April 21, 1964 M. CARLSON 3,129,936

AUTOMATIC DOOR OPERATOR

Filed Dec. 23, 1960 4 Sheets-Sheet 1

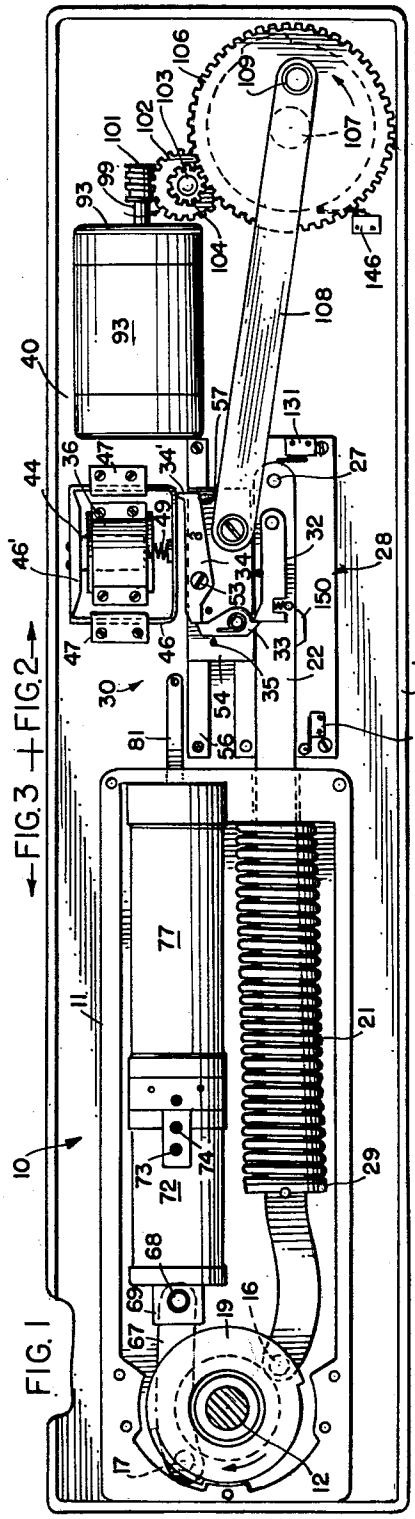

FIG. 1

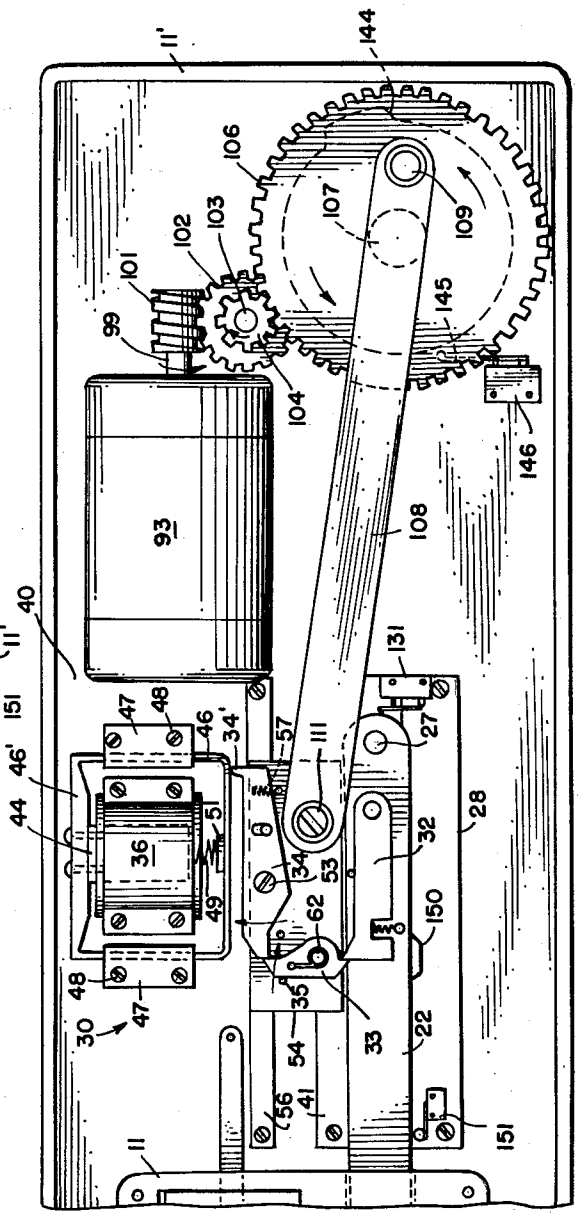

FIG. 2

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AUTOMATIC DOOR OPERATOR

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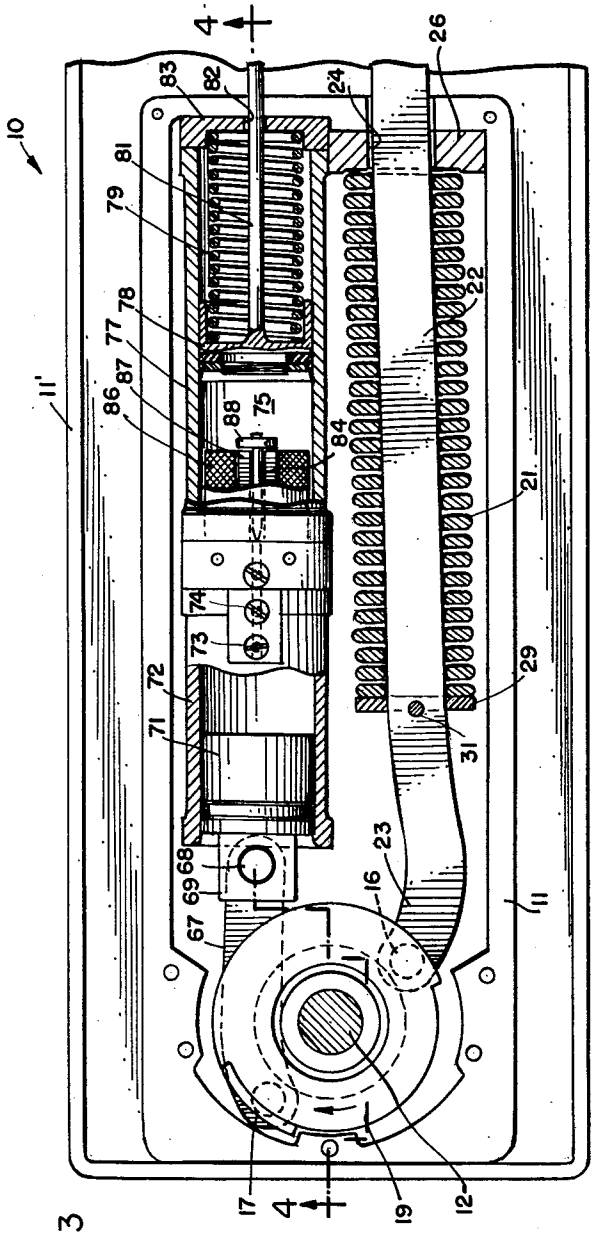

