

June 8, 1943.

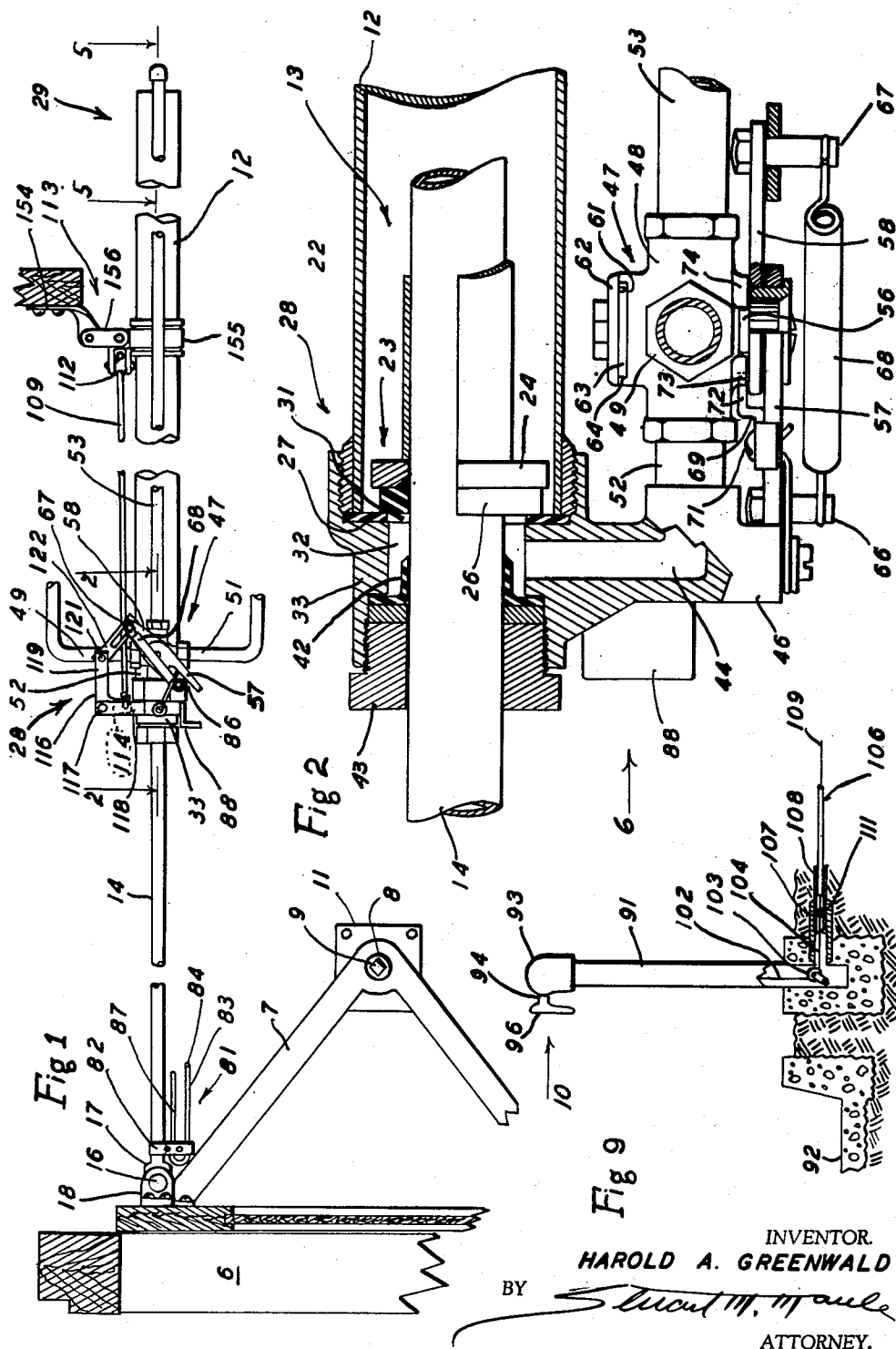
H. A. GREENWALD

2,321,079

HYDRAULIC DOOR OPERATOR

Filed Jan. 30, 1940

4 Sheets-Sheet 1



June 8, 1943.

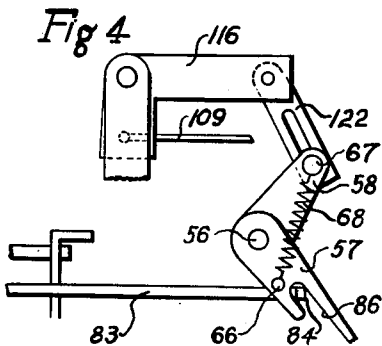
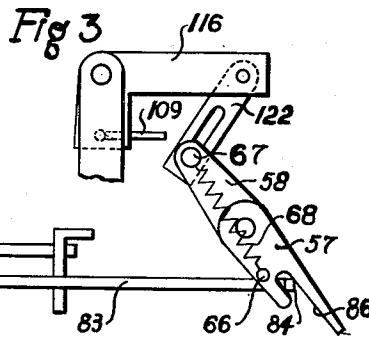
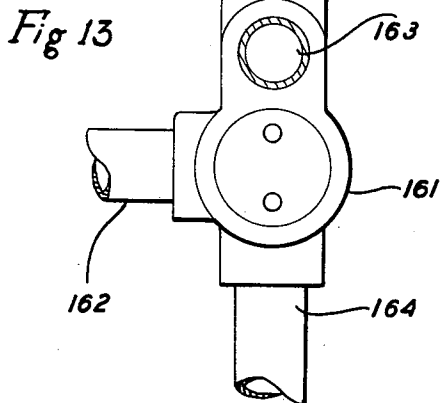
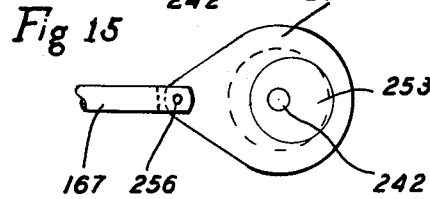
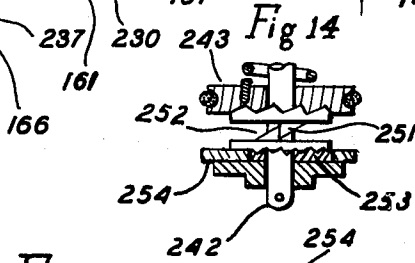
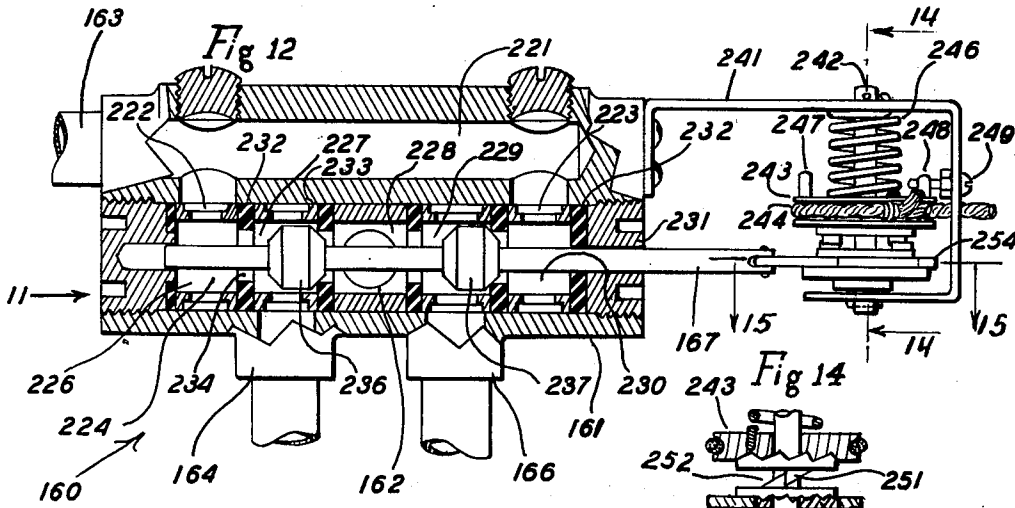
H. A. GREENWALD

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HYDRAULIC DOOR OPERATOR

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4 Sheets-Sheet 2



INVENTOR.

