

[54] DOOR ACTUATOR

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[52] U.S. Cl.....49/280, 49/281, 49/358, 192/45

[51] Int. Cl. E05f 15/12

[58] Field of Search.....49/139, 140, 280, 281, 300, 49/302, 358; 192/45, 44, 105 B, 84 PM

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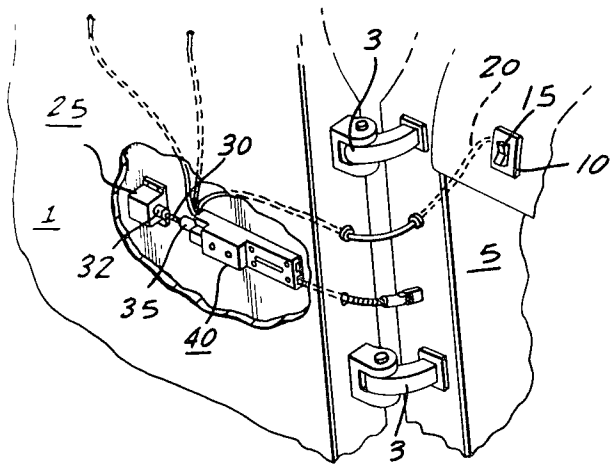
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[57] ABSTRACT

A door actuator device to automatically, by means of a remotely actuated electrical switch, complete the opening as well as closing and locking cycle of a door. The actuator device is driven by a D. C., externally powered motor. In the opening cycle of a closed and locked door, the motor drives a latch mechanism which releases the door wherein the door lock and latch are interconnected and release of the latch also releases the lock. In the closing cycle of an open door, an automatic locking mechanism latches and locks the door member. The operator has the option of overriding the actuator device to open and close the door manually.

37 Claims, 13 Drawing Figures



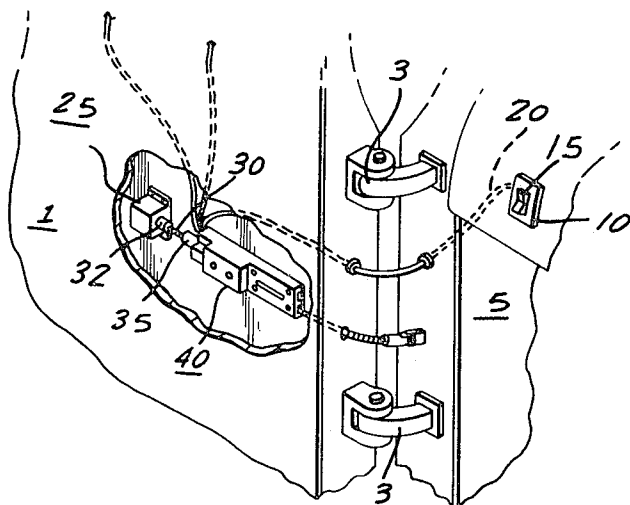


FIG. 1

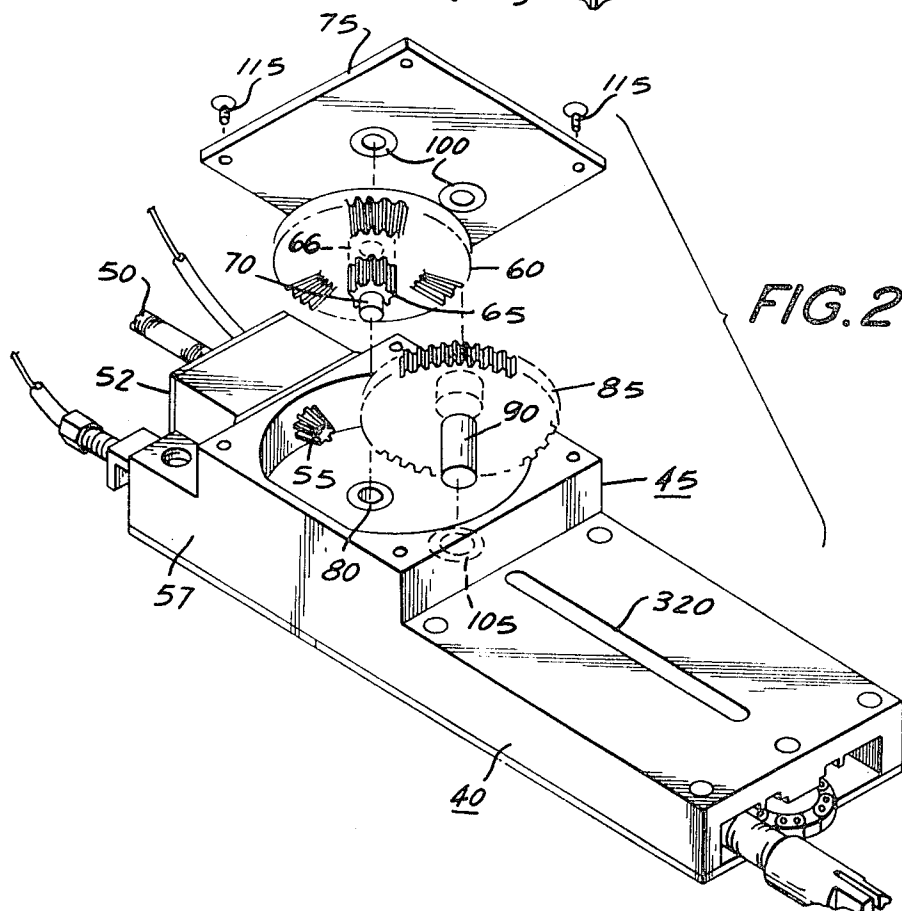


FIG. 2

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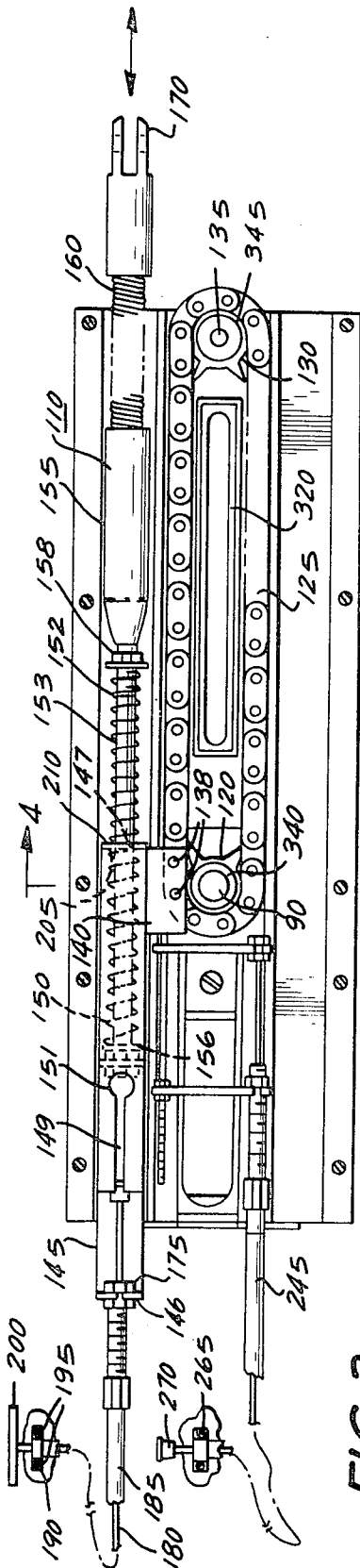