FIG. 3

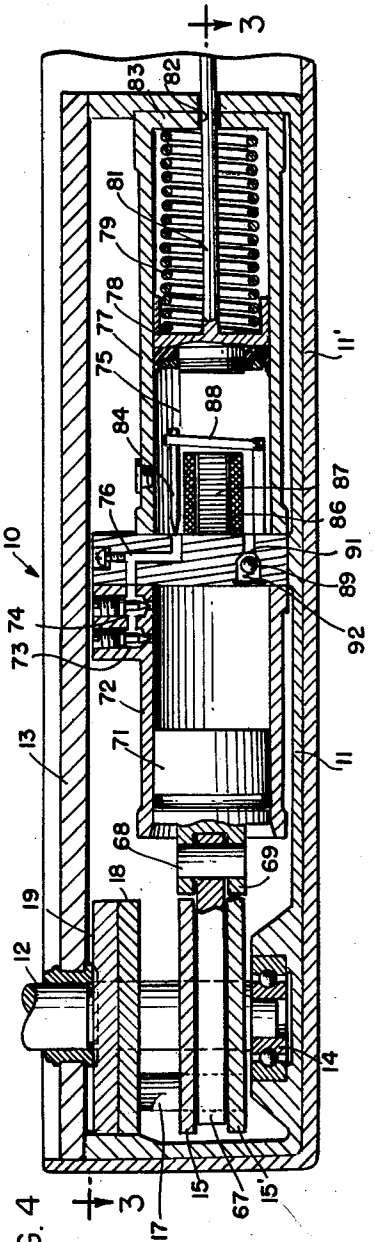

FIG. 4

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AUTOMATIC DOOR OPERATOR

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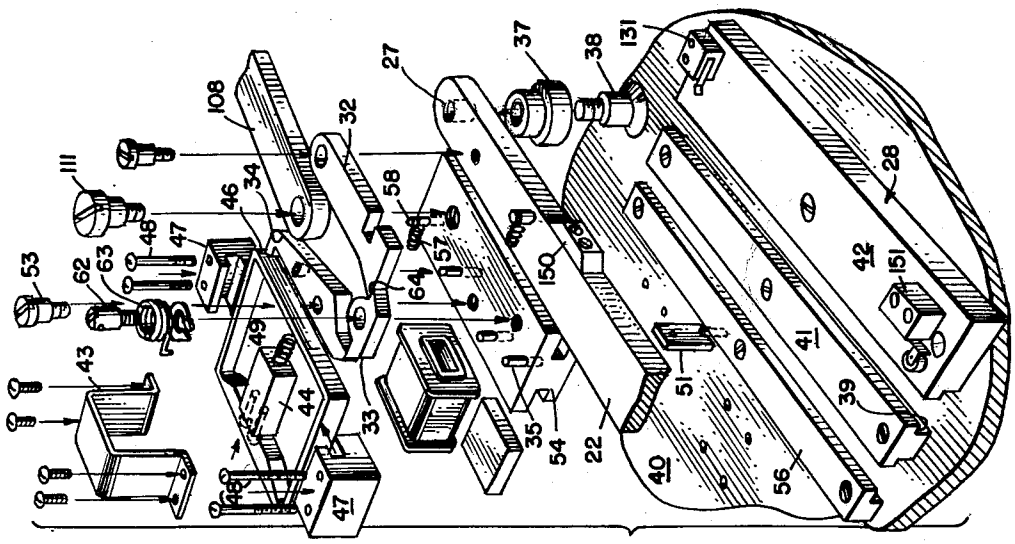