HAROLD A. GREENWALD

BY

Stuart M. Maule
ATTORNEY.

June 8, 1943.

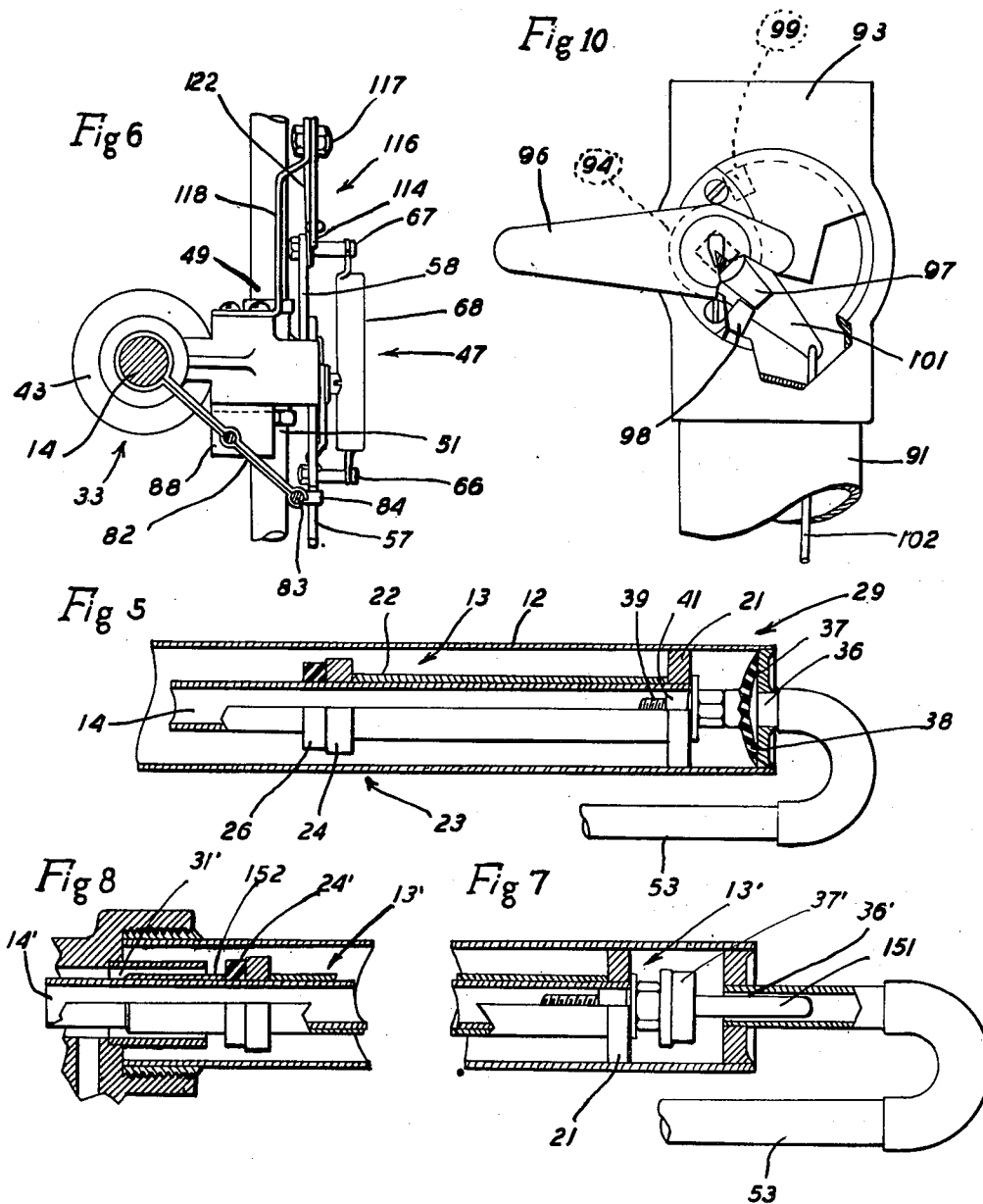
H. A. GREENWALD

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HYDRAULIC DOOR OPERATOR

Filed Jan. 30, 1940

4 Sheets-Sheet 3



INVENTOR.
HAROLD A. GREENWALD

BY

Stuart M. Mule
ATTORNEY.

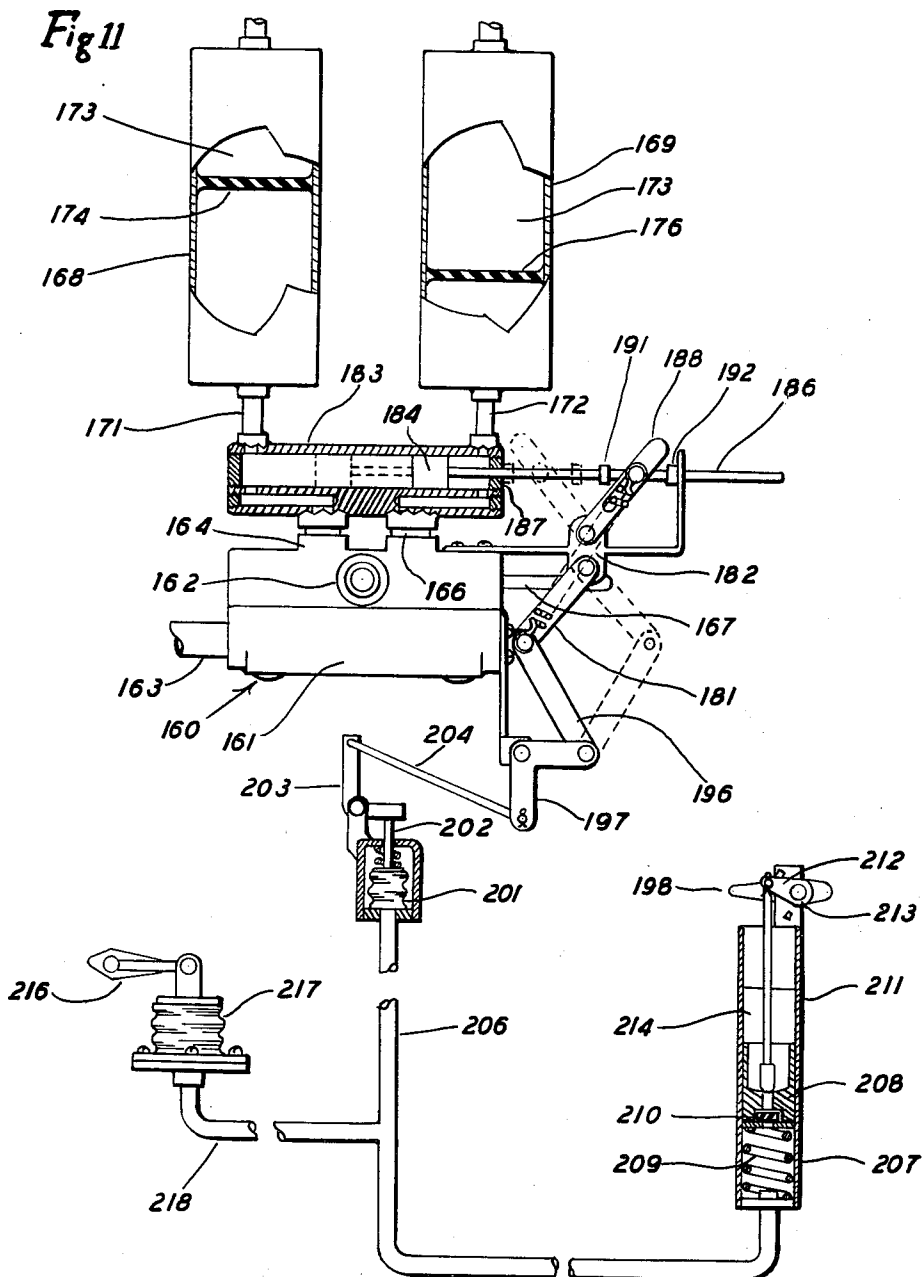
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H. A. GREENWALD
HYDRAULIC DOOR OPERATOR

