June 7, 1955 P. H. MAURER 2,710,186

DOOR OPERATION AND CONTROL

Original Filed July 21, 1948 4 Sheets-Sheet 1

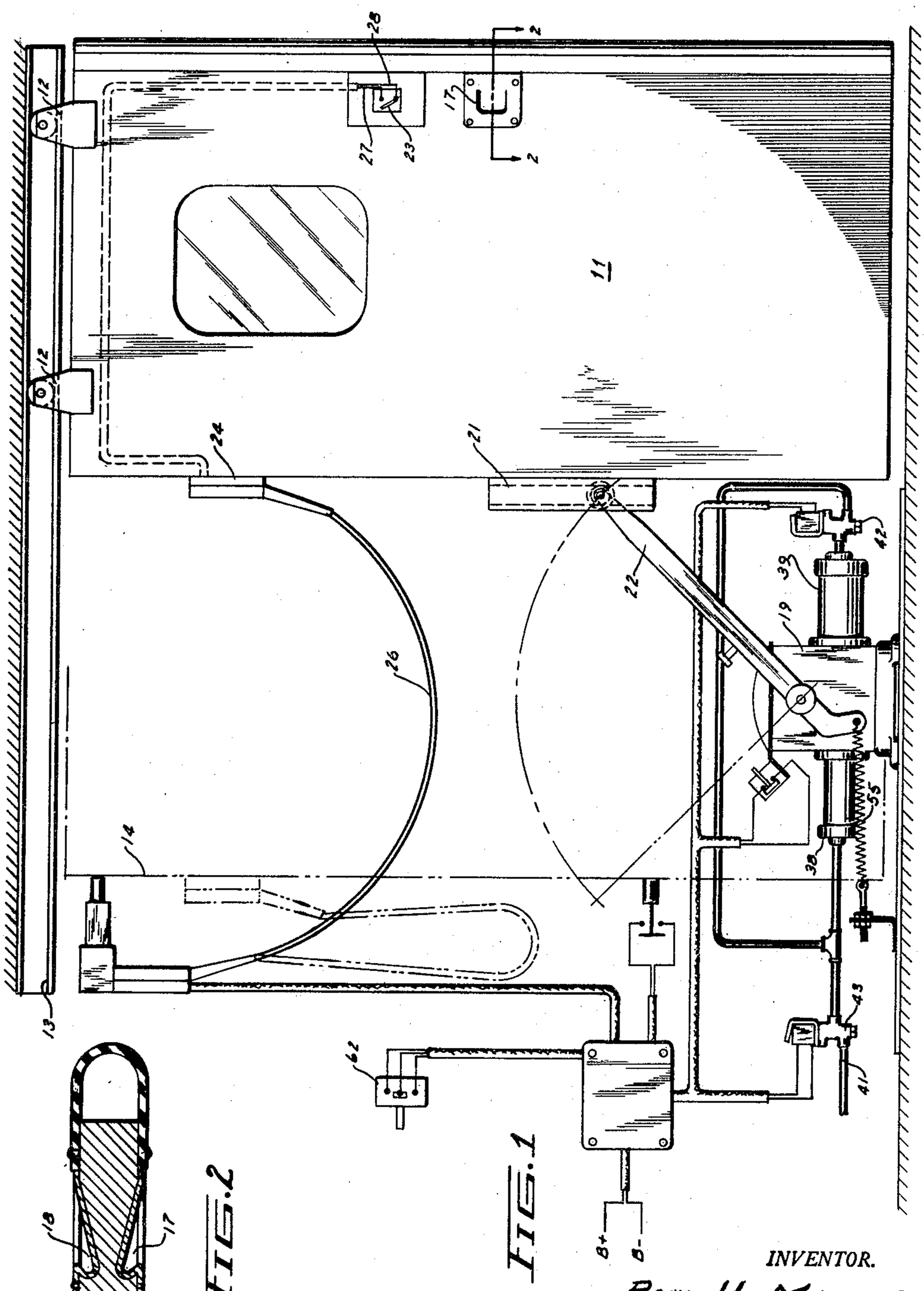

FIG. 1

FIG. 2

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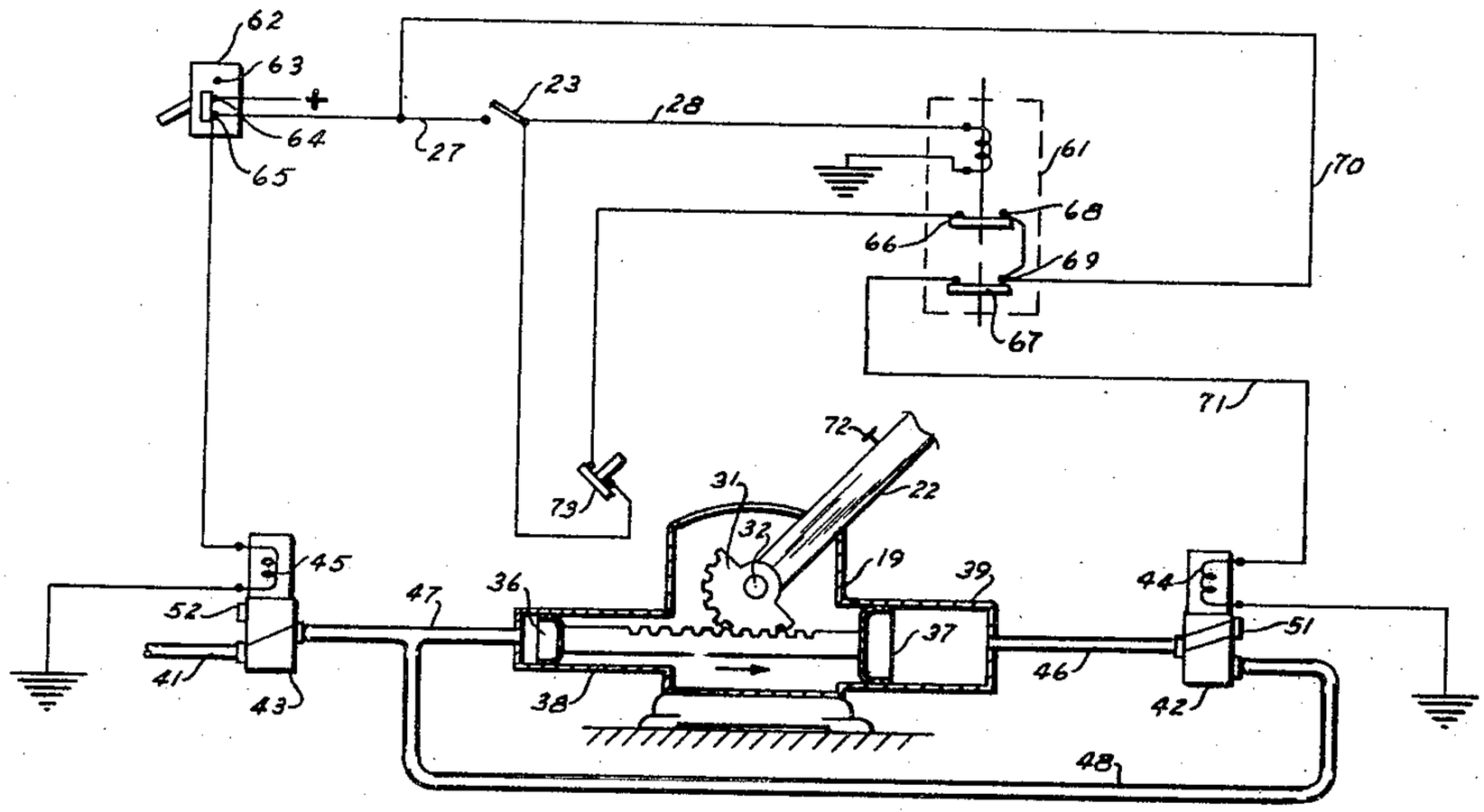