FIG. 6

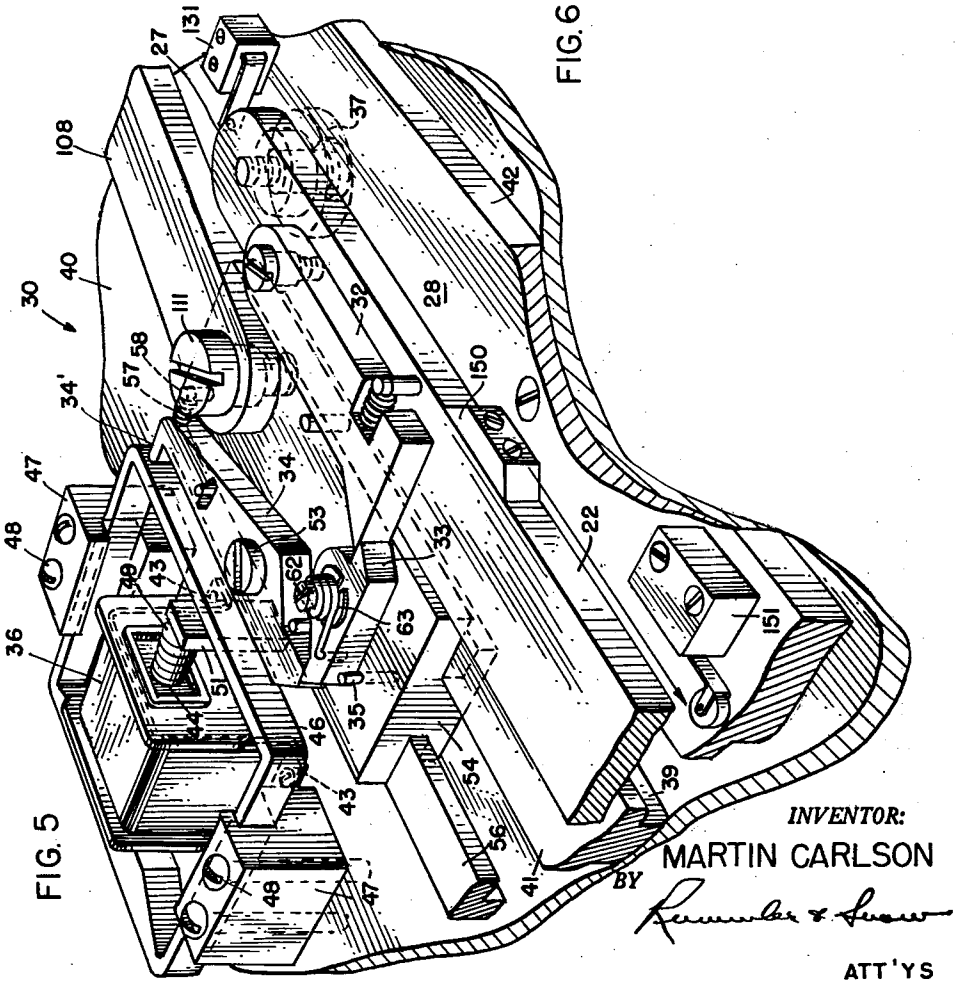

FIG. 5

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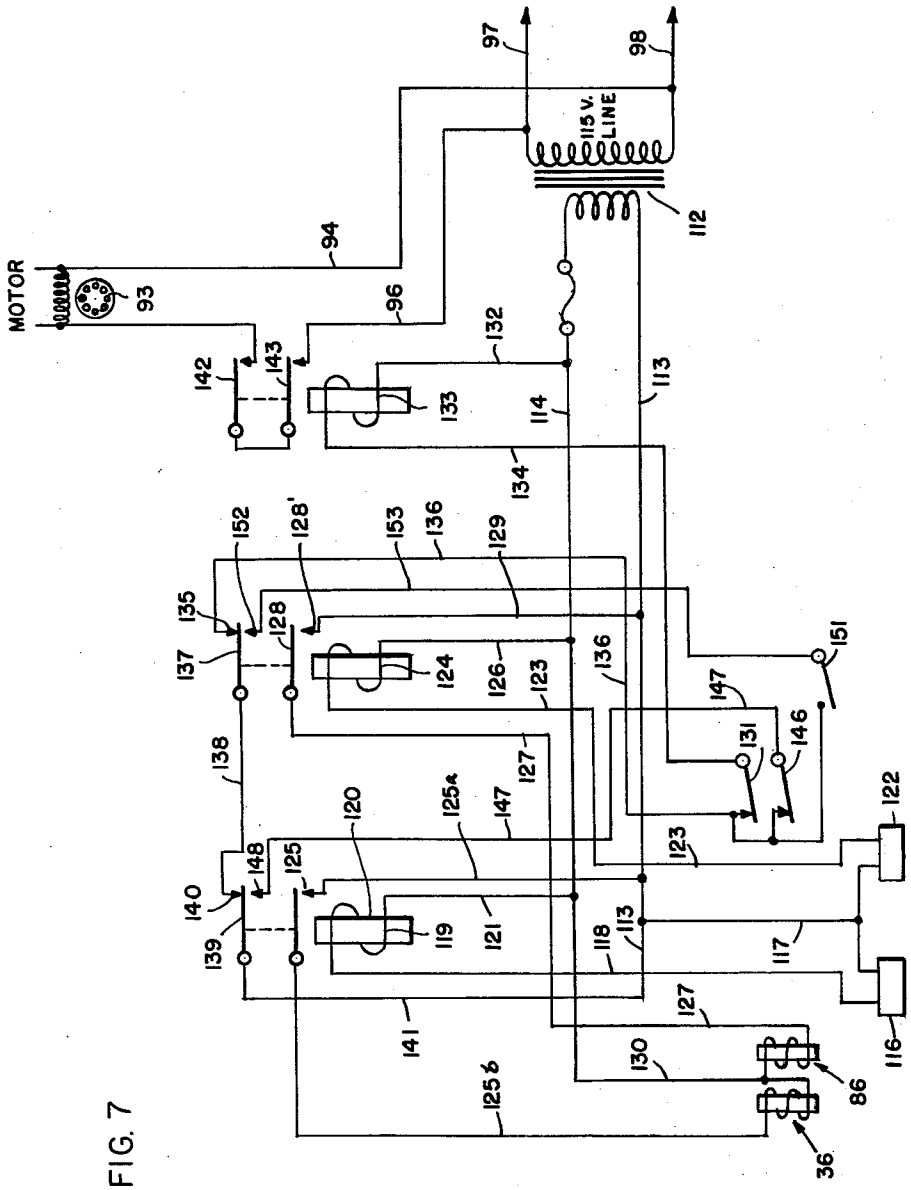

FIG. 7

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Patented Apr. 21, 1964

3,129,936

AUTOMATIC DOOR OPERATOR

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Filed Dec. 23, 1960, Ser. No. 78,086
10 Claims. (Cl. 268—34)

This invention relates to power actuated door operators and particularly to such devices which are adapted for concealed installation as in the floor below the door or in the head frame above the door.

The main objects of this invention are to provide an improved automatic door operator; to provide a device which is wholly self-contained requiring only an electrical connection for its installation; to provide a device which is hydraulically controlled by wholly self-contained means; to provide a device having an improved hydraulic speed controlled unit; and to provide an improved operator wherein the power applied to the door during the door opening cycle is at a continuous and constantly diminishing rate during the entire movement of the door to its fully opened position.

Other principal objects of this invention are to provide an automatic door operator having structure for storing energy to drive the door during its opening cycle; to provide a door operator wherein the driving power from an external source is employed only during the door closing cycle; to provide a device wherein the opening movement of the door can be stopped at any point of the opening cycle; to provide a device wherein the closing movement can be instantly reversed at any point in the closing cycle; and to provide a device that is subject to full and automatic control of the door at any time during both opening and closing cycles by means of the conventional pedestrian actuated door operating control structure.

Other objects and important features of the invention will be apparent from a study of the specification following taken with the drawings, which together describe and illustrate a preferred embodiment of the invention and what is now considered to be the best mode of practicing the principles thereof. Other embodiments may be suggested to those having the benefit of the teachings herein, and such other embodiments are intended to be reserved especially as they fall within the scope and spirit of the subjoined claims.

In the drawings:

FIG. 1 is a plan view of an automatic door operator constructed in accordance with the present invention;

FIG. 2 is an enlarged elevational view of that portion of the door operator seen to the right of the arrow labeled FIG. 2 in FIG. 1;

FIG. 3 is an enlarged elevational view of that portion of the operator seen to the left of the arrow marked FIG. 3 in FIG. 1;

FIG. 4 is a longitudinal sectional view taken along the line 4—4 of FIG. 3, looking in the direction of the arrows, certain parts being shown in elevation;

FIG. 5 is a perspective view of a release and latching mechanism for controlling the operation of the door operator seen in FIGS. 1 to 3 inclusive;

FIG. 6 is an exploded perspective view of parts of the structure seen in FIG. 5; and

FIG. 7 is a circuit diagram showing an electrical circuit for controlling the door operator according to the present invention.