2,321,079

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4 Sheets-Sheet 4



INVENTOR.
HAROLD A. GREENWALD

BY

Stuart M. Mace
ATTORNEY.

UNITED STATES PATENT OFFICE

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HYDRAULIC DOOR OPERATOR

Harold A. Greenwald, Los Angeles, Calif.

Application January 30, 1940, Serial No. 316,392

4 Claims. (Cl. 121-44)

This invention relates to closure operators, and more particularly to door operators of the fluid motor type.

An object of the present invention is to provide means for opening and closing such closures as the door or doors of a garage by the occupant of an automobile without the necessity of alighting from the vehicle.

A further object is so to construct the operating mechanism that it is operable with the utmost ease and convenience by properly authorized persons, but is securely locked against operation by others, thereby offering efficient protection for whatever goods are stored within the space to which access is controlled by the closure.

Another object of my invention is the provision of a door operator of the character described which operates in complete silence.

A more detailed object in this connection is the provision of means for retarding the rate of movement of the door and its operator as it approaches the ends of its stroke, thereby contributing not only to the silent nature of its operation, but reducing the strain on both door and operator by avoidance of slamming, with consequent increase in length of their useful life.

Yet another object is the provision of a hydraulic door operator which receives the energy for its actuation from any suitable supply of water or other fluid under pressure, such as the water supply system of a residence, and yet which is so arranged that it is protected against being rendered inoperative when the temperature of the atmosphere in the vicinity of the door with which it is associated drops below the freezing point.

A further object of the present invention is to provide a door operating mechanism of the character described, which is of very simple construction, thus making it possible to produce the apparatus at low cost, and yet which is of ample strength to operate even heavy doors efficiently, and sufficiently rugged to assure its efficient and continued operation without requiring adjustment or other servicing over prolonged periods of time.

The invention possesses other objects and features of advantage, some of which, with those enumerated, will be set forth in the following description of the preferred forms of my invention illustrated in the drawings accompanying and forming a portion of the specification. It is to be understood that I do not limit myself to the showing made by the said drawings and description, as I may adopt variations of the preferred forms within the scope of my invention as set forth in the claims.

Referring to the drawings:

Figure 1 is a view in side elevation of a door operator embodying principles of the present in-

vention, and illustrating the manner of its association with a door to be opened and closed thereby. Portions of the figure are broken away to reduce its size.

5 Figure 2 is an enlarged view, partly in plan and partly in horizontal section taken on the line 2-2 of Fig. 1, of the head end of the operating cylinder, showing a portion of the plunger in the position assumed thereby when at the outer
10 end of its stroke, and showing the parts of the valve in their respective positions when in readiness to be tripped to cause the plunger to move toward the inner end of its stroke.

Figure 3 is a diagrammatic layout showing the
15 valve-operating parts after the plunger has completed its inward stroke and moved the valve parts to their cocked positions in readiness for tripping to start outward movement of the plunger.

20 Figure 4 is a view similar to Fig. 3 but showing the valve parts tripped from their Fig. 3 position, but before the plunger has started to move.

Figure 5 is a horizontal sectional view taken through the other end of the cylinder and showing the plunger in the position assumed thereby
25 when at the inner end of its stroke. The plane of section may be assumed to have been taken on the line 5-5 of Fig. 1 with the direction of view as indicated.

30 Figure 6 is an end elevation, the direction of view being indicated by the arrow 6 of Figure 2.

Figure 7 is a view similar to Figure 5, but showing a slightly modified form of construction wherein means are provided for retarding movement of the door and its operating mechanism as
35 it approaches the limit of its opening movement.

Figure 8 is a detail view in horizontal section taken through the head end of the cylinder of Figure 7, and showing the apparatus for retarding
40 movement as the door approaches the limit of its closing movement.

Figure 9 is a detail view in vertical section taken transversally of the driveway leading to a door with which an operator of the present in-
45 vention is associated, and showing the manually operable control for actuating the apparatus from the driver's position within an automobile upon the driveway.

50 Figure 10 is an enlarged view in front elevation of the upper end of the control standard of Figure 9. Part of the figure is broken away to reveal the interior construction; and the direction of view is indicated by the arrow 10 of Figure 9.

55 Figure 11 is a side elevation, partly broken away in vertical section, of a modified form of control valve, and of a modified form of hydraulic system adapting the door operator of my invention for use in cold climates where protection
60 against freezing is desirable. A modified form

of actuating mechanism is also illustrated in this figure.

Figure 12 is an enlarged view in plan, partly in horizontal section, of the control valve of Figure 11. A further modified form of actuating mechanism is also illustrated in this figure.

Figure 13 is an end elevation, taken in the direction of the arrow 11 of Figure 12.

Figure 14 is a detail view in horizontal section taken on the line 14—14 of Figure 12, with the direction of view as indicated.

Figure 15 is a vertical sectional view taken on the line 13—13 of Figure 12 with the direction of view as indicated.

In terms of broad inclusion, the present invention contemplates the provision of hydraulically operated apparatus for opening and closing a door or gate, which apparatus includes control means operable from a point remote from the door, and preferably so situated that it is accessible to the driver of an automobile upon the driveway leading to the door or gate associated therewith, thus permitting opening or closing of the door or gate without the necessity of alighting from the automobile. The apparatus is designed to operate efficiently, quickly, and in perfect silence, toward which end it, in one of the illustrated modifications thereof, is provided with means for retarding the rate of movement of the door as it approaches either of its extremes of movement, thereby preventing slamming. In one of its illustrated forms, the apparatus has incorporated therewith means for protecting its hydraulic mechanism against freezing, thus adapting the device for installation in communities where low temperatures are encountered. Different types of actuating mechanism are illustrated, one feature which they all have in common being that they set the apparatus in operation by the simple turning of a handle resembling the door handle of an automobile, and the same type of movement of the actuating handle effects either opening or closing of the door or gate, as the case might be, depending upon its position at the time the handle is moved. As a factor contributing to the ease of operation of the device, a special type of control valve is illustrated, the details of which make it peculiarly adaptable for use with the door operator of the present invention.