FIG. 3

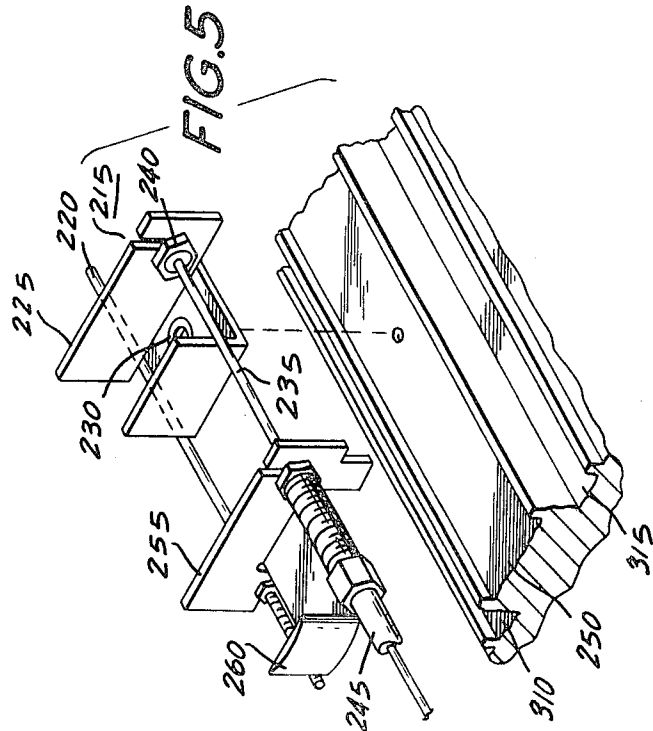


FIG. 5

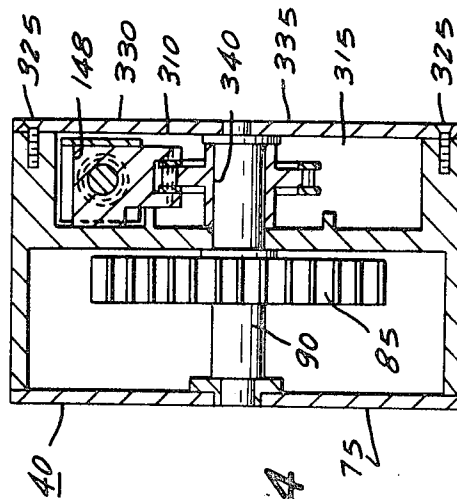


FIG. 4

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FIG. 7

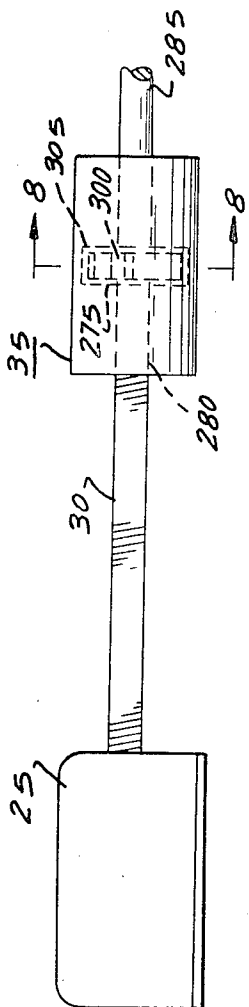


FIG. 6

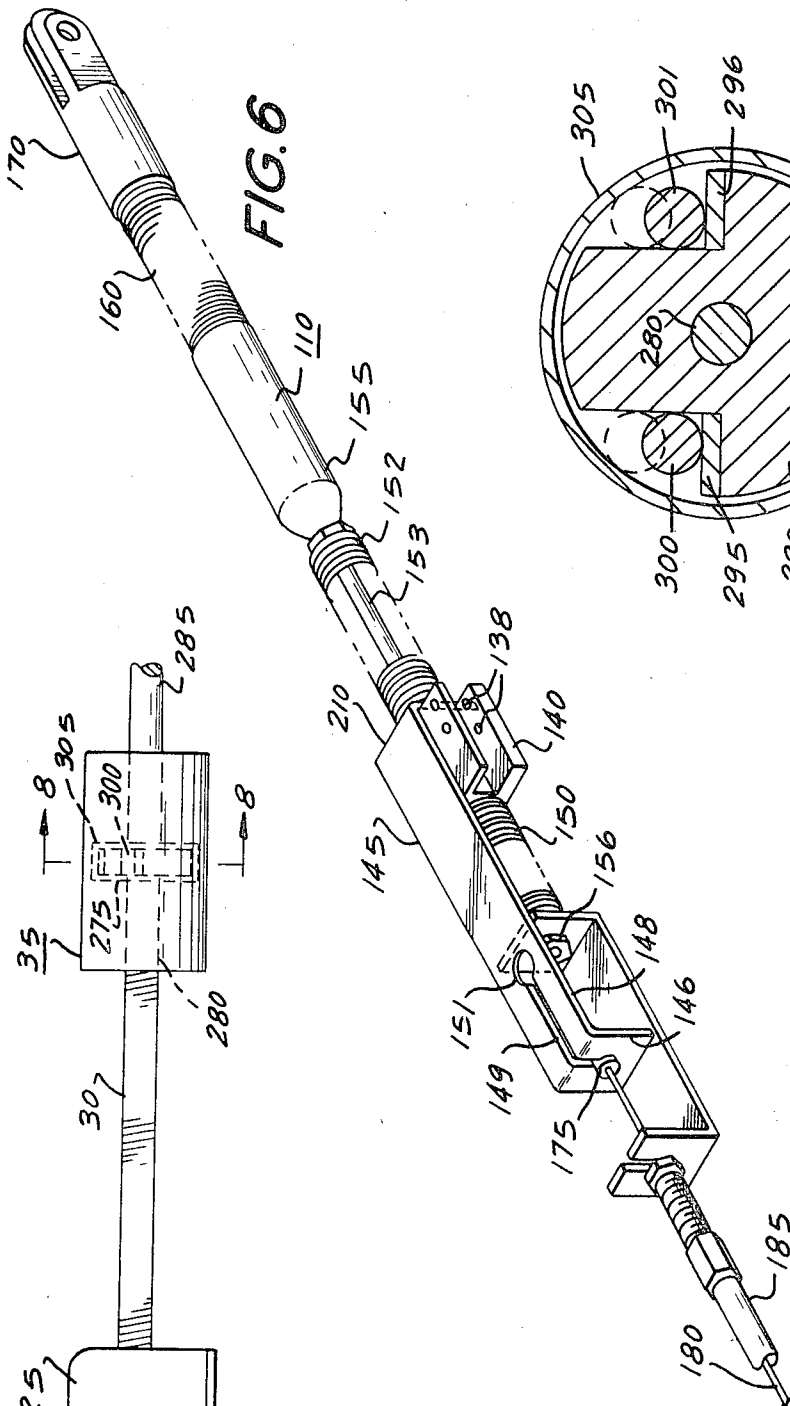
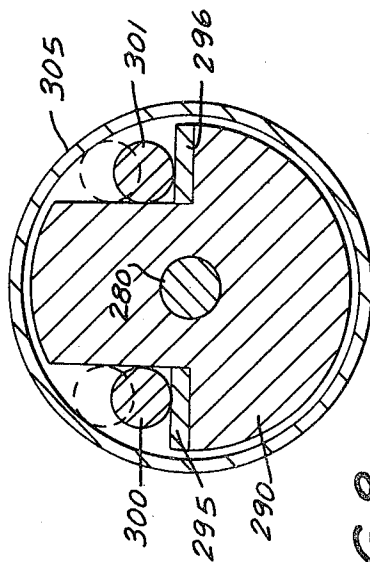