Referring now to the drawings, the improved door operator according to the present invention is embodied in a door operator of the floor hinge type and referred to generally by the reference numeral **10**. The operator mechanism **10** is enclosed within a housing **11** of more or less conventional form and arranged to support a

drive spindle **12** which extends vertically through a cover plate **13** and supports a door, not shown. The spindle **12** is stepped in a suitable thrust bearing **14** mounted on the bottom of the housing **11**, and the spindle **12** supports a pair of vertically spaced crank plates **15** and **15'**, crank pins **16** and **17** being supported on the spaced crank plates **15** and **15'**. As seen in FIG. 3, the crank pins **16** and **17** are disposed substantially 180° apart with reference to the axis of the spindle **12**.

The crank plates **15** and **15'** are freely rotatable upon the spindle **12** and are drivably connected to the spindle **12** by means of drive plates **18** and **19**. Drive plate **18** is directly connected to the crank pins **16** and **17**, and a break-away connection is provided between the drive plates **18** and **19** by break-away pins, not shown. The drive arrangement thus far described for the spindle **12** is no part of the present invention, but is fully disclosed in Martin Carlson Patent No. 2,869,861, and in Carlson applications Serial No. 863,213, filed December 31, 1959, now Patent No. 3,064,964, and Serial No. 69,369, filed November 15, 1960, now Patent No. 3,119,310, and for that reason will not be described in further detail.

Structure is provided for turning the spindle **12** and opening the door mounted thereon upon actuation of a circuit as seen in detail in FIG. 7. The turning of the spindle **12** is accomplished by a loaded compression spring **21** which releases its energy in the door opening operation. The spring **21** is guided upon a rod **22** having an end **23** thereof pivotally connected to the pin **16**. The rod **22** is guided in a slot **24** of a wall **26** within the housing **11**. The end of the rod **22** remote from its connection to the crank pins **16** has a pivoting and sliding connection **27** to a fixed guide **28**. The spring **21** is normally constrained between a washer **29** held by a pin **31** to the rod **22** and the wall **26**, to provide power for opening the door when the constraint thereon is removed.

The spring **21** is maintained in its constrained position as seen in FIG. 1 by a latching mechanism indicated generally by the reference numeral **30**, and comprising a latching finger **32** cooperating with a latching finger release **33** which is released by a locking lever **34** operated by a solenoid **36**.

Structure is provided for enabling the spindle **12** to have rotative movement corresponding to a door opening operation, and to this end the energy stored within the constrained spring **21** is operable to drive the plate **19** and the spindle **12** in a clockwise direction as seen in FIGS. 1 and 3, the guide rod **22** having a translative movement during the extending movement of the spring **21**. The rod **22** is accordingly pivoted at **27** to a generally cylindrical slide member **37** held to the rod **22** by a counter sunk screw **38**. The slide member **37** is arranged to be guided in a slide way **39** formed by spaced guideways **41** and **42** of the guide **28**, see particularly FIG. 6.

The structure for releasing the energy in the spring **21** to turn the spindle **12** in a door operating cycle includes the solenoid **36** which is secured by a fastening bracket **43** to the bottom plate **40** of the main unit housing **11'**. Solenoid **36** has an armature **44** therein which is directly connected with a yoke **46** slidably guided in spaced slide blocks **47** secured by screws **48** to the plate **40**. A spring **49** is connected between a fixed bracket **51**, extending from the plate **40**, and the armature **44** of the solenoid **36**. Preferably the yoke **46** is made with an iron cross piece **46'**, at its end opposite the spring **49**, and the remainder of the yoke is made of brass or any other suitable non-magnetic material. Also the yoke is made so that the side opposite the cross bar **46'** will be of substantial length for the purpose that will hereafter appear.

As shown, the armature 44 drives the yoke 46 against the force of the spring 49 and the yoke is in constant engagement with the locking lever 34. Thus, when the solenoid 36 is energized the yoke 46 is moved toward the locking lever 34 to rock the same about a pivot 53 tapped into a slide 54 guided between a slideway 56 and the slideway 41. Locking lever 34 is biased toward the yoke 46 by a spring 57 held between one end of the locking lever 34 and a pin 58 extending from slide 54, as shown in FIG. 5.

The locking lever 34 is disposed so that its end, to the left of the pivot 53, is engaged with the latching release lever 33 to prevent its movement under the force of the latch lever 32. Thus, upon energization of solenoid 36, the yoke 46 swings the locking lever 34 clockwise out of contact with the latching finger release 33 and allows it to rock clockwise, as seen in FIGS. 1, 2 and 5. This rocking movement of latching lever 34 and latching finger release 33 is indicated by the long arrows in FIG. 2. Latching finger release 33 is mounted on a pin 62 tapped into the slide block 54 and is biased in a clockwise direction by means of a torsion spring 63 supported on pin 62. Thus, when the locking lever 34 is rocked in a clockwise direction to release the latching finger release 33, the release lever 33 rocks out of engagement with the latching finger 32 to enable the rod 22 and its slide block 37 to move to the left under the stored-up power in the main operator spring 21.

As the rod 22 is driven by the main spring 21, the spindle 12 will be turned in a clockwise direction to effect a door opening cycle.

Structure is provided for controlling the rate at which the spring 21 performs the door opening cycle, and to this end a connecting rod 67 is connected to the crank pin 17, and in turn to a pin 68 passing through a clevis 69 extending from a piston 71. A cylinder 72 guides the piston 71, and a plurality of adjustable bleed ports 73 and 74, located in passageway 76 between an oil receiving chamber 75 of a cylinder 77 and the cylinder 72, control the rate of movement of fluid swept from cylinder 72 by piston 71 and hence the speed of travel of the piston 71 and the rate of rotation of the spindle 12. A piston 78 moves in cylinder 77, and a spring 79 guided upon a piston rod 81 imposes a small amount of pressure upon the oil swept from the cylinder 72 when the piston 71 moves to the right as seen in FIG. 4. Piston rod 81 is guided in an opening 82 in an end wall 83 of the cylinder 77.

Movement of the fluid from the chamber 75 of cylinder 77 to the cylinder 72, and hence movement of the piston 71, may be prevented by a needle valve 84 adapted to seat on the passageway 76, whenever, through control means hereafter to be described, it is necessary to stop the swing of the door in its opening operation. The needle valve 84 is normally unseated from the passageway 76 and is actuated to close the passageway by a solenoid 86 having an iron core 87 adapted to magnetically actuate a clapper 88 in turn supporting the needle valve 84. However, movement of fluid from the chamber 75 to the cylinder 72 during return movement is unimpeded by a check valve 89 normally seated across a passageway 91 between the cylinder 72 and the chamber 75, the check valve 89 being biased lightly to closed position by a spring 92. Check valve 89 is seated during the opening movement so that all fluid flow is past bleed ports 73 and 74 and needle valve 84.