More specifically described, and referring first to that embodiment of my invention which is illustrated in Figures 1 to 4, inclusive, my closure operator is shown as being co-operatively associated with a garage door 6 of conventional type and mounted upon a pair of brackets 7 having aligned bearings 8 which support the door 6 for opening and closing movement by swinging about a horizontal axis spaced inwardly from the plane of the door. These bearings 8 are revoluble about trunnions 9 carried by mounting plates 11 rigidly affixed to any suitable supporting structure within the garage. It should be understood, however, that this type of door and mounting therefor are merely exemplary, inasmuch as the operator of my invention is equally well adaptable for use in connection with other types of closures and other types of closure mountings.

The operator comprises a cylinder 12 having a plunger 13 reciprocable therein, the rod 14 of the plunger being pivotally connected to the door 6 as by a pin 16 extending through an eye 17 on the outer end of the rod 14 and through a suitable bracket 18 affixed to the door 6. The parts are so proportioned and arranged that when the

plunger moves inwards with respect to the cylinder 12 from the position in which it is illustrated in Figure 1, it causes the door 6 to swing about the axis of its trunnions 9 in a clockwise direction, from the vertical, closed position illustrated, through substantially 90 degrees of rotation, during which the door is raised (such doors are usually balanced by a suitable counterweight or springs), to an elevated position wherein it lies in a substantially horizontal plane, permitting a vehicle to be driven into or out of the garage by passing under the thus opened door.

Whereas the member 14 is termed a "rod" herein, it has been found most expedient to form it of suitable tubing. The head 21 of the plunger 13 is most conveniently mounted on the rod 14 by means of a suitable length of tubing 22 which is slipped upon and affixed to the rod 14 as by welding. This serves as a distance piece between the head 21, which is fitted to the bore of the cylinder 12 to establish a sliding and substantially fluid-tight seal therewith, and a valve 23, comprising an annular head 24 carrying a facing 26 of resilient material adapted to engage an annular valve seat 27 (Figure 2) adjacent the end 28 of the cylinder. (Inasmuch as this is the end of the cylinder toward which the plunger moves during its outward stroke, the end 28 will be considered herein as the "outer" end of the cylinder, and the other end as the "inner" end 29.) The valve seat 27 adjacent the outer end 28 of the cylinder comprises an annular plate having an orifice 31 through which the rod 14 extends, the orifice being amply large to permit fluid to flow from the cylinder 12 to the hollow interior 32 of the head 33 which closes the outer end 28 of the cylinder. Such flow can occur, however, only when the plunger is displaced from the outer end of its stroke, inasmuch as when at the end, the valve 23 closes the orifice 31 of the valve seat 27. The importance of this detail of construction lies in the fact that the valve 23 is carried by the plunger 13, itself, with the result that even though full pressure remain imposed upon the head 21 of the plunger, urging the plunger to continue its motion after its outward stroke has been completed, the full force of the plunger will be resisted by the valve seat 27 against the valve 23 with a force equal to the force of the plunger. Therefore, even though the head 21 of the plunger, which is required to slide within the bore of the cylinder, might not maintain an absolutely fluid-tight seal with the cylinder walls, all danger of leakage of fluid during the relatively long intervals when the plunger is at the outer end of its stroke, is obviated, since the only possible path of escape of fluid from the outer end of the cylinder is through the orifice 31.

A similarly operating safety feature is provided at the inner end 29 of the cylinder 12. Flow to and from this end 29 is exclusively through an orifice 36 in a valve seat 37; and arranged upon the plunger 13 in position to engage the seat 37 and close the port, or orifice 36, when the plunger 13 is at the inner end of its stroke, is a valve 38, preferably a cup-shaped member of resilient material mounted on the end of the plunger by means of a short stem 39 threaded through a plug 41 closing the inner end of the tubing of which the rod 14 is formed.

Beyond the valve seat 27, the head 33 at the outer end 28 of the cylinder is provided with a suitable packing 42, which is retained in sliding and substantially fluid tight engagement with

the rod 14 as by a gland nut 43 threaded into the outer end of the head 33. A fluid passage 44 communicates with the chamber 32 between the valve seat 27 and the packing 42. This passage 44 is through a fitting 46 affixed to the head 33 and serving as the support for a four-way valve 47. Inasmuch as the four-way valve illustrated in connection with the modification of Figures 1 to 4, inclusive, is of conventional construction, it will suffice for the purpose of the present disclosure to explain that it comprises a housing 48 having an inlet 49, an outlet 51, and two working orifices. These working orifices are not shown, but with one of them the passage 44 communicates by a nipple 52, and with the other the port 36 at the other end 29 of the cylinder communicates by suitable tubing 53. Mounted for rotary motion within the housing 48 of the valve 47 is a core (not shown) the stem 56 of which extends from the housing to receive two arms or levers 57 and 58, respectively. The arm 58 is rigidly attached to the stem 56; whereas the arm 57 is free to rotate thereabout; and the two arms extend oppositely from the stem 56, at least to the extent that the fixed arm 58 extends upwards and the freely mounted arm 57 extends downwards from the stem. The stem 56 and the arm 58 affixed thereto are designed to swing through approximately 90 degrees of rotation about the axis of the core, any suitable means being employed to limit movement of the core, such as a pin 61 rigid with and extending from the inner face of a washer 62 which is fitted upon a non-circular portion of the stem 56 so that the washer 62 is locked with the stem 56. The pin 61 projects into an indentation 63 in the valve housing 48; and the shoulders 64 at the ends of this indentation 63 serve to limit the distance through which the stem 56 and the core can be turned. The result of turning the stem 56 and the core through the angular displacement determined by the length of the indentation is to direct fluid to the end of the cylinder 12 opposite to that to which it was being directed prior to movement of the stem 56. For this purpose, the stem 56 is provided with passages (not shown) adapted, when the stem is in one of its two extreme positions, to connect the inlet 49 with one of the two working orifices and at the same time connect the other working orifice with the outlet 51; and when the stem is in its other extreme position, these same passages alternate the working orifices with which the inlet 49 and the outlet 51, respectively, are connected.

The arms 57 and 58 are each provided with a pin 66, 67, respectively, rigid therewith adjacent the outer end of the arm; and a coil spring 68 is under tension between these pins. The loosely mounted arm 57 also is provided with means for limiting the distance through which it can be rotated, such as a detent 69 affixed to the arm 57 as by a screw 71, and having its inner end 72 offset so as to enable it to extend around the inner end of the other arm 58 without interference therewith. This offset end 72 of the detent 69 extends upwards into the space between two lugs 73 and 74 formed on the housing 48 of the valve, the spacing between these lugs determining the distance through which the arm 57 can rotate. The parts are so proportioned and arranged that when the loosely mounted arm 57 swings from one extreme of its movement to the other, carrying with it the associated end of the spring 68, it causes the spring to be extended and so disposed that the axis of the spring inter-

sects the axis about which the arm 58 swings, or so closely approaches that position that after the arm 57 has assumed this new position, it requires only slight movement of the arm 58 from its then position, carrying with it its associated end of the spring 68, to cause the axis of the spring to move sufficiently far past the axis of movement of the arm 58 to permit the tension of the spring to cause the arm 58 to swing to the opposite extreme of its movement. It is apparent, therefore, that the loosely mounted arm 57 serves only as a spring carrier, and that it can be so adjusted that it tensions and so arranges the spring 68 that the other arm, i. e., the arm 58 which is affixed to the core of the valve, can be caused to move to its other extreme of movement by imparting to the arm 58 only a slight movement in that direction. In other words, the effect of this adjustment of the spring-carrying arm 57 is to "cock" the apparatus, placing it in readiness for the valve arm 58 to be snapped to its opposite position by the spring 68 when only a slight starting movement in that direction is imparted to the valve arm 58.