FIG. 8



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FIG. 12

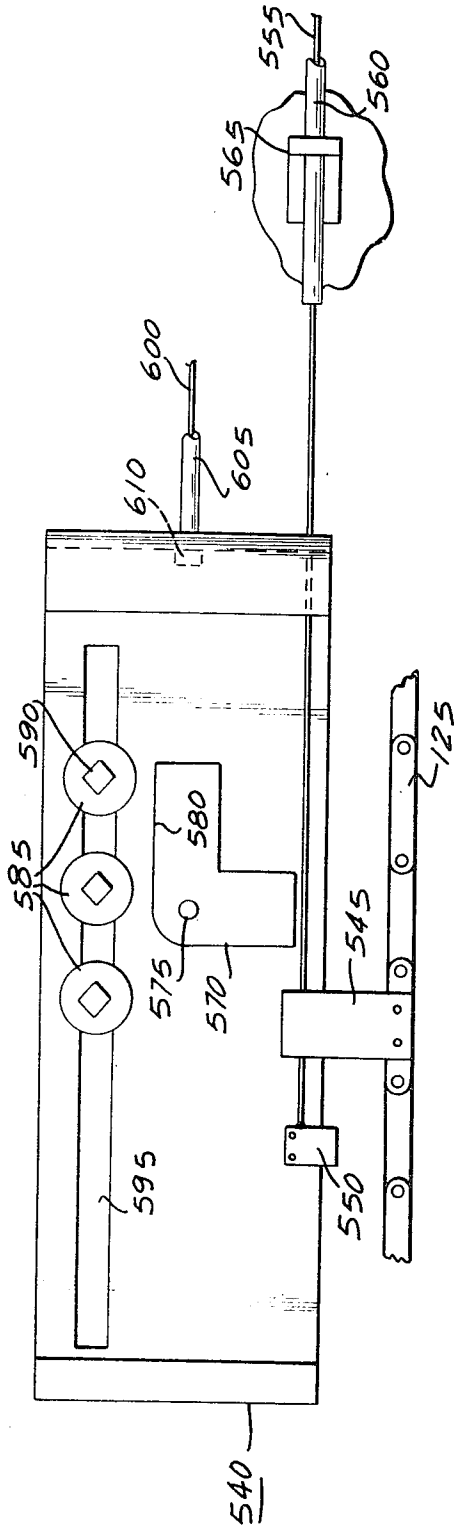
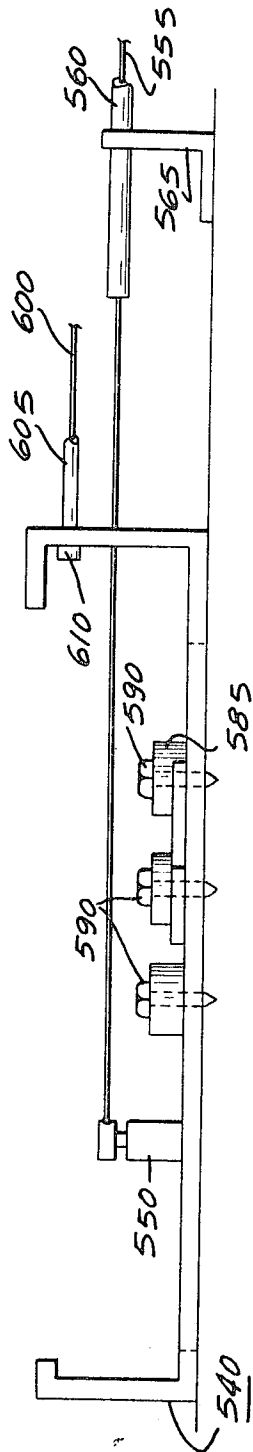


FIG. 13



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DOOR ACTUATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the field of door actuators which allow for automatic latching or unlatching, locking and unlatching, as well as providing a mechanism to let the movable door member swing free of the stationary post or chassis by means of a remotely actuated motor.

2. Prior Art

Actuator devices to open and close doors are known in which a door is latched and a mechanism allows a movable door member to swing free or come in contact with a stationary post or chassis. Until this time automatic unlocking of the door could only be accomplished where the unlatching mechanism was directly connected to the lock mechanism and upon actuation of the latch would force the lock to an opening position.

In prior devices actuation of the lock mechanism to a locking position was a manual operation. Such manual operation of the lock mechanism might cause the operator to assume an added motion in locking the door, as well as being a negative safety feature in that the operator may forget to complete the locking operation.

Until this time actuators were operated either by vacuum compression which had the disadvantage of only allowing such a device to operate from a piston type motor drive such as an auto engine, further not permitting the actuator to be operated continuously after shutdown of the motor drive; or by D. C. drive separately excited field motors which had to be controlled by a number of resistors, and relays to provide reasonable opening and closing characteristics of the door. When a motor has previously been used to operate the actuator, the motor has been directly connected to the actuator thereby restricting the possible mounting locations within a door.

There has not, in the prior art, been provided an engaging clutch from motor to actuator. Without a clutch mechanism, applied force by the operator when opening the door manually is greatly increased, thereby causing additional strain on the gears, motor and driving mechanism thereby lowering the life cycle of the entire actuator device.