Structure is provided to power the spindle 12 in a counterclockwise direction to close the door after the opening operation and to reload the spring 21, so that the energy stored therein can be released for a subsequent door opening operation. To this end the main housing 11' encloses a motor 93 connected across a pair of power leads 94 and 96, connected respectively to supply leads 97 and 98, see FIG. 7.

Motor 93 drives a shaft 99 having a worm 101 fast thereon which meshes with a worm gear 102 turning on a

shaft 103. Worm gear 102 turns with a pinion 104 meshing with a crank gear 106 turning on a stub shaft 107 supported in the bottom of the housing 11'. The crank gear 107 drives a connecting rod 108 which is connected to the gear 106 by a crank pin 109. The connected rod 108 is pivotedly connected to the slide block 54 by means of a slotted head screw 111, see also FIG. 6, tapped thereinto. Rotation of the gear 106 by the motor 93 will, through the connecting rod 108, cause a reciprocation of the slide block 54 forwardly and then rearwardly to pick up and return the spindle actuating drive shaft 22, as will be later described.

The operation of the door is achieved by a control circuit best shown in FIG. 7. The power leads 97, 98 have a step-down transformer 112 connected thereacross to furnish a control circuit voltage preferably of the order of 24 volts across a pair of control circuit main leads 113 and 114.

The opening cycle of the door is initiated by an actuating mat 116 which is connected in a circuit including a lead 117 branching from the main lead 113, the actuating mat 116, a lead 118 to a winding 119 of an actuating mat relay 120, a lead 121 from winding 119 and thence to the other power lead 114. Energization of the winding 119, as by a person stepping on the actuating mat 116, closes contact 125 which in turn closes a circuit through the release solenoid 36 for the main driving arm 22, the circuit including a lead 125*a* branching from power lead 113, contacts 125, a lead 125*b*, solenoid 36 and thence to the other main lead 114 by a lead 130. When solenoid 36 is energized the yoke 46 will move to rock the latching device 34, so as to release the latch release lever 33 which will then swing clockwise, as shown in FIG. 5, under the force of the latch lever 32 as it is urged forwardly, to the left, by the main driving arm 22. The driving arm 22 is then free to move, under the force of the spindle driving spring 21, to turn the spindle 12 and thereby swing the door to its opened position.

As the driving arm 22 moves forwardly, to open the door, its rearward end is guided between the slideways 41 and 42, seen more clearly in FIG. 6, to transport the latch lever 32 to a forward position and normally this movement is unimpeded since the solenoid 86 is not energized and the needle valve 84 is unseated so that the fluid in the cylinder 72, ahead of the crank actuated piston 71, is able to move past the speed control ports 73 and 74 and into the reservoir chamber 75 in the cylinder 77. As shown, the driving arm 22 carries a cam 150 disposed to engage a normally open micro-switch 151 to close it when the arm 22 reaches its limit of forward movement. The function of the switch 151 will be explained in connection with the safety control means.

At the conclusion of the normal operating cycle, that is, when the door has reached its full opened position, and the pedestrian has passed through, beyond the safety mat 122, a circuit will normally become closed to energize the motor 93 for returning the door to the closed position and at the same time cocking the spring 21 for a subsequent door opening operation. This is accomplished by the movement of the rod 22 to the left which upon beginning its forward stroke, closes a switch 131 mounted on the fixed guide 28 adjacent the extreme rearward limit of travel of the rod 22 to the right. Switch 131 which is a normally closed micro-switch opened by engagement of rod 22 therewith, is connected in a circuit including a lead 132, branching from power lead 114, a motor relay winding 133, a lead 134 from the winding 133 to the switch 131, lead 136, normally closed contacts 135 and 137 of the safety mat relay 134 (which is not de-energized), lead 138 to the closed contacts 139 and 140 of actuating mat relay 119 (which is also now de-energized), and a lead 141 connected to the other power lead 113.

When motor relay 133 is energized, a pair of contacts

142, 143 are closed to complete a circuit through the lead 96 to the motor 93. The motor 93 then turns in a direction to drive the gear 106 in a clockwise direction to move the slide block 54 initially to the left in its stroke as seen in FIG. 2.

Prior to the movement of the slide block 54 to the left, and upon the de-energization of solenoid 36, the latch finger release 33 will be maintained in the position seen in FIG. 1 by the locking lever 34 which is biased in a counter clockwise direction by the spring 57. The counter clockwise movement of the latch 33 by the spring 62 will be limited by the pin 35 extending from the slide 54.

As the crank pin 109 has turned past center from the position seen in FIGS. 1 and 2, the slide 54 will start its movement to the right and as it reaches the end of its forward stroke, the latch finger release 33 thereon will override the latch finger 32 and engage behind it to pull the rod 22 to the right, the motor continuing in its operation until the rod 22 operates the normally closed switch 131 to open it at which time the motor relay 133 will be de-energized and the motor 93 stopped. The rearward movement of the rod 22 causes the spindle crank assembly and the spindle to rotate in the counterclockwise direction and to swing the door to its closed position. During this closing operation the speed control piston 71 is withdrawn in the cylinder 72 and the hydraulic control fluid is transferred from the reservoir cylinder 75 to the cylinder 72 by the combined action of suction by the piston 71 and pressure from the piston 78 under the power of the spring 79. The fluid in the cylinder 77 is free to return to cylinder 72 past the check valve 89 during such return movement of the door.

The mechanism is now back in position for the resumption of a conventional door opening and closing operation.

The operation just described is for a normal door opening cycle, but if anyone is in a position of danger by reason of the door opening, the operating cycle is not initiated. As a corollary, if the user remains in a position, after going through the door opening, where the door can swing against the user in its return cycle, such return cycle is prevented. As a further corollary, if the door opening cycle is initiated and a person moves into a position of danger after the start of the cycle, the opening of the door is immediately ceased, and no movement thereof will take place until the person moves out of position. Still further, if a person moves into such position at the conclusion of the door opening cycle, and the door closing cycle commences, the door movement will immediately stop until the danger position is left. Also, in the event that a person steps on the actuating mat while the door is moving from opened to closed position, the pull-back or closing mechanism will be immediately released and the door will return to its opened position thus obviating any possibility of the door closing in the face of an on-coming person.