Means are provided for automatically cocking the arm 57 and its spring 68 in this manner, each time the plunger 13 moves, regardless of the direction of such movement. That is to say, regardless of whether the plunger is moving inwards or outwards of its cylinder, the spring 68 and its carrier 57 are automatically moved to that position wherein only a slight movement of the valve arm will then be required to reverse the position of the valve core, and thus supply fluid to the cylinder in such a manner as to cause reversal of movement of the plunger 13. This means for cocking the apparatus conveniently takes the form of a rod 81 affixed to the rod 14 of the plunger as by a clamp 82, adjacent the outer end of the plunger rod 14. One end 83 of the rod 81 is bent to extend substantially perpendicularly from the remainder thereof, thus providing a hook 84 adapted to enter a slot 86 in the spring-carrier 57 as the plunger 14 approaches the inner end of its stroke, and, after such engagement has occurred, carry the carrier arm 57 from the position in which it is illustrated in Figure 1, to the other extreme of its movement, wherein it points downward and to the right as viewed on that figure. The rod 81 is so adjusted with reference to the plunger rod 14, that the carrier arm 57 arrives at this described position just as the plunger 13 arrives at the inner end of its stroke, with the result that so long as the plunger 13 remains in this position, the hook 84 remains within the slot 86, in readiness to pull the carrier arm 57 back again to the position in which it is illustrated in Figure 1, when outward movement of the plunger commences.

The other end 87 of the rod serves merely as a guide to assure proper alignment of the hook 84 and the slot 86 as the former approaches the latter. For this purpose, a bracket 88 is rigidly mounted on the head 33 of the cylinder 12, and this bracket is provided with a hole (not shown) which the pointed end of the portion 87 of the rod 81 is adapted to enter as the hook 84 approaches the slot 86, and thus assure proper alignment of these parts for their subsequent interengagement.

Means are provided for tripping the mechanism after it has been cocked in the manner described, and thus causing the plunger 13 to move to the opposite end of the cylinder 12 from that at which it is disposed at the time such tripping

occurs, and thus moving the door 6 to its open or to its closed position, as the case might be. This tripping mechanism is operable from a remote point, preferably being so arranged that it can be operated by the driver of an automobile without requiring that he leave the driver's compartment of his vehicle. With this object in view, a standard 91 is disposed adjacent the driveway 92 over which an automobile is driven in order to enter or leave the garage controlled by the door 6. Upon the upper end of the standard 91, a housing 93 is provided; and in the front of this housing the shaft 94 of an actuating handle 96 is journaled. The handle 96 and its shaft 94 carry a lock cylinder, the details of which are not illustrated, but which functions to restrain the handle 96 against movement except when the proper key is inserted therein, and thus prevent actuation of the door operator by others than properly authorized persons. The inner end of the shaft 94 carries a lug 97 adapted to engage a stop 98 when the shaft 94 has been turned to one limit of its movement, and another stop 99 when the shaft 94 reaches the other extreme of its movement. The inner end of the shaft 94 also carries an arm 101, to the outer end of which a suitable pull cord, such as a wire 102 is attached, the parts being so arranged that by turning the handle downwards from the position in which it is illustrated in Figure 8, the wire 102 can be pulled upwards.

From the arm 101, the wire 102 extends downward through the standard 91 through a pulley 103, whence the wire extends through a laterally extending tube 104 affixed to the standard below the surface of the ground. To the outer end of the tubular extension 104, a length of tubing 106, preferably ductile copper tubing, is releasably connected by a coupling member 107 adapted to threadedly engage the outer end of the extension and suitably engaging a section of tubing 108 which is slidably mounted upon the tubing 106 in such a manner that the section 108 and its coupling member 107 can be slid along the tubing 106, away from the extension 104, and thus leave exposed a sufficient length of the wire 109 which is disposed within the tubing 106, to permit the wire 102 to be attached thereto. Any suitable type of clamp 111 may be employed to so attach the wires 102 and 109 together. After such interconnection of the wires 102 and 109 has been completed, the section of tubing 108 and the coupling 107 can be slid back into place so that the coupling 107 can be threaded upon the extension 104, and thus effect a substantially watertight interconnection between the ductile tubing 106 and the standard 91.

The tubing 106 and the wire 109 therein contained extend from the standard 91 to a suitable location within the garage. After entering the garage, the wire 109 can continue on without the tubing, provided the inner end of the tubing 106 is so disposed that entry of water thereinto is prevented. The wire 109 passes over a pulley 112 (see Figure 1) mounted upon the cylinder 12, preferably closely adjacent the bracket 113 by means of which the cylinder is supported. From the pulley 112, the wire extends toward the head 33 of the cylinder 12, where it is affixed to the downwardly extending end 114 of a bell crank 116 which is pivotally mounted as by a pin 117 upon a bracket 118 carried by the cylinder head 33. The other end 119 of the bell crank 116 is pivoted as by a pin 121 to one end of a link 122, the other end of which is connected as by the pin 67

to the upper end of the valve lever 58. The parts are so arranged that the arm or lever 58 carries the pin 67 from one side of the plane including the axes of the pin 121 and the axis about which the lever 58 moves, to the other side of that plane and to substantially the same distance therefrom, and the movement of the pin 121 which results from pulling upon the wire 109 is diametrically away from the axis about which the arm 58 moves. Hence, when the wire 109 is pulled, it will start the arm 58 swinging from its then position toward its opposite extreme position; and the interconnection between the arm 58 and its tripping bell crank 116 is such that the movement of the lever 58 induced by the bell crank 116 in this manner is sufficient to permit the previously cocked spring to complete movement of the valve arm 58 to its opposite extreme of movement, in accordance with the description hereinabove.

It is apparent therefore that only a slight movement of the wire 109 and its actuating handle 96 is necessary to effect reversal of the door operator, i. e., if the door is in its closed position it can be caused to move to open position merely by turning the handle 96 from the position illustrated in Figure 8 to that illustrated in Figure 7; whereas if the door is closed it can be caused to open by identical manipulation of the handle 96. The rod 84 co-operates with the spring-carrying arm 66 in setting the control mechanism each time the control operates in either direction, so as to place the control mechanism in readiness for subsequent movement of the control in the opposite direction. Say, for example, that the door is closed as illustrated in Figure 1 and the plunger 13 in its outermost position, the spring carrier 66 and the spring 68 will then be cocked so that only a slight movement of the valve arm 58 will be required to cause it to swing through substantially 90° from the position illustrated in Figure 1; therefore, when the wire 109 is pulled either by the described manipulation of the handle 96 adjacent the driveway leading to the garage, or by pulling upon the wire 109 itself in the event that someone inside the garage desires to open the door, the bell crank 116 will be swung about its pin 117, raising the end 119 of the bell crank, and thus imposing tension upon the link 122. This will cause the valve arm 58 to swing in a counter-clockwise direction from its Figure 1 position until the center portion of the spring 68 moves far enough past its dead-center position to snap the valve arm 58 clear across to the opposite extreme of its rotary movement where it is illustrated in Fig. 3, without, however, affecting any movement of the spring carrier 51. In this manner the core of the valve 47 is rotated so as to interconnect the inlet 49 with the working orifice which communicates with the passage 44 and through it with the interior 32 of the head 33 at the outer end 28 of the cylinder 12. At the same time the other working orifice, i. e., the one which communicates with the inner end 29 of the cylinder through the tubing 53, is placed in communication with the outlet 51. Inasmuch as the inlet 49 is continually in communication with any suitable source of fluid pressure such as a city water supply, this described movement of the valve core will cause fluid pressure to be imposed upon the facing 26 of the head 24 through the port 31; and inasmuch as the pressure of fluid against the inner face of the head 21 of the plunger has been re-