A further disadvantage of prior devices has been that driving forces applied to the latching and door rotation devices have been accomplished by either gear interaction or direct linkage movement. This mode of operation produces high stress concentrations over individual gear teeth or at specific points in the linkage.

SUMMARY OF THE INVENTION

A door actuator device to operate the locking and latching mechanisms of a door and to open and close the door by respectively rotating the moveable section of the door free from, and into engagement with a stationary post. A motor actuates a driving mechanism which forces a rotational velocity to be imparted to the moveable door section. However, a latching device moves responsively to the actuation of the driving mechanism unlocking and unlatching the moveable door section prior to the moveable door section having a rotational velocity imparted to it. A locking device is responsive to the actuation of the driving mechanism and locks the moveable door section upon engagement of the moveable door section and the stationary post.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the movable door section and the door stationary post with a cutout section showing the operational door actuator within the movable door section;

FIG. 2 is an isometric drawing of the door actuator housing showing an exploded view of the gear box housing mechanisms;

FIG. 3 is an elevational drawing of the door actuator locking and latching mechanisms;

FIG. 4 is a sectional view of the door actuator mechanisms;

FIG. 5 is an exploded view of the door actuator locking mechanisms;

FIG. 6 is an isometric drawing of the door actuator latching device;

FIG. 7 is an elevational drawing of the clutch mechanism and its attachment to the actuator motor;

FIG. 8 is a cross-sectional drawing of the clutch;

FIG. 9 is a perspective drawing of the door actuator locking device attached to the chain drive;

FIG. 10 is a side view of the embodiment wherein a pivot bar operates the door locking and latching mechanism;

FIG. 11 is an elevational drawing of the movable door actuator with associated locking and latching devices;

FIG. 12 is a top view of the embodiment wherein locking and unlocking mechanisms utilize the lower track of actuator housing;

FIG. 13 is an elevational section view of the embodiment shown in FIG. 12.

DETAILED DESCRIPTION OF INVENTION

Referring now to FIGS. 1-7 with special emphasis on FIG. 1, there is seen a movable door member 1 which has rotational capabilities about an axis through a plurality of hinges 3 attached to stationary chassis 5 at one end and to movable door member 1 on the other end. An electrical switchbox 10 is attached to stationary chassis 5 at a convenient location for the operator. An electrical switch 15 on electrical switchbox 10 activates actuator motor 25. Electrical cabling 20 passing between electrical switchbox 10 through stationary chassis 5 to movable door member 1, and then attached to actuator motor 25 is the electrical conduit for operation of actuator motor 25. Where door actuator 40 is in use to operate automobile doors the remote means stated for the actuation of the device may include switchbox 10 to be installed external to the automobile, on the fender or some such convenient place, where operation of door actuator 40 would still be operated by electrical switchbox 10 by electrical switch 15 or a key insert wherein turning the key to different positions would have the effect of opening different auto doors.

Actuator motor 25 is separately excited and is of the permanent magnet type. Actuator motor 25 is a 12 volt, two directional type, drawing between 18 and 120 watts which allows the necessary power to operate the actuator, but not so much power that when movable door member 1 is free and all of the load taken away that motor 25 would begin to turn at a very high RPM. Thus with the load removed, the motor does not gallop away in the manner of a separately excited field motor. Motor 25 allows for a minimum change in RPM between a heavy load condition and a no load condition.

Actuator motor 25 drives flexible shaft 30 attached at one end to actuator motor 25 and at the other end to clutch box 35. Flexible shaft 30 is constructed of a base wire bound cable enclosed in a flexible casing of cylindrical form with layered, suitably resilient material such as steel or fiberglass. End fitting 32 attaches flexible shaft 30 to actuator motor 25 on one end and on the opposing end to clutch box 35. Clutch box 35 will later be described in detail. Flexible shaft 30 allows actuator motor 25 to be placed at various locations on movable door member 1 which point is dictated by the ease of installation. Flexible shaft 30 also has the advantage of minimizing the noise level that may occur if a rigid drive were incorporated between motor 25 and door actuator 40.

As is shown in FIG. 2 bevel gear input shaft 50 is driven from clutch box 35 on one end, thus causing rotation of bevel gear 55 upon engagement of actuator motor 25. Bevel gear 55 is rotated and in contact with bevel gear 60. The ratio of gear teeth between bevel gear 60 and the pinion bevel gear 55 is approximately 4:1. Upon engagement the axis of rotation is changed by 90° from the original axis described by the bevel gear input shaft 50, and an included speed reduction of approximately one-half the original rotational speed.

Bevel gear 60 is force fitted into gear pin 70 which is also force fitted to spur gear 65 approximately one-half the diame-

ter of bevel gear 60. Bevel gear 60 and spur gear 65 are forced into contact on mating surfaces in the plane of rotation. In order to assume contact with no slipping between the surfaces, two flat screws 66 are attached through bevel gear 60 to spur gear 65. Extending from the upper surface of bevel gear 60 is gear pin 70 which further extends through gear box cover plate 75 through a hole 100 which of sufficient diameter to allow rotation of bevel gear 60. Pin 70 also extends below the lower surface of spur gear 65 and rotates freely in a pin hole 80 of sufficient diameter in the base of gear box housing 45 to allow complete rotation of the gear mechanism.

Spur gear 65 in a driving mode comes in contact with driving actuator gear 85 which in turn drives the actuating mechanism. Driving gear pin 90 extends through the gear box cover plate pin holes 100 allowing free rotation of driving actuator gear 85. Gear Pin 90 is force fit on the driving actuator gear 85 to prevent slipping and passes through gear box housing 45 to actuate the mechanism for locking and opening the door. Drive gear pin 90 passes through a drive pin hole 105 drilled into the base surface of gear box housing 45 and is of sufficient diameter to allow free rotation of drive gear pin 90. In order to seal gear box housing 45 from the external environment, gear box housing 45 is fitted by gear box upper plate 75 and attached to gear box housing 45 by screw members 115 passing through gear box cover plate 75 into gear box housing 45 and thereby rigidly attaching the aforesaid members to each other.

As shown in FIG. 2 bevel gear input shaft 50 enters gear box housing 45 from vertical surface 52, however, input shaft 50 may enter through adjacent vertical surface 57 or the opposing surface without causing any change in the operation of the device or significantly changing the invention. Entrance of input shaft 50 through vertical surface 57 or its opposing side may be necessitated by location restrictions placed on actuator motor 25.