To the foregoing ends, a safety mat 122 is provided in the area over which the door swings in its opening movement, and is operable to prevent operation of the door in either direction if anyone is standing thereon. The safety mat 122 is connected in a circuit which includes the main lead 113, branch lead 117, safety mat 122, and a lead 123 to a safety mat relay 124, the circuit being completed to main lead 114 by a lead 126.

Operation of the safety mat relay 124, by a person stepping or standing on the safety mat 122 so as to close the circuit therethrough, opens the normally closed contacts 135—137, and de-energizes the lead 136 to the switch 131 which controls the relay 133 for the door closing motor 93. Simultaneously, the relay 124 closes contacts 137—152 and energizes lead 153 which connects with the normally open switch 151 and thence to the switch 131 on the same side as the lead 136. If the door is closed no motor operation can take place because the switch 131 will be opened by engagement of the rod 22 therewith, as shown in FIGS. 1 and 2. However, if the door is fully opened so that the switch 131 is closed by its own spring closing action and the switch 151 is closed by the engagement therewith of the cam 150 on the operating arm 22, the energizing of the lead 153 will actuate the motor relay 133 and the motor 93 will drive the gear 106 until the gear has turned a sufficient distance to pull the arm 22 rearwardly to disengage the cam 150 from the switch 151 and allow it to open, whereupon the motor relay 133 will be de-energized and the motor stopped. This will result in but a small movement of about 10 degrees, or less, in the swing of the door toward closed position and there will be no danger to a person standing on or stepping back onto the safety mat.

The control circuit for this last mentioned safety control operation, as shown in FIG. 7, includes the power lead 113 and the lead 114, the normally closed contacts 139—140 of the actuating mat relay, the lead 138, contacts 137—152, lead 153 and switch 151, switch 131, lead 134 and the motor relay 133, and finally lead 132 to the power lead 114.

An additional function for the safety mat relay 124 is to stop the opening movement of the door whenever the safety mat is actuated so as to close the circuit through the mat. This is accomplished by a second contact arm 128 on the relay 124 adapted to engage a contact 128' having a direct connection to the power line 113 by way of lead 129. The contact arm 128 is connected by lead 127 to one side of the solenoid 86, which actuates the needle valve 84 for closing the fluid port 76 between the cylinders 72 and 75 (see FIG. 4). The other side of the solenoid 86 connects with lead 130 and thence directly to the power line 114. Thus when the safety mat is actuated during a door opening cycle the solenoid 86 is energized and actuates the needle valve 84 to shut the passageway 76 and stop the flow of fluid outwardly of the cylinder 72. This then blocks the piston 71 against inward movement in the cylinder 72 and immediately stops any further rotation of the door spindle 12 under the action of the driving spring 21. When the person or object actuating the safety mat 122 is removed the relay 124 is, of course, de-energized. This opens the circuit of the solenoid 86 and the needle valve is immediately opened by the pressure of the fluid in the passageway 76 generated by the force of the piston 71, and opening movement of the door is resumed under the action of spring 21 to complete its cycle.

It will now be seen that whenever and however the safety mat 122 is actuated, to close the circuit through it, and no matter whether the door is open or shut, or moving in either direction therebetween, the door movement is prevented or stopped until the interference is removed. Thus positive safety control for the door is had at all times.

During the normal door operation, however, safety mat relay 124 is energized for only the brief interval necessary for the user to step on and off the same in going through the door opening, and the opening and closing of the door will be a substantially continuous operation as first described.

The structure according to the present invention is also designed to re-institute a normal door opening cycle, even though the closing door has not returned to the full closed position, whenever the actuating mat 116 is tread upon and provided no one is in a position of danger by a re-opening movement of the door. Under such conditions, the motor 93 is being operated in the normal manner to turn the spindle 12 in the door closing direction by pulling on the rod 22, and at the same time loading the spring 21 for a subsequent door operating cycle. As shown in the drawings, the inner side of the yoke 46, which engages the lock lever 34, is made to have a length greater than the stroke distance of the slide block 54 and the lock lever is provided with a projecting tip 34'

at its rearward end, which is always in engagement with the yoke 46. Thus, no matter where the slide block 54 may be, in its travel back and forth, under the actuating action of the motor 93 and gear 106, operation of the yoke 46 by the solenoid 36 will depress the rear end of the lock lever 54 and render it inoperative to hold the release lever 33 in engagement with the latch arm 32. As before mentioned, the solenoid 36 is energized to actuate the yoke 46 whenever the actuating mat 116 is stepped upon to close a circuit therethrough. Thus, if the door is being closed by the motor 93 when the mat 116 is actuated the lock lever 34 is instantly moved to release the latch 32 and the spring 21 will thereupon swing the door to its full open position. The motor 93 is caused to operate, during this interruption of the normal door closing operation, to a reset position from which the door closing cycle can be re-instituted automatically as soon as both the actuating mat 116 and the safety mat 122 are clear.

To this end, a normally closed switch 146, mounted adjacent the gear 106, is provided in a circuit to the motor relay 133, which is energized by operation of the actuating mat relay 120, and the gear 106 carries a cam lobe 144 for contacting a switch arm 145, adapted to open the switch 146, when the gear 106 and connecting rod 108 are displaced 180°, from the position seen in FIG. 2. Thus if the door is in a closing cycle when the mat 116 is actuated to operate the relay 120, the motor 93 will continue to operate until the gear has turned far enough to shift the slide block 54 to the drive rod pick-up position at the forward end of its stroke at which point the cam 144 will open the switch 146 and stop the motor 93.

Ordinarily, treading upon actuating mat 116 would break the normal circuit to motor relay 133, through the switch 131, by reason of relay 120 being energized. However, the energizing of relay 120 closes contacts 139 and 148 connected in a circuit comprising main line 113, lead 141, contacts 139 and 148, lead 147, closed switch 146, closed switch 131 (which is closed by reason of rod 22 having moved to the left from the position as seen in FIG. 2), lead 134, motor relay 133 and lead 132 to the other main line 114. Contacts 142 and 143 are thus kept closed to energize motor 93 until the switch 146 is opened.

When the gear 106 reaches the position to open switch 146, and the slide block 54 is at the rod pick-up position, the mechanism and circuitry are set up to begin the door closing cycle. However, as long as either the actuating mat 116 of the safety mat 122 are in a circuit closing condition the mechanism cannot operate and the door stays in its open position. As soon as both mats are clear the motor 93 resumes its operation and, except if either mat is re-activated, the door will be closed by motor power in the normal way.