Heaved (since the port 36 and tubing 53 are in communication with the outlet 51) the plunger 13 will move to the right as viewed upon Figures 1 and 2. Immediately this occurs, fluid will flow through the port 31 and thus impose its pressure against the outer face of the plunger 21 which fits the cylinder 12, thereby causing the plunger 13 to move to the inner end 29 of the cylinder, and effecting opening of the door 6. Upon completion of the plunger's stroke, the valve 38 engages the valve seat 37, thereby closing the port 36. Inasmuch as fluid pressure remains imposed upon the plunger, the fluid pressure itself serves to press the valve 38 into intimate engagement with the seat 37 as long as the door remains in its fully opened position, thereby effectually sealing the port 36 against escape of fluid as long as the door remains motionless, even though the plunger head 21 might not make a perfectly water-tight seal with the interior of the cylinder 12.

As the door approaches the limit of its opening movement, the hook 84 on the rod 81 enters the slot 86 in the spring-carrier 57 and carries it through substantially 90° from its position illustrated in Figure 1. This carries the lower end of the spring 68 to the right until its central portion closely approaches the axis of rotation of the valve core and valve arm 58 as illustrated in Fig. 3, where the spring 68 remains until the wire 109 again is pulled. This raises the link 122 in the manner previously described and moves the upper end of the valve arm 58 far enough to carry the spring 68 sufficiently beyond the dead center position for the spring to snap the arm back to the position of the arm 58 illustrated in Figures 1, 2, and 4, but again without affecting any movement of the spring carrier, i. e., leaving it in the position thereof shown in both Figures 3 and 4. This of course returns the valve core to that position in which the inlet 49 is in communication with the tubing 53 and through it with the port 36 at the inner end 29 of the cylinder 12. At the same time the passage 44 which communicates with the outer end 28 of the cylinder is placed in communication with the outlet 51; therefore, the fluid pressure causes the plunger to move outwards carrying with it the door 6 to its closed position.

As the plunger starts this outward motion, i. e., the motion thereof which is coincident with the closing movement of the door, the hook 84 on the rod 81 returns the spring-carrier 57 to the position thereof which is illustrated in Figures 1 and 2, but, of course, without moving the arm 58, and thereby cocking the spring 68 so that the mechanism is in readiness for subsequent operation to cause immediate opening of the door as soon as the wire 109 is pulled. It is of importance that this cocking of the spring and its carrier arm occurs at the start of the closing movement of the door, inasmuch as after the mechanism has been so cocked the door can be caused to open instantly the wire 109 is pulled. For example, if after the mechanism had been actuated to start the door towards its closed position a child should run under the door or it should be observed that some object is dangerously near the position towards which the door is moving, it is necessary only to pull upon the wire 109, whereupon the door immediately will be caused to return to its open position without having first to complete its closing movement.

Figures 5 and 6 illustrate a slightly modified form of construction provided with means for

cushioning both the opening and closing movements of the door and thereby preventing its slamming. The plunger 13' is provided with a rod 151 projecting beyond the inner face of the valve 37' far enough to enter the port 36' as the plunger approaches its inner extreme of movement. The rod 151 is of slightly less diameter than the port 36' so that after the rod has entered the port fluid can continue to flow through the port 36 and to the outlet, but at a greatly reduced rate; therefore, the movement of the plunger 13' and the door as the latter approaches the extreme of its opening movement will be greatly retarded, thus permitting the door to come gently to rest at its fully opened position.

Similarly, an enlarged portion 152 is provided upon the rod 14' of the plunger 13' projecting outwards from the valve 24'. This enlarged portion 152 is of sufficiently less diameter than the port 31' to permit the fluid to continue to flow through the port 31 after the enlarged portion 152 has entered the port, but at a rate sufficiently retarded to dampen the closing movement of the door and thereby cause the door to come gently to rest in its fully closed position.

The hanger 113 whereby the operator is mounted preferably comprises a bracket 154 adapted to be rigidly affixed to a beam or other supporting structure, a band 155 encircling the cylinder 12 and rigidly affixed thereto, and a link 156 pivoted at one end to the bracket 154 and at the other end to the band 155. This arrangement permits the operator to adjust itself automatically to the door 6 when being open and closed. Also, the apparatus can be so installed that the stroke of the plunger is slightly longer than necessary to effect completion of movement of the door in either direction; and therefore the inclusion of the link 156 reduces the degree of accuracy which must be adhered to when the apparatus is installed. The position of the hanger 113 with respect to the cylinder and plunger is of importance, the preferable arrangement disposing it substantially at the center of gravity of the unit, when the plunger 13 is in its most extended position. This results in reducing to a minimum the maximum bending moment imposed upon the rod 14 and the cylinder by gravity, and thereby permits their being constructed of lighter materials than otherwise would be the case.

A modified form of construction is shown in Figure 11, wherein means are provided to protect the apparatus against being made inoperative by freezing of its energizing fluid when low temperatures are encountered. An improved type of 4-way valve 160 also is shown in this figure, but inasmuch as its interior construction will be more fully described hereinbelow, it will suffice for the purpose of describing the apparatus of Figure 9 to state that it comprises a housing 161 having an inlet 162, an outlet 163, two working orifices 164 and 166, and a stem 167 which instead of being rotatable as in the case of the valve 47 previously described, is mounted for longitudinal reciprocatory movement. As will become apparent from the description to follow, when the stem is in communication with one of the working orifices, say the orifice 164, and the other working orifice 166 communicates with the outlet 163; and when the stem 167 is in its other extreme position, the connections are reversed, i. e., the inlet 162 communicates with the orifice 166 and the orifice 164 with the outlet 163.

As indicated, the apparatus here under discussion is intended for use in localities where below-freezing temperatures are expected. In order to protect the apparatus, it is intended that the valve 160 be installed inside a suitable enclosed space where the temperature is not permitted to drop dangerously low, even though such enclosed space be situated at a material distance from the garage, the door of which is to be controlled, and to connect the valve with the door engine, which, of course, must be situated adjacent the door, and therefore is subject to the temperature prevailing within the garage, by conduits containing suitable fluid not subject to freezing at the low temperatures expected to be encountered there. Consequently, each of the working orifices 164, 166, communicates with means for transmitting the pressure of the water flowing through that orifice to a fluid having a lower freezing point, but without permitting intermingling of the two fluids. Towards this end the working orifices 164, 166 communicate with the lower ends of cylinders 168 and 169 respectively, as by conduits 171 and 172 respectively. The lower portions of the cylinders 168 and 169, the conduits 171 and 172, and the valve 161 are filled with water supplied thereto through the inlet 162 which communicates with a suitable water supply system. However, the upper portions of the cylinders 168 and 169 are filled with fluid 173 having a sufficiently lower freezing point, such as oil, or in some instances merely a salt solution. If the fluid 173 selected differs in specific gravity from that of water to such a degree that intermingling of the two fluids will be avoided with sufficient assurance merely because of the tendency of the non-freezing fluid to remain supernatant upon the water within the cylinders, it may in some instances be unnecessary to provide mechanical means for preventing their intermingling. However, flexible diaphragms may be employed for this purpose, if desired, or each of the cylinders 168, 169, may be provided with a plate 174, 176, respectively, fitted to the interior of its associated cylinder for reciprocatory sliding movement longitudinally of its cylinder, but without permitting any material leakage therepast of either of the two fluids which it separates.