As shown in FIG. 3 and 4, to be used in conjunction with FIG. 1, door latch and opening mechanism 110 is activated by drive sprocket 120 attached to drive gear pin 90 which in turn is driven by driving actuator gear 85. Drive sprocket 120 is rigidly attached to drive gear pin 90 and drives chain drive 125 which is in contact on one surface with drive sprocket 120 and on the other end to movable sprocket 130. Movable sprocket 130 is force fit to movable sprocket pin 135. A movable sprocket pin hole 345, of sufficient diameter to allow free rotation of the movable sprocket pin 135 is drilled into door actuator housing 40 which in turn allows rotation of movable sprocket 130. Chain drive plate 140 is rigidly attached to chain drive 125 by way of two rigid pin members 138. Chain drive plate 140 is contacted by latch bar 145. Rotation of the drive sprocket 120 causes translation of chain drive plate 140 and by necessity the same linear translation by latch bar 145.

Latch bar 145 is essentially a piece of flat steel rectangular in shape with a head end surface 146 and a rear surface 147 bent at an angle of 90° to the upper surface 148. Latch bar upper surface 148 has slot 149 milled into it which continues around to the head end surface 146. The width of slot 149 is sufficient to allow passage of the latch release cable 180 but not sufficient in width to allow passage of the latch release cable head 175 which rests against the latch bar head end 146. To allow latch release cable head 175 to be placed in the proper position an enlarged slot opening 151 is drilled into latch bar 145 at the end of slot 149. Latch bar rear surface 147 has a hole drilled into it of sufficient diameter to allow passage and free translation of latch rod 153.

In order to open door member 1 drive sprocket 120 moves chain drive 125 which in turn causes translation of chain drive plate 140 and latch bar 145. Translation of latch bar 145 causes compressive stresses on latch spring 152 and tension stresses on lock actuator spring 150 which are in turn coiled around latch rod 153. Lock actuator spring 150 is free floating and not joined to drive plate 140, and further is in a pre-compressed position before actuation of door actuator 40. Latch rod 153 is cylindrical in shape and holds both lock actuator

spring 150 and latch spring 152 in place by their attachment to lock spring head 156 and latch spring head 158 at opposing ends of latch rod 153. In addition, lock actuator spring 150 and latch spring 152 are separated from each other by latch bar rear surface 147 and are in contact with latch bar 145 on opposing surfaces 205 and 210 respectively. Translation of latch bar 145 will not move latch rod 153 and its attached member cylindrical bar 155, however, movement of latch bar 145 does cause latch release cable 180 to move. Latch release cable 180 is attached to latch bar 145 by latch release cable head 175. Movement of latch release cable 180 causes a tension stress to be applied to latch mechanism 200 which in turn opens the latch and lock mechanism. In order to allow for placement of latch release cable 180 in various positions in movable door member 1, latch release cable 180 is surrounded by a stationary flexible cable housing 185 which is rigidly attached to movable door member 1 through cable housing head 190 by a set of cable housing screw attachments 195.

When latch mechanism 200 is released, movable door member 1 is then free to move away from stationary chassis 5 and does so by release of the compressive stresses placed on latch rod 153. Latch rod 153 is rigidly attached to rigid cylindrical bar 155 which in turn is attached to its opposing end by a flexible cylinder spring 160 which in turn is attached to clevis 170. Movement of the relatively rigid mechanism causes clevis 170, flexible cylinder 160, rigid cylindrical bar 155 and latch rod 153 to move within movable door member 1 and relative to stationary chassis 5 thereby allowing movable door member 1 to swing free of stationary chassis 5.

In order to close and lock the movable door member 1, drive sprocket 120 is driven in the opposing direction thereby causing chain drive plate 140 to translate, putting latch spring 152 in tension and pulling with it latch rod 153, rigid cylindrical 155, flexible cylinder 160, and clevis 170. Movable door member is thus brought into contact with stationary chassis 5, thereby closing the door. Chain drive plate 140 then comes in contact with locking mechanism 215. Chain drive plate 140 comes in contact with locking pin 220 which is a thin cylindrical rod rigidly attached to movable head 255. Movable head 255 moves in locking mechanism track 250 provided in door actuating housing 40. In order to provide a stop mechanism for locking device 215 when moving in locking mechanism track 250, rigid plate 225 is attached to door actuator housing 40 by plate screw 230. On the opposing end of locking mechanism track 250 there is also provided stop control 260 consisting of a rigidly attached plate which makes contact with movable head 255 thereby stopping locking mechanism 215 when the door has been locked. Locking cable 235 is rigidly attached to plate 225 by a locking cable head 240. Locking cable 235 passes through movable head 255 on the opposing side from which locking pin 220 is attached. Movement of movable head 255 causes locking cable 235 to move relative to stationary locking cable housing 245 which in turn forces lock 270 closed. Stationary locking cable housing 245 is rigidly attached by way of locking cable housing attachment 265 to movable door member 1 thereby allowing no relative motion between stationary locking cable housing 245 and movable door member 1 but allowing relative motion between locking cable 235 and stationary locking cable housing 245. Once locked, movable head 255 is in contact with stop control 260, due to the tension placed on latch spring 152, chain drive plate 140 now reverses its translation and moves chain drive 125 to its original closed position. This movement provides a space between locking pin 220 and chain drive plate 140, and further allows the operator to lift lock 270 manually if he wishes. When lock 270 is lifted manually if he wishes. When lock 270 is lifted manually the process reverses wherein movable head 255 is translated with its locking pin 220 to come in contact with chain drive plate 140.

In order to manually override the entire mechanism clutch 275 is attached to one end of flexible shaft 30 and on the opposing end to gear box housing 45. On manual override the

clutch will negate any of the input loading on such components as the gears and other mechanisms and by keeping such a strain to a minimum the life of the unit is increased.

As shown on FIGS. 7 and 8 clutch mechanism input shaft 280 is attached to flexible shaft 30, movement of input shaft 280 in a rotational mode of operation causes a rotation of input plate 290. Input plate 290 is basically a circular plate with a segment of the base circle cut out on either side of the axis, taking the shape of a rounded rectangle sitting on top of a semi-circle. Input plate 290 is smaller in diameter than the outer cylinder 305 and therefore is free to rotate without making contact. Composition of input plate 290 must be of a non-magnetic material such as fiberglass or plastic.

Assuming actuator motor 25 is turned on and drives flex shaft 30 thereby driving input shaft 280 and finally rotating input plate 290 it is seen that input plate 290 initially is not in contact with outer cylinder 305. Assuming counterclockwise motion once input plate 290 begins its rotation, ferrite roller 300, due to friction, mass drag, and centrifugal forces are forced in an upward direction against outer cylinder 305, thus causing a friction block between input plate 290 and outer cylinder 305. Once outer cylinder 305 begins to rotate, output shaft 285 which is rigidly attached to outer cylinder 305, begins to rotate thereby driving bevel gear 55. The gap between outer cylinders 305 and input plate 290 is a very small magnitude and can be as little as one thirty-second inch. Upon completion of the cycle actuator motor 25 stops, roller 300 made of a ferrite material is moved by inertial forces and attracted by permanent magnet 295 which is attached to input plate 290. Roller 300 is constructed either as a ball or as a cylindrical rolling section. Input plate 290 must be constructed of a non-ferrite material in order that roller 300 is not attracted to input plate 290. Attachments of permanent magnet 295 to the input plate 290 may be accomplished by screws, gluing, or press fit. This action is predicated on counterclockwise rotation of input plate 290 as is seen in FIG. 8, during counterclockwise rotation roller 301 remains attached to permanent magnet 296, during clockwise rotation of input plate 290 the process is reversed and roller 301 is acted upon by the same forces, and operates in the same manner as roller 300 does in counterclockwise rotation with the exception then being that roller 301 is attracted by permanent magnet 296.