In the event that the actuating mat is actuated while the door is in its closing cycle, so that the drive rod 22 is released from the pull-block 54 to allow the door to swing back to opened position, the motor 93 will continue to operate until the gear 106 has turned to the position where its cam 144 will open the switch 146.

If a person steps on the actuating mat 116 and then steps off without continuing toward the door, the opening cycle is of course immediately initiated by actuation of the latch release solenoid 36 through the mat relay 120. The door will thus swing to its full open position and then, because the safety mat circuit is open, will begin to close as soon as the motor 93 has turned the gear 106 through one-half revolution to cause the drive rod pickup block 54 to engage the latch 32. The motor 93 will then continue to operate, to pull the door closed, until the rear end of the drive rod 22 engages the switch 131 to open it. Opening switch 131 de-energizes the motor relay 133 and the motor switch contacts 142—143 open to stop the motor.

The circuitry for this operation is first a momentary activation of actuating mat 116 to energize the relay 120 (main line 113, branch lead 117 to mat 116, lead 118 to coil 119 of relay 120, and lead 121 to main line 114). The relay 120 closes the circuit for the solenoid 36 to release the drive rod 122 (main line 113, lead 125*a*, contacts 125, lead 125*b*, solenoid 36, and lead 130 to main line 114). Simultaneously, the relay 120 closes a circuit to the motor relay 133 to start the motor 93 (lead 141 from main line 113 to contacts 139—148, lead 147, closed switch 146, switch 131, which is now closed by rod 22 moving away from it, lead 134, relay 133, and lead 132 to main line 114). As soon as the actuating is cleared the relay 120 is de-energized and the contacts 139—140 become closed so that current will then flow from lead 141 to the normally closed contacts 137—135, by way of lead 138, and thence to switch 131 by way of lead 136, so that the motor 93 will continue to operate to drive the pick-up block 54 to its pick-up position and then backwardly to pull the drive rod to its rearward door-closed position where the rod 22 opens the switch 131 and stops the motor.

In the event a person steps on the actuating mat 116 and then just stands there, the door opening cycle will be initiated in the normal manner and the door will swing to full open position. Meanwhile, since the mat relay 120 remains energized, the contacts 139—148 will remain closed to complete the circuit through lead 147 and closed switch 146, to the switch 131 controlling the motor relay 133, so that the motor 93 will run to shift the block 54 to pick-up position. At that point switch 146 will open to stop the motor and the motor will remain de-energized until the person steps off the actuating mat to allow the motor circuit and motor to function in the normal manner to close the door.

As before stated, the motor 93 is energized, simultaneously with actuation of the trip-or release solenoid 36, at the instant that a person steps upon the actuating mat 116 and continues to run to drive the gear 106 until the connecting rod 108 has shifted the slide block or driving rod pick-up means 54 to its full opened position by the cam 144 to interrupt the motor control circuit. The speed of the motor 93, and the gear drive for the gear 106, are preferably determined to turn the gear at a speed of about 10 seconds per revolution so as to leave about 5 seconds for a person, walking at an ordinary gait, to pass through the door and beyond the safety mat so that motor can run continuously from the door opening phase and then the door closing phase, the motor relay 133 being energized through the normally closed switch 131, since both mats will be clear. The door will, of course, open at a relatively fast rate and stay open until the safety mat is clear and only when a person hesitates on either of the mats, or walks too slowly, will the switches 146 and 151 function to stop the motor 93.

It will now be seen that the switches 131, 146 and 151, provide the full control of the operation of the door closing motor 93 that is necessary to accommodate all of the possible situations that might occur in the course of actual pedestrian actuated uses of my improved door operator mechanism. The function of the self-closing switch 131 is to set up the circuit to the motor relay 133 for control by the mat relays 120 and 124, at the moment that the door is released for its spring powered operation of its opening cycle. The function of the self-closing switch 146 is to stop the motor 93 when the drive rod pick-up mechanism is positioned to begin a door closing cycle and a person is still on the mat 116. And the function of self-opening switch 151 is to permit the motor 93 to run, while the door is in full open position and a person is on the safety mat, until the pick-up mechanism has reached the drive rod pick-up position and started a closing cycle at which time the switch 151 opens to stop the motor. An additional function of the switch 151 is to stop the motor 93, at any time during the door closing cycle in the event

the safety mat 122 is actuated while the door is being power driven in the closing direction.

From the description foregoing it is believed evident that there has been provided a new and useful improvement in the field of automatically operated door actuating mechanisms. The structure as disclosed herein presents a number of advantages which are believed not to be found in the prior art. A salient advantage lies in the fact that the energy storing spring is effective to give its maximum opening force at the start of the door opening cycle, this force diminishing as the door approaches the end of the opening cycle so that slamming or rocking of the door at the end of the cycle is obviated. Another feature resides in the fact that under normal conditions the motor is required to be operated only during the time that the door is moving during the closing cycle. Further advantages reside in the fact that the door will open automatically upon activation of the actuating mat, even though the motor is itself inoperative, as long as there is power to energize the control circuit; in the fact that interruption of door movement by actuation of the safety mat for any reason, stops the motor; and in the fact that continued activation of the actuating mat results in stopping the motor when the pull back mechanism reaches the condition of starting a door closing cycle.

Although but one specific embodiment of the invention has been herein shown and described it will be understood that details of the structure and control means shown may be altered or omitted without departing from the spirit of this invention as defined by the following claims.

I claim:

1. A door operating mechanism comprising a rotatable spindle adapted to support a door for swinging movement and to have a driving connection therewith, a normally tensioned spring in driving relation with said spindle and adapted to release its stored energy to turn said spindle in a door opening direction, motor means for turning said spindle in a door closing direction and loading said spring for a subsequent door opening operation, latch means for holding said spindle in door closed position against the tension of said spring, and circuit means for controlling the movement of said door in both door opening and door closing directions; said circuit means including actuating means for releasing said latch means and said spring for door opening operation, means for operating said actuating means, and means for preventing the turning of said spindle in the door opening direction under the force of said spring and upon release of said latch means when a person is in the swing path of the door.

2. A door operating mechanism comprising a rotatable spindle adapted to support a door for swinging movement and to have a driving connection therewith, a normally tensioned spring in driving relation with the spindle and adapted to release its stored energy to turn said spindle in a door opening direction, motor means for turning said spindle in a door closing direction and tensioning said spring for a subsequent door opening operation, latch means for holding said spindle in door closed position against the tension of said spring, and circuit means for controlling the movement of said door in both door opening and door closing directions; said circuit means including actuating means for releasing said latch means and said spring for door opening operation, means for starting and stopping said motor means when the door reaches its opened and closed positions respectively, means for operating said actuating means, means for preventing the turning of said spindle in the door opening direction under the force of said spring and upon release of said latch means when a person is in the swing path of the door, and means operable to prevent rotation of said spindle in the door closing direction while a person is in the swing path of the opened door.