The valve 160, however, is intended to be operated in the same fashion as the valve 47 previously described, i. e., merely by tripping its actuating lever 181 so that a previously cocked spring 182 can snap the lever 181 across to its alternative position. Inasmuch as the moving portions of the door engine upon which reliance is placed in the previously described modification to cock the spring are disposed at a point remote from the valve 160, means are provided in association with the valve 160 for cocking the spring 182, which means are actuated by the fluid moving between the valve 160 and the cylinders 168 and 169. With this object in view, both of the conduits 171 and 172 communicate with a cylinder 183 upon opposite sides on a plunger 184 which is reciprocable therein and the stem 186 of which extends through a suitable packing 187 into engagement with the spring-carrying arm 188 between which and the valve arm 181 the spring 182 is under tension. Preferably a degree of sliding movement of the stem 186 with respect to the spring carrier 188 is permitted, the extent of this movement, however, being limited by stops 191 and 192 which can be locked in selected position upon the stem 186

by any suitable means such as set screws (not shown). The working orifices 164 and 166 are at all times in communication with the conduits 171 and 172 respectively; but inasmuch as this communication is through the associated end of the cylinder 183, whatever pressure is imposed upon the fluid within the conduit 171 will also be imposed upon the proximal end of the plunger 184, whereas the pressure of the fluid within the conduit 172 will be imposed upon the other face of the plunger 184. Consequently, when the stem 167 of the valve 160 is moved so as to place the inlet 162 in communication with the working orifice 164 and thence through the associated end of the cylinder 183 and the conduit 171 with the cylinder 168, full pressure will be imposed upon the outer end of the plunger 184; and inasmuch as the other working orifice 166 is simultaneously placed in communication with the outlet 163, thus relieving the pressure of the fluid at the working orifice 166 pressure will simultaneously be relieved from the inner face of the plunger 184. Therefore, the plunger 184 will be caused to move to the right as viewed upon Figure 11, carrying with it its stem 186 and causing the spring-carrier 188 to swing from the dotted line position in that figure to the position thereof indicated in full lines. This tensions the spring 182 and places it so nearly in its dead-center position with respect to the axis about which the valve arm 181 swings that only a slight movement of the arm 181 from its full line position will be required to enable the spring 182 to complete moving the valve arm 181 to the right to the position thereof indicated in broken lines, carrying with it the valve stem 167 which is connected thereto by suitable means (not shown). Similarly when the stem 167 of the valve 160 is moved to that position wherein the inlet 162 communicates with the working orifice 166, the action just described will be reversed inasmuch as full pressure will be imposed upon the inner face of the plunger 184 and pressure will be relieved from its outer face, thereby causing the plunger 184, its stem 186, and the spring-carrier 188, to be moved to the position thereof indicated in broken lines, thus tensioning the spring and placing it so close to its dead-center position so that only a slight movement of the valve arm 181 from its broken line position will be required before the spring 182 can snap it across to its full line position, carrying with it the valve stem 167.

As in the previously described modification, the valve arm 181 receives its initial impulse by means of a link 196 and bell-crank 197. Figure 11 also illustrates a modified form of apparatus for connecting the bell crank 197 to the remotely situated actuating handle 198. This is a hydraulic apparatus and comprises a small bellows 201 adapted to be expanded by fluid pressure thereinside and provided with a rod 202 which the bellows pushes upwards when the bellows 201 expands. Such upward motion of the rod 202 actuates a bell-crank 203 which is connected by a link 204 to the bell-crank 197 in such a manner that when the bellows 201 expands the link 196 is pulled downwards, thereby tripping the valve lever 181 in the manner hereinabove described. Communicating with the bellows 201 is suitable tubing 206 which leads to the remote station where the actuating handle 198 is disposed, preferably adjacent the driveway which leads to the garage, a door of which is controlled by an apparatus of the present in-

vention. The tubing 206 communicates with the bottom of the cylinder 207 within which a plunger 208 is reciprocable, this plunger being continually urged upwards within the cylinder 207 as by a spring 209 and preferably being provided with a check valve 210. The plunger 208 is connected as by a connecting rod 211 with an arm 212 which is rigid with a shaft 213 upon which the actuating handle 198 is affixed. The parts are so proportioned and arranged that when the handle 198 is depressed, the arm 212 pushes the connecting rod 211 and the plunger 208 downwards, thereby forcing fluid from the cylinder 207 through the tubing 206 and into the bellows 201 which are thus caused to expand sufficiently to operate the bell-crank 197 and trip the valve lever 181. The cylinder 207 extends for a material height above the top of the plunger 208 which it contains, thereby providing a material space 214 above the plunger which serves as a reservoir for excess fluid; hence any slight leakage of fluid past the plunger 208 is immaterial inasmuch as it will return to the cylinder 207 below the plunger 208 as the spring 209 urges the plunger 208 to its idle position. Similarly, the reservoir 214 will take care of any expansion of the fluid within the tubing and cylinder due to temperature changes and the like permitting the plunger 208 to be fitted sufficiently loosely for fluid to escape therepast at a rate sufficient to compensate for such variations in volume but without impairing the efficiency of the plunger 208 in imposing pressure upon the fluid within the cylinder and tubing 206 when the handle 198 is depressed.

This hydraulic actuating mechanism possesses the added advantage that it facilitates providing additional handles 216 at other locations, each of these additional handles 216 being provided with a bellows 217 adapted to be collapsed when its associated handle 216 is actuated, or suitable mechanical equivalent. Each of these additional bellows (of which only one is illustrated) is connected as by tubing 218 to the tubing 206 so that the bellows 201 is expanded each time any one of the bellows 217 is actuated.

Referring now to Figures 12 to 15 inclusive, it will be seen that the housing 161 of the valve 160 has a passageway 221 extending longitudinally thereof. The outlet 163 communicates with an end of the passage 221; and adjacent each of its ends the passage 221 communicates by openings 222 and 223 respectively with the ends of a second bore 224 which extends longitudinally of the housing 161 preferably parallel to the manifold passage 221. This second bore 224 is divided into five compartments 226, 227, 228, 229 and 230, respectively; and the outer end of the bore 224 is closed by a threaded plug 231 through which the stem 167 extends, suitable packing 232 being employed to permit the stem 167 to reciprocate without leakage of fluid between the stem 167 and the plug 231. The five compartments 226 to 230 inclusive are defined by suitable partitions 232 retained in spaced relationship by tubular spacers 233 which fit the bore 226. Each of the four partitions 232 has a central aperture or port 234 and the stem 167 extends through all of these aligned ports 234. Within each of the compartments 227 and 229 a valve head 236 and 237 respectively is disposed and both of these valve heads are affixed to the stem 167. Parts are so proportioned and arranged that when the stem 167 is at one end of its stroke, say moved to the right as viewed upon

Figure 10, both valve heads 236 and 237 engage the respective partitions 232 which define the right hand end of the compartment within which the valve heads are disposed, closing the ports 234 in those partitions. This of course leaves the ports 234 in the partitions at the left hand ends of the compartments 227 and 229 open, consequently the compartment 227 communicates with the compartment 226 and thence through the opening 222 with the outlet manifold passage 221. Also the compartment 229 permanently communicates with the central compartment 228. Therefore, water under pressure from the water supply system is permitted to flow by way of the compartments 228 and 229 to the working orifice which communicates with the compartment 229 which, as described hereinabove, communicates with one end of the cylinder 12 of the door motor either directly or indirectly through apparatus such as that illustrated at the top of Figure 11. The other working orifice 164 communicates in a similar manner with the other end of the cylinder, hence a quantity of fluid corresponding to that which flows out of the valve 160 through the working orifice 166 will flow back into the valve through the working orifice 164 which communicates with the compartment 227 which, as stated, is open to the outlet 163.