In the manual override basic concept it can be seen that output shaft 285 is moved, thereby forcing a rotation of outer cylinder 305 but causing no movement of input plate 290 due to the fact that rollers 300 are attached to permanent magnet 295. Since there is no connection between outer cylinder 300 and input plate 290 no movement of flex shaft 30 or of actuator motor 25 will occur thereby lowering the amount of force necessary to operate the door in manual operation.

Door actuator housing 40 is basically rectangular in nature, symmetrically cast in order to allow general movement of latching rod mechanism 153 to be placed either in upper track 310 or in lower track 315. This symmetrical design allows for flexibility in constructing the entire mechanism, and further allows an embodiment which will be later explained in detail. Elongated opening 320 passes entirely through door actuator housing 40 and is centrally located. Elongated opening 320 allows the door actuator housing 40 to be attached by means of screw enplacements to movable door member 1 at various locations. Two housing coverplates 330 and 335 are used to protect door actuator housing 40 from external environment and are separate and distinct in order that any repairs in one section can be made without opening the other cover plate. Driving sprocket 120 passes through a hole 340 sufficient in diameter to allow free movement of driving sprocket pin 90. Driving sprocket hole 340 extends throughout the width of door actuator housing 40. Movable sprocket hole 345 is drilled on the opposing side of the elongated opening 320, this movable sprocket hole 345 is sufficient in diameter to accept the pin from movable sprocket 130.

An embodiment to the actuating mechanism includes locking device 215 to utilize lower track 315 of door actuator

housing 40. Attached to drive chain 125 is contact roller 380 held in place and in rigid fashion to chain drive 125 by bolt 385 and nut 390 on the opposing surface of chain drive 125 with contact between contact roller 380 and chain drive 125 interspersed with plate 395. Upon actuation of the locking cycle contact roller 380 moves until it is in contact with contact end plate 355, the entire catch plate 350 now is translated along lower track 315. Catch plate 350 is held in movable contact with lower track 315 by a movable screw 370 through slot 365 in the lower base of catch plate 350. Contact between contact roller 380 and contact end plate 355 and subsequent movement allows for a translation of latch release cable 185 which is attached to locking cable end plate 360 through a locking cable hole 375 which is sufficient in diameter to allow free movement of latch release cable 185 but not sufficient to allow passage of latch release cable head 175. Movement of latch release cable 185 actuates the lock which in turn locks the door.

Another embodiment is shown in FIG. 10 wherein release of the door latch mechanism 425 does not automatically release the lock 270. This embodiment is seen on certain types of automobile doors and the attachment to automatically release both the lock 270 and the separate door latch mechanism 425 is added for the sake of completeness. Pivot bar 350, made of hardened steel, is pivoted around a pivot bar pin 375 and is rigidly attached to structural members on the movable door member 1.

In the operation of opening the movable door member 1, latch release cable 180 has a tensile load applied which is transmitted to pivot bar 490 through latch cable washer 500 which rests on the upper surface of pivot bar 490. Latch cable washer 500 is rigidly attached to latch release cable 180 which extends through pivot bar 490 within pivot bar latch cable hole 495 of sufficient diameter to allow passage of latch release cable 180 but not of large enough diameter to allow passage of latch cable washer 500.

Movement of pivot bar 490 causes a tension induced movement on door latch cable 410 which is connected to pivot bar 490 by door latch washer 405 resting on the upper surface of pivot bar 490. Pivot bar door latch cable hole 407 is of sufficient diameter to allow passage of door latch cable 410 but not large enough to allow passage of door latch washer 405. Door latch cable 410 is encased in a stationary door latch cable housing 420 which is attached rigidly to movable door member 1 through door latch cable housing head 415. Movement of door latch cable 410 causes unlatching of door latch mechanism 425.

In addition to the unlatching process, pivot bar 490 also moves against a helical lock spring 505 wrapped around lock 270, in contact with the upper surface of pivot bar 490 on one side and with upper lock washer 510 on the other side. Upper lock washer 510 is rigidly attached to lock 270 and is of diameter in excess of diameter of lock spring 505. Compressive loads are transmitted from upper surface of pivot bar 490 through helical lock spring 505 to upper lock washer 510 and finally to lock 270 causing a movement in an upward direction to unlock movable door member 1.

In a closing operation movable door member 1 closes automatically latching door latch mechanism 425. Locking cable 235 compresses with respect to stationary locking cable housing 245 attached rigidly to movable door member 1 by locking cable housing attachment 265. Movement of locking cable 235 forces pivot bar 490 to rotate about pivot bar pin 515. Force is applied to pivot bar 490 through lock cable washer 520 which is sufficient in diameter not to pass through pivot bar lock cable hole 525. Movement of pivot bar 490 forces the lower surface to come in contact with lower lock washer 530 attached rigidly to lock 270. Movement of lower lock washer 530 causes lock 270 to move in a downward direction, thereby completing the locking cycle.

A further embodiment provides for a movable door actuator housing 40 within movable door member 1. Such an embodiment may be necessitated by the need associated with a

particular door opening mechanism. Internal operation and activation within door actuator housing is similar in nature to the base invention and will not be discussed for the sake of brevity, however, the latching and locking process, which covers the embodiment are described in detail.

Door actuator housing 40 is attached to movable door member 1 by two slot bolts 430, which extend through door actuator housing 40 and are rigidly attached to movable door member 1. Slot bolts 430 have a smaller diameter than the width of elongated opening 320, thereby allowing linear translation of door actuator housing 40. Upon actuation of the opening cycle, actuator motor 25 which is now attached to adjacent vertical surface 57, forces clevis 170 against stationary chassis 5. Actuator housing 40 moves with respect to slot bolts 430 causing a compression of latch actuator spring 435. Latch actuator spring 435 is coiled within latch tube 440.

Compressive forces of latch actuator spring 435 are transmitted to latch plate 445 which allows linear movement of latch tube 440 with respect to latch bolt 450. Latch bolt 450 is rigidly attached to movable door member 1 on one end and allows movement of latch tube 440 by two latch slots 455 milled into the upper and lower surface of latch tube 440. Movement of latch tube 440 causes latch release cable 180 to compressively stress latching mechanism 425 by causing latch release cable 180 to move with respect to stationary cable housing 185 which is rigidly attached to latch tube end plate 460. Latch deactivation spring 465 coiled within latch tube 440 and in contact with latch plate 445 on one end and latch tube end plate 460 on the other end, forces door actuator housing 40 to a non-stressed position.