3. A door operating mechanism comprising a spindle adapted to support a door for swinging movement and to have driving connection therewith, a tensioned spring in driving relation with said spindle and adapted to release its stored energy to turn said spindle in a door opening direction, motor means for turning said spindle in a door closing direction and for loading said spring for a subsequent door opening operation, circuit means for controlling the movement of said door in both door opening and door closing directions including actuating means operable for releasing said spring for door opening operation of said spindle, means connected in said circuit for operating said actuating means, and safety means connected in said circuit including hydraulic means for preventing movement of said door in the opening direction under the force of said spring, said safety means being in the path of the opening movement of the door and operable by a person in said path.

4. A door operating mechanism comprising a rotatable spindle adapted to support a door for swinging movement and to have a driving connection therewith, a tensioned spring in driving relation with said spindle and adapted to release its stored energy to turn said spindle in a door opening direction, motor means for turning said spindle in a door closing direction and for loading said spring for a subsequent door opening operation, latch means for holding said spring in its tensioned condition, circuit means for controlling the turning of said spindle in both door opening and door closing directions including actuating means for releasing said latch means and said spring for door opening operation, hydraulic means including a fluid flow passage for regulating the rate of door opening movement under the driving action of said spring, means connected in said circuit for operating said actuating means, and safety means connected in said circuit for blocking the fluid flow passage of said hydraulic means to stop said door opening movement.

5. A door operating mechanism comprising a rotatable spindle adapted to support a door for swinging movement and to have a driving connection therewith, a tensioned spring in driving relation with said spindle and adapted to release its stored energy to turn said spindle in a door opening direction, motor means for turning said spindle in a door closing direction and for loading said spring for a subsequent driving of the spindle in a door opening movement, crank means having driving connection with said spindle, a connecting rod on said crank means having translative movement linearly upon rotation of said spindle, latching means for engaging said connecting rod and holding said rod in a position corresponding to an energy stored condition of said spring, and means for releasing said latching means to permit rotation of said spindle in the door opening direction under the driving action of said spring.

6. A door operating mechanism comprising a rotatable spindle adapted to support a door for swinging movement between opened and closed positions and to have driving connection with the door, a crank means co-axial with the spindle and having driving connection therewith, a connecting rod having pivoted connection with said crank means, a spring mounted for normally urging the spindle to turn in a direction to swing the door to opened position, means for confining said rod to substantially linear movement during rotation of the spindle, motor means for turning said spindle in the door closing direction against the force of said spring and moving said connecting rod rearwardly, latch means mounted for engaging said connecting rod and holding the same against forward movement by said spring, means for releasing said latch means to permit forward movement of the connecting rod by said spring, and means for starting and stopping said motor means when said spindle has been turned to its door open and door closed positions respectively.

7. A door operating mechanism comprising a rotatable spindle adapted to support a door for swinging move-

ment between opened and closed positions and to have driving connection with the door, a crank means co-axial with the spindle and having driving connection therewith, a connecting rod having pivoted connection with said crank means, a spring mounted for normally urging the spindle to turn in a direction to swing the door to opened position, means for confining said rod to substantially linear movement during rotation of the spindle, latch means mounted for reciprocative movement parallel with and adjacent said connecting rod, motor means for reciprocating said latch means over a distance substantially equal to the maximum stroke movement of the connecting rod between the door opened and door closed positions thereof, means on said connecting rod adapted to be engaged by said latch means at the door opened position of the connecting rod, and means for releasing said latch means to permit forward movement of the connecting rod by said spring.

8. A door operating mechanism comprising a rotatably mounted spindle adapted to support a door for swinging movement between opened and closed positions and to have a driving connection with the door, a normally tensioned spring mounted in driving relation with said spindle and to normally urge the spindle to turn in the door opening direction, a crank means on said spindle in driving relation therewith, a connecting rod pivoted on said crank means, a hydraulic dash pot having a piston operatively connected with said connecting rod and adapted to control the rate of turning of said spindle in the door opening direction, motor means for turning said spindle in the door closing direction and tensioning said spring for a subsequent door opening operation of the spindle, latch means for holding said spindle in the door closed position against the force of said spring, means for operating said latch means to release said spindle for a door opening operation, means in said dash pot operable to hydraulically stop the movement of said piston therein during a door opening operation, and means for operating the last named means.

9. A door operating mechanism comprising a rotatably mounted spindle adapted to support a door for swinging movement between opened and closed positions and to have a driving connection with the door, a normally tensioned spring mounted in driving relation with said spindle and to normally urge the spindle to turn in the door opening direction, a crank means on said spindle in driving relation therewith, a connecting rod pivoted

on said crank means, a hydraulic cylinder closed at one end and having a piston therein operatively connected with said connecting rod for controlling the turning rate of said spindle during the door opening operation, said cylinder being adapted to be filled with hydraulic fluid, a reservoir having a normally open passage communicating with said cylinder for receiving fluid therefrom under the force of said piston during door opening turning of said spindle, valve means operable for stopping the flow of fluid through said passage to stop the movement of said piston during door opening operation, remotely controlled means for operating said valve means, motor means for turning said spindle in the door closing direction and tensioning said spring for a subsequent door opening operation of the spindle, latch maens for holding said spindle in the door closed position against the force of said spring, and means for operating said latch means to release said spindle for a door opening operation.

10. In a door operating mechanism having a rotatably mounted spindle adapted to a support a door for swinging movement between opened and closed positions and to have a driving connection with the door, and a crank means on said spindle, a hydraulic spindle rotation control means comprising a cylinder having a closed end, a piston in said cylinder and a connecting rod operatively connecting said piston with said crank means for moving said piston toward and away from the closed end of the cylinder as said spindle turns, a second cylinder having closed ends and arranged in end to end relation with the first named cylinder, a piston in said second cylinder and resilient means normally urging said piston toward one end of the second cylinder, a passageway connecting the closed end of the first cylinder with said one end of the second cylinder, a normally open valve means operable for closing said passageway, and remotely controlled means for operating said valve means.

References Cited in the file of this patent

UNITED STATES PATENTS

505,270	Hicks et al.	Sept. 19, 1893
554,819	Hicks et al.	Feb. 18, 1896
1,594,706	Berger	Aug. 3, 1926
1,700,433	Cox	Jan. 29, 1929
2,843,376	Osuch et al.	July 15, 1958
2,893,725	Katz	July 7, 1959