When the valve stem 167 is in its alternative position the valve heads 236 and 237 close the ports 234 in the partitions 232 which define the left hand ends of the compartments 227 and 229 respectively. Hence water supplied through the inlet 162 goes to the compartment 227 and thence through the working orifice 164 which communicates with that end of the cylinder 12 toward which the plunger 13 was caused to move before the stem 167 was moved into the position now being described. Therefore the plunger will now be caused to move back toward its first position forcing fluid back into the valve 160 through the working orifice 166 and thence through the compartments 229 and 230 through the opening 223 and into the outlet manifold passage 221.

A feature of this valve 160 is that it operates with utmost ease, being balanced, and with a minimum length of stroke of the stem 167 to effect complete reversal of the direction of flow of fluid through the working orifices 164 and 166. Due to the tapering configuration of the opposed faces of the valve heads 236 and 237 only a relatively short stroke of the valve heads is necessary to remove them from their respective valve seats in the partitions 232 to present an area in the minimum space between the valve and the valve seat, at least as large as the minimum cross sectional area of the port 234 and thereby assure maximum flow. Another important feature of the valve 160 is that the stem 167 passes through the compartment 230 which is always in communication with the outlet 163, before passing through the packing 232 to the exterior of the valve; hence there never will be any pressure of fluid against the packing 232 in excess of that which prevails in the outlet or waste pipe and thereby offering substantially positive assurance that no leakage of fluid will occur around the stem 167.

It is preferred that actuating means for the valve 160 be provided which when performing its working stroke moves in only one direction, thus permitting the use of a flexible cord upon which tension can be imposed in order to actuate the valve stem 167 and cause it to move in either

direction. This arrangement adapts the valve 160 for use in connection with a tension cord or cable such as the cord 109 of Figures 1 and 9 or a hydraulically operated mechanism such as that of Figure 11. One simple means for attaining this result is illustrated in Figures 12, 14, and 15 and it comprises a bracket 241 affixed to one end of the housing 161 and having a shaft 242 journaled therein, the shaft 242 being disposed in a plane perpendicular to that of the stem 167. Mounted rotatably on the shaft 242 is a drum or shiev 243 to which the cord 244 is affixed after being wound around the drum 243 far enough to assure rotation of the drum 243 through 180° each time the cord 244 is pulled. A spring 246 preferably encircling the shaft 242 resists such rotation with the result that when the cord 244 is released the spring 246 will return the drum 243 to its starting position. The extent of rotation of the drum each time the cord 244 is pulled is limited by stops 247 and 248 carried by the drum in position to engage a detent 249 carried by the bracket 241. The drum 243 can slide axially upon the shaft 242, the same spring 246 serving to resist such sliding movement and to press the drum 243 downwards as viewed upon Figures 10 and 12 so that a dog 251 on the lower face of the drum is disposed in position to engage a dog 252 which is carried by an eccentric 253 also mounted for free rotation upon the shaft 242. Journaled upon eccentric 253 is an eccentric strap 254 connected as by a pin 256 with the valve stem 167 in such a manner that when the eccentric 253 turns through 180° the stem 167 is moving from one extreme of its movement to the other. The back faces of the dogs 251 and 252 are disposed obliquely so that after the valve stem 167 has been thus moved by rotation of the cam 253 imparted thereto by pulling upon the cord 244, the cord 244 can be released whereupon the spring 246 will rotate the drum 243 back to its starting position without similarly returning the eccentric 253 because the slipping surfaces of the dogs which then come in contact with each other merely cause the drum 243 to be pressed away from the eccentric 253 permitting the dogs to ride over each other without imparting rotation to the eccentric.

I claim:

1. In an operating mechanism of the character described, an hydraulic engine comprising a reciprocable piston, hydraulic means for moving said piston in either direction, and control means for determining in which direction said piston shall move, said control means comprising a valve adapted to be placed in either of two optional positions to direct hydraulic fluid to said engine upon the associated side of said piston, spring means for actuating said valve, and means actuated by said piston in moving in either direction for deforming said spring to store energy therein and for moving said spring to that position wherein it yieldably retains said valve in its then position but requires only slight movement of the valve from said position to cause said spring to urge this valve to move to its opposite position, movement of said spring by said piston while said piston is moving in one direction occurring as said piston is in the final portion of its stroke, and movement of said spring by said piston while said piston is moving in the oppo-

site direction, occurring as said piston is in the initial portion of its stroke.

2. In an operating mechanism of the character described, an hydraulic engine comprising a reciprocable piston, hydraulic means for moving said piston in either direction, and control means for determining in which direction said piston shall move, said control means comprising a valve adapted to be placed in either of two optional positions to direct hydraulic fluid to said engine upon the associated side of said piston, an oscillatably mounted spring carrier, a spring stressed between said carrier and said valve in position to urge said valve to either of said valve's positions while said carrier is in either of its extreme positions but requiring, for each position of said carrier, only slight tripping movement of said valve from one of its said positions for said spring to move said valve to its other position, and means operated by said piston just prior to its reaching one of its extremes of movement and again as the piston is just leaving that same extreme of movement for reversing the position of said spring carrier, and means for tripping said valve.

3. In an operating mechanism of the character described, an hydraulic engine comprising a reciprocable piston, hydraulic means for moving said piston in either direction, and control means for determining in which direction said piston shall move, said control means comprising a valve adapted to be placed in either of two optional positions to direct hydraulic fluid to said engine upon the associated side of said piston, an oscillatably mounted spring carrier, a spring stressed between said carrier and said valve in position to urge said valve to either of said valve's positions while said carrier is in either of its extreme positions but requiring, for each position of said carrier, only slight tripping movement of said valve from one of its said positions for said spring to move said valve to its other position, and means operable independently of said piston and from a position remote from said engine for tripping said valve, said valve tripping means being operable in either positions of said valve.

4. In an operating mechanism of the character described, an hydraulic engine comprising a reciprocable piston, hydraulic means for moving said piston in either direction, and control means for determining in which direction said piston shall move and comprising a valve mounted for rotary movement to either of two optional positions to direct hydraulic fluid to said engine upon the associated side of said piston, an arm rigid with said valve and extending radially therefrom to one side of a line parallel to the direction of movement of said piston and through the axis of rotation of said valve, a spring carrier rotatable on said valve and extending radially therefrom to the other side of said line, a spring interconnecting said arm and carrier and urging them to rotate toward each other, means actuated by said piston in moving in either direction for turning said rotatable arm away from said rigid arm through an angular distance slightly less than that necessary to carry the line of action of said spring past the axis of rotation of said valve and thereby placing said spring in readiness for subsequent reversal of the position of said valve.

HAROLD A. GREENWALD.