In a locking operation, door actuator housing 40 translates in the opposite direction leading to compressive spring stresses of latch deactivation spring 465 on latch plate 445. Locking pin bar 475, attached to latch tube 440 by lock rigid pin 470 pulls locking cable 235 with respect to stationary locking cable housing 245 which in turn is rigidly attached to latch bolt 450. Operation of this action pulls lock 270 to a closed position, thereby automatically locking the door.

A further embodiment is shown in FIGS. 12 and 13 wherein lower track 315 is utilized to permit unlocking of movable door member 1 by a separate and distinct mechanism not related to the unlatching procedure. Lock plate 540 is free to translate in lower track 315 of door actuator 40. In the locking operation, lock bar 545, rigidly connected to chain drive 125 is translated, and acting in response to chain drive 125 motion, contacts lock trip plate 550. Lock trip plate 550 being rigidly attached to lock plate 540 forces movement of lock plate 540 within lower track 315. Lock cable 555 is attached through stationary lock cable housing 560 to lock trip plate 550. Stationary lock cable housing 560 is rigidly connected to mounting bracket 565 which in turn is attached in rigid fashion to the base of lower track 315. Movement of lock plate 540, and in turn lock trip plate 550 causes tension loading on lock cable 555 which in turn is connected to lock 270 and causes lock 270 to be forced into a lock position.

In the unlocking mode of operation, chain drive 125 moves in the opposite direction thereby causing lock bar 545 to contact trip arm 570 which is constructed of one or two metal plates rigidly attached so that adjacent edges form a right angle wherein a trip arm pin 575 extends through trip arm 570 and is connected to lock plate 540. Trip arm pin 575 allows rotation of trip arm 570 with respect to lock plate 540. Contact with, and subsequent motion of trip arm 570 causes lock plate 540 to translate with respect to the base of door actuator 40. Trip arm 570 comes in rolling contact with lock rollers 585 and moves with rolling contact along contact roller trip arm surface 580. Lock rollers 585 are free to rotate, however, are fixed in location with respect to the base of door actuator 40 by lock roller bolts 590 which are rigidly attached to base of door actuator 40. Motion of lock plate 540 is possible in this mode of operation because of a lock plate slot 595 whose width is large enough to allow passage of lock roller bolts 590 but smaller in width than diameter of lock rollers 585.

Unlock cable 600 attached to lock plate 540 through unlock cable stationary housing 605 and unlock cable head end 610 which is rigidly attached to lock plate 540, is compressed, thereby forcing locking mechanism on moveable door section 1 to move and be forced to an unlock position.

Upon completion of the unlocking procedure trip arm 570 is no longer in contact with lock rollers 585 and freely rotates out of the way of contact with lock bar 545, thereby allowing free movement of chain drive 125 and further allowing manual operation of locking mechanism if the operator desires such.

What is claimed is:

1. A door actuator device to operate the locking and latching mechanisms of a door and to open and close the door by respectively rotating the moveable section of the door free from, and into engagement with a stationary post comprising:

a. motor means,

b. drive means actuated by said motor means said drive means being movable (1) in a first direction forcing an opening rotational movement of said door section, and (2) in a second direction forcing a closing rotational movement of said door section,

c. latch means responsive to the initial actuation from a initial position of said drive means by said motor means for operating said locking and said latching mechanisms to unlock and unlatch said moveable door section prior to said moveable door section having imparted thereto a rotational velocity, and

d. locking means driven by said drive means in response to said second direction movement of said drive means for operating said locking mechanism to lock said moveable door section upon engagement of said moveable door section with said stationary post.

2. The door actuator device of claim 1 wherein said drive means includes a drive plate rigidly coupled to a chain drive means, said drive plate in contact with said latch means to sequentially actuate said latch means, to contact and linearly translate said locking means, to return to said initial position upon completion of a cycle.

3. The door actuator device of claim 2 wherein said latch means comprises a spring loaded cylindrical rod moving in linear translation responsive to the movement of said drive plate, and in contact with said stationary post of said door.

4. The door actuator device of claim 3 wherein said spring loaded cylindrical rod includes a flexible actuator coupling cylindrical in nature attached in a rigid manner to allow said door actuator device to rotate through an opening cycle.

5. The door actuator device of claim 3 wherein the latch means includes a spring actuated rod with a moveable cable capable of movement with respect to said door actuator causing a release of said locking and said latching mechanisms.

6. The door actuator device of claim 1 wherein said locking means includes moveable head means coupled to said locking mechanism, said drive means contacting and moving said moveable head until a lock position of said locking mechanism is attained, means for thereafter returning said drive means to an initial position thereby allowing free translation of said moveable head and said locking mechanism allowing manual operation of said locking mechanism.

7. The door actuator device of claim 6 wherein said drive means is moved by a resilient and spring means to said initial position upon actuation of said locking mechanism.

8. The door actuator device of claim 6 wherein said moveable head means includes a forcing rod rigidly attached to a moveable plate, said forcing rod moving responsively upon contact pressure between said forcing rod and said drive means.

9. The door actuator device of claim 8 wherein said moveable head means is responsively driven by said chain drive plate in linear translation within a locking means track machined into the base of said door actuator device, thereby allowing said moveable head motion with one degree of freedom.

10. The door actuator device of claim 6 wherein said locking means has rigidly coupled to it a locking cable passing through a stationary locking cable housing attached to said moveable section of said door, wherein motion of said locking means being driven by said chain drive plate causes stress to be exerted on said locking mechanism thereby actuating said locking mechanism.

11. A door actuator device to operate the locking and latching mechanisms of a door and to open and close the door by respectively rotating the moveable section of the door free from, and into engagement with a stationary post comprising:

- a. D. C. operated permanent magnet, self excited motor means,
- b. remote actuation means to operate said motor means from varying locations,
- c. means for reducing the rotational velocity of said motor means and increase the applied load said actuator device imparts to said stationary post to provide sufficient force to respectively rotate the moveable section of the door free from, and into engagement with said stationary post,
- d. engaging and disengaging means actuated by the rotational velocity of said motor means allowing free rotation of said motor means without any load applied through said actuator device when said door is operated manually, further applying a forcing load to be transmitted through said actuator device to said door when said actuator device is actuated by said motor means,
- e. flexible coupling means actuated by said motor means, connected rigidly to said motor means on one end and further connected to said engaging and disengaging means on the opposing end,
- f. drive means actuated by said motor means for opening and closing said moveable door section by forcing a rotational velocity to be imparted to said moveable door section,
- g. latch means responsive to the initial actuation from an initial position of said drive means by said motor means for operating said locking and said latching mechanisms to unlock and unlatch said moveable door section prior to said moveable door section having imparted thereto a rotational velocity, and
- h. locking means responsive to said drive means for operating said locking mechanism to lock said moveable door section upon engagement of said moveable door section with said stationary post.