FIG. 3

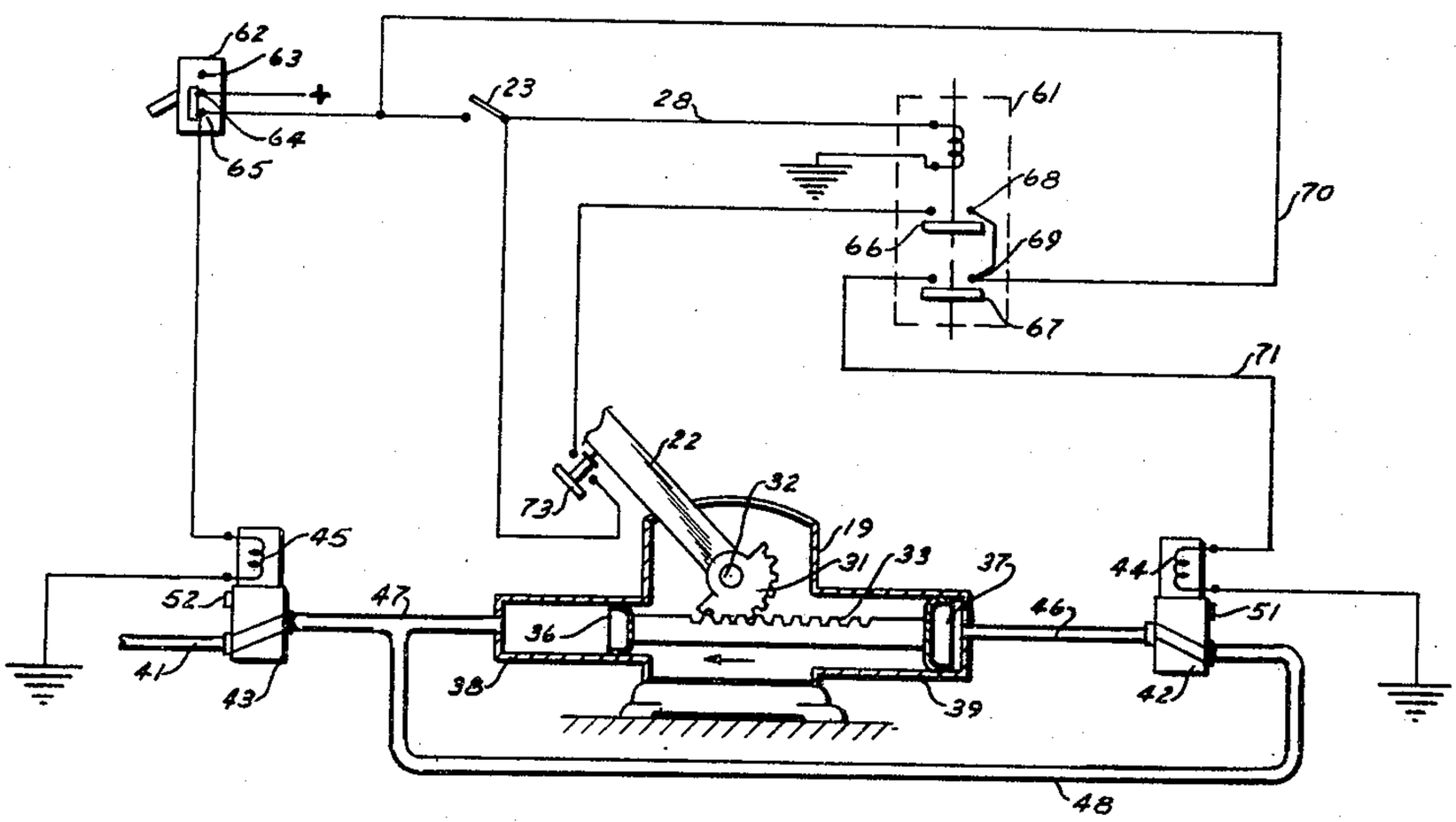

FIG. 4

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