

An aperture 92 is provided in the wall 88 of the housing 86 for receiving the shaft 74 therethrough. The shaft 74 may be journaled in the aperture 92 in any suitable manner, such as by a bearing sleeve or bushing 94, and is freely rotatable therein. The shaft 74 extends into the interior of the housing 86 and is provided with an outwardly extending circumferential flange 96 at the left hand end thereof, as viewed in FIGURE 1. A plurality of circumferentially spaced gear shafts 98 (preferably three, but not limited thereto) are secured to the flange 96 and extend longitudinally outwardly therefrom substantially parallel to the axis of the shaft 74. A planet gear 100 is disposed on each gear shaft 98 and may be journaled thereon in any suitable manner, such as a bushing 102, for rotation. An internally toothed ring gear 104 is disposed around the planet gears 100 and is in engagement therewith as is well known. The outer periphery of the ring gear 104 is complementary to the inner periphery of the housing 86, and a cylindrical extension portion 106 of the ring gear 104 extends into engagement with the wall 88 for facilitating assembly of the gears within the housing 86. The ring gear 104 is keyed or otherwise secured to the inner periphery of the housing 86 for precluding rotation of the ring gear 104.

A sun gear 108 is centrally disposed between the planet gears 100 and is carried by a shaft 110 which is disposed in substantial axial alignment with the shaft 74. A spacer member 112 is disposed within the housing and is provided with a substantially cylindrical extension member 113 which bears against the exposed end of the ring gear 104 for retaining the ring gear 104 in position within the housing 86. The shaft 110 extends through an aperture 114 provided in the spacer 112 and may be journaled therein in any suitable manner, such as by a bushing 116. The sun gear 108 is keyed, or otherwise secured to the shaft 110 for rotation therewith. Rotation of the sun gear 108 causes simultaneous rotation of the planet gears

100, and conversely, rotation of the planet gears 100 causes rotation of the sun gear 108.

The shaft 110 extends through the spacer 112 and is provided with an outwardly extending circumferential flange 118 on the left hand end thereof for carrying a planetary gear arrangement generally similar to that carried by the flange 96. A plurality of circumferentially spaced gear shafts 98a are secured to the flange 118 and extend outwardly therefrom substantially parallel to the axis of the shaft 110. A planet gear 100a is carried by each gear shaft 98a and is journaled thereon in any suitable manner, such as by a bushing or bearing sleeve 102a. An internally toothed ring gear 104a is disposed around the planet gears 100a in the usual manner and the ring gear 104a is provided with a cylindrical extension 106a which extends into engagement with the spacer 112. A sun gear 108a is centrally disposed between the planet gears 100a and is carried by a rotatable output shaft 120 of a power source generally indicated at 122. Of course, the ring gear 104a is keyed or otherwise secured to the inner periphery of the housing 86 for precluding rotation of the ring gear 104a.

An adapter housing 124 is secured to the left hand end of the housing 86, as viewed in FIGURE 1, for securing the power source 122 thereto. An aperture 126 is provided in the adapter housing 124 for receiving the shaft 120 therethrough, and the shaft may be suitably journaled therein for rotation, as is well known. The power source may be any suitable device, such as an electric motor, or the like, for providing energy for the operation of the door operator 10.

Suitable switches (not shown) are preferably provided or mounted on the cover member 32 for actuation by the cam 38 in a manner similar to that set forth in my prior Patent No. 3,087,720, issued Apr. 30, 1963, and entitled "Automatic Door Operator." These switches may be of any suitable type, such as micro switches or the like, and function in the manner set forth in the aforementioned patent. For example, upon opening of the door (not shown) to a predetermined angular disposition, as will be hereinafter set forth, one of the switches may be energized for holding the door open in this position until the person passing through the open doorway has safely cleared the passage. An additional switch may be provided, if desired, for cooperating with a suitable braking apparatus (not shown) for simultaneously actuating the brake mechanism and stopping the power source 122 for securely holding the door in the open position as an added safety feature. Of course, any desired switching arrangement may be utilized as is well known.

The door operator 10 may be installed above a door (not shown) in any well known manner and is connected therewith whereby the shaft 20 is engaged with the door axis or pivot shaft (not shown) for simultaneous rotation therebetween. It is preferable that the door be adapted to open in one direction only and this power source 122 is suitably electrically connected with a switch mat (not shown) or other remote control source in order that the power source 122 will be activated for opening the door as a person approaches the door.

When the motor or power source or motor 122 is energized, the shaft 120 is rotated thereby for simultaneously rotating the sun gear 108a. The sun gear 108a meshes with the planet gears 100a for rotation thereof about the shafts 98a. The planet gears 100a are in meshing engagement with the ring gear 104a and since the ring gear 104a is keyed to the housing 86, the ring gear 104a cannot rotate. Thus, the planet gears 100a and shafts 98a move within the ring gear 104a and rotate about the sun gear 108a. The planet gears 100a are carried by the flange 118 and the movement of the planet gears 100a and shafts 98a around the sun gear 108a causes the flange 118 and the shaft 110 to rotate.

The rotation of the shaft 110 causes the sun gear 108 to rotate and the engagement between the sun gear

5

108 and planetary gears 100 transmits rotation to the planet gears 100 about the shafts 98. Since the ring gear 104 is keyed to the housing 86, the planet gears 100 and shafts 98 move around the interior of the ring gear 104 or around the sun gear 108. This causes the flange 96 and integral shaft 94 to rotate. The rotation of the shaft 94 causes the clutch element 72 to rotate and the engagement of the straight sides of the serrations on the clutch faces 84 and 82 causes the clutch element 70 to rotate simultaneously with the clutch element 72. The rotation of the clutch element 72 causes the shaft 44 to rotate whereby the beveled gear 42 rotates simultaneously therewith. The beveled gear 42 engages the beveled gear 40 which in turn is secured around the shaft 20 whereby rotation of the gear 40 causes rotation of the shaft 20. The shaft 20 is connected with the door axis or door pivot shaft (not shown) and the rotation of the shaft 20 is thus transmitted to the door.

Of course, the cam 38 rotates simultaneously with the shaft 20 and as hereinbefore set forth when the shaft 20 has been rotated through a sufficient arc to open the door to a preselected position for permitting passage of traffic therethrough, the cam 38 may engage a suitable switch or switches (not shown) for de-energizing the power source 122 and actuating the brake (not shown) for holding the door in the open position.

During the rotation of the shaft 44 in the door opening operation, the torsion spring 68 is "wound up" by virtue of the connection of the spring 68 between the rotating flange 62 and stationary pin 89. When the pedestrian has cleared the doorway opening, the power to the holding switch may be interrupted whereby the brake is released. The power source 122, however, is still de-energized. The torsion spring 68 then returns to its normal position and thus rotates the flange 62 in an opposite direction from the door opening rotational direction. The rotation of the flange 62 causes the shaft 44 to rotate in an opposite direction from the door opening direction and, of course, the rotation of the shaft 44 rotates the complementary beveled gears 40 and 42 in a direction opposite to the door opening direction whereby the shaft 20 is rotated in any direction for closing the door. The straight sided portions of the serrations on the clutch faces 82 and 84 engage each other and cause the clutch element 72 to rotate simultaneously with the clutch element 70 during this door closing operation, which, of course, transmits rotation through the planetary gears thus effecting a dampening action or control of the closing speed of the door.

In the event of a power failure, the door may be opened manually by exerting manual pressure thereagainst in the usual manner for opening a pivotal door. In this instance, the shaft 20 may be rotated in the door opening rotational direction by virtue of the connection between the shaft 20 and the door axis. This causes the beveled gears 40 and 42 to rotate in the door opening direction for simultaneously rotating the shaft 44 in the door opening direction. In this direction of rotation of the shaft 44 the tapered portions of the serrations of the clutch face 82 will ride over the tapered portions of the serrations of the clutch face 84 and will permit the clutch element 70 to slip with respect to the clutch element 72 thus precluding transmitting of rotation between the two clutch elements. The spring 78 permits the clutch element 72 to slide with respect to the shaft 74 a sufficient amount to permit this slipping action, as is well known. When the manual pressure is released from the door the torsion spring 68 will close the door in the same manner as hereinbefore set forth.

It will be readily apparent that the sun gears, planet gears, and ring gears may be of any size ratio to provide substantially any desired gear reduction between the power

6

source 122 and the shaft 20. In addition, substantially any desired number of planetary gear arrangements may be provided in a series as required, and as permitted by the space limitations in the particular installation site of an operator above a door.

From the foregoing, it will be apparent that the present invention provides a novel door operator wherein planetary gear means is interposed between the power source and door axis for transmitting rotation to the door axis thus precluding the necessity of expensive reciprocating members. In addition, torsional spring means is provided in lieu of the usual compression spring for returning an opened door to a closed position. The novel door operator is simple and economical in construction and durable and efficient in operation.

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 power means, planetary gear means operably connected with the power means for actuation thereby, clutch means connected with the planetary gear means, shaft means adapted for connection with the door for simultaneous rotation therewith during an opening and closing operation, gear means cooperating between the clutch means and shaft means for transmitting rotation therebetween, and torsional spring means connected with the clutch means and cooperating therewith for returning the door to a closed position subsequent to the opening thereof.

2. A door operator for opening and closing a door as set forth in claim 1 wherein the planetary gear means includes a plurality of planetary gear arrangements disposed in series.

3. A door operator for opening and closing a door as set forth in claim 1 wherein the planetary gear means comprises sun gear means, planet gear means rotated by the sun gear means, non-rotatable ring gear means in engagement with the planet gear means whereby the planet gear means is rotated around the outer periphery of the sun gear means, and second shaft means connected with the planet gear means and rotatable therewith in one direction for transmitting rotation to the first mentioned shaft means for opening of the door.

4. A door operator for opening and closing a door as set forth in claim 3 wherein bevel gear means is interposed between the second shaft means and first mentioned shaft means for transmitting rotation therebetween.

5. A door operator for opening and closing a door as set forth in claim 1 wherein said clutch means includes clutch elements which are adapted to slip with respect to each other for manual opening of the door during a power failure.

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U.S. Cl. X.R.