12. The door actuator device of claim 11 wherein the remote actuation means includes electrical wiring connected to said motor, traversing to a remote location, terminating in a switchbox with corresponding means to allow operation of said motor from said remote location.

13. The door actuator device of claim 11 wherein said means for reducing the rotational velocity of said motor means include a set of bevel gears to allow a change in the rotational plane through an angle of ninety degrees, a spur gear rigidly attached to one of said bevel gears, contacting a second spur gear to force actuation of said driving means responsively as a function of said engaging and disengaging means directly couples to said bevel gears.

14. The door actuator device of claim 11 wherein said locking means comprise a contact roller rigidly connected to said drive means to contact a moveable plate flexibly coupled to the base of said actuator device wherein said moveable plate freely translates in one degree freedom of motion responsive to the motion of said contact roller.

15. The door actuator device of claim 14 wherein said moveable plate is coupled to a locking cable passing through a stationary locking cable housing rigidly attached to said moveable door member, wherein translation of said moveable plate causes movement of said locking cable attached in rigid manner to said locking mechanism, whereby said locking mechanism is forced into a closed position.

16. The door actuator device of claim 11 wherein said locking means actuates said locking and latching mechanisms

within said door through a pivot means free to rotate about an axis through said pivot means.

17. The door actuator device of claim 11 wherein said pivot means include a pivot bar pinned through an axis of rotation to said moveable door member, wherein said pivot bar is attached at one end to said latching cable, and movement of said latching cable forces rotation of said pivot bar around the axis of rotation causing contact and relative movement at different points of said pivot bar between said pivot bar and said locking mechanism as well as between said pivot bar and said latching mechanism, to cause sequential opening respectively of said locking mechanism and said latching mechanism.

18. The door actuator device of claim 17 wherein said locking mechanism is actuated by movement of a locking cable connected to said pivot bar, whereby movement of said locking cable imparts a rotative force to said pivot bar causing contact between said pivot bar and said locking mechanism, whereby said locking mechanism is linearly translated to affect a locking of said door.

19. The door actuator device of claim 11 wherein latch means and lock means of said device are actuated responsively to the drive means wherein said device is moved in linear translation by said motor means.

20. The door actuator device of claim 19 wherein means for unlocking and unlatching said door are actuated by movement of said device compressing a spring encased within metal tubing whereby said spring applies force to a screw rigidly attached to said door and further extending laterally through said metal tubing, being free to translate with respect to said metal tubing through a slot machined into opposing surfaces of said metal tubing, whereby said latching cable is provided motion due to relative movement between said metal tubing and said screw.

21. The door actuator device of claim 20 wherein means for locking said door is actuated by a locking cable attached rigidly to said metal tube whereby a stationary locking cable housing is rigidly attached to said screw, and said locking cable is rigidly attached to said metal tube on one end and said locking mechanism on the opposing end, movement of said metal tubing with respect to said door imparts motion respectively to said locking cable and said locking mechanism, thereby forcing said door to a lock position.

22. A door actuator device to operate the locking and latching mechanisms of a door and to open and close said door by respectively rotating a moveable section of said door free from, and into engagement with a stationary post comprising

- a. drive means having a drive member moveable (1) in a first direction forcing an opening rotational movement of said door section and (2) in a second direction forcing a closing rotational movement of said door section,
- b. latch means for operating and releasing said locking and said latching mechanisms prior to said moveable door section having said rotational movement imparted thereto, and
- c. locking means driven by said drive means in response to said second direction movement of said drive member for operating said locking mechanism to lock said door.

23. The device as recited in claim 22 wherein said locking means is moved in said second direction for locking said door.

24. The device as recited in claim 23 wherein said drive member is moveable (1) through a first predetermined displacement in said first direction, and (2) through a second predetermined displacement in said second direction.

25. The device as recited in claim 24 wherein said second displacement is greater than said first displacement.

26. The device as recited in claim 25 wherein said drive member engages said locking means when said drive member moves in said second direction.

27. The device as recited in claim 26 wherein said drive member engages said locking means through only a portion of said second displacement.

28. The device as recited in claim 26 wherein said drive member engages said locking means only during a termination phase of said second displacement.

29. The device as recited in claim 27 wherein said locking means driven in said second direction is linearly translated.

30. The device as recited in claim 26 including means for disengaging said locking means from said drive member after said door is locked.

31. The device as recited in claim 30 wherein said disengaging means provides freedom of movement of said locking means in said first direction.

32. The device as recited in claim 30 wherein said disengaging means moves said drive member in said first direction.

33. The device as recited in claim 22 wherein said drive means includes a moveable member rigidly secured to said stationary post, said drive member being resiliently connected to said moveable member.

34. The device as recited in claim 33 wherein said latch means is coupled to said moveable member for releasing said locking and latching mechanisms when said moveable member moves from an initial position in said first direction.

35. The device as recited in claim 34 wherein said moveable member is linearly moveable in a first direction only when said drive member moves from said initial position in said first direction through a distance sufficient to provide a resilient force providing an opening rotational movement of said door section.

36. A door actuator device to operate the locking and latching mechanisms of a door and to open and close the door by respectively rotating the moveable section of the door free from, and into engagement with a stationary post comprising:

- a. motor means,
- b. drive means actuated by said motor means for opening and closing said moveable door section by forcing a rotational velocity to be imparted to said moveable door sec-

tion,

c. locking means responsive to said drive means for operating said locking mechanism to unlock said moveable door section before release of said moveable door section from said stationary post,

d. latch means responsive to actuation from an initial position of said drive means by said motor means for operating said latching mechanism to unlatch said moveable door section prior to said moveable door section having imparted thereto a rotational velocity,

e. means responsive to said drive means for operating said locking mechanism to lock said moveable door section upon engagement of said moveable door section with said stationary post, and

f. a drive plate responsively driven by said driving means in linear translation within a locking means track machined into the base of said door actuator device.

37. The door actuator device of claim 36 wherein said drive plate comprises, a lock trip plate contacted by said driving means to translate said drive plate in a first direction, a locking cable connected to said drive plate to actuate said locking means into a lock position, a trip arm contacted by said driving means to translate said drive plate in a motion opposite to said first direction, an unlocking cable connected in rigid fashion to said drive plate to operate said locking means to unlock said locking mechanism, and a set of rollers contacted by said trip arm to allow relative motion of said drive plate and trip arm relative to said rollers, to allow return of said driving means to said initial position and manual control of said locking mechanism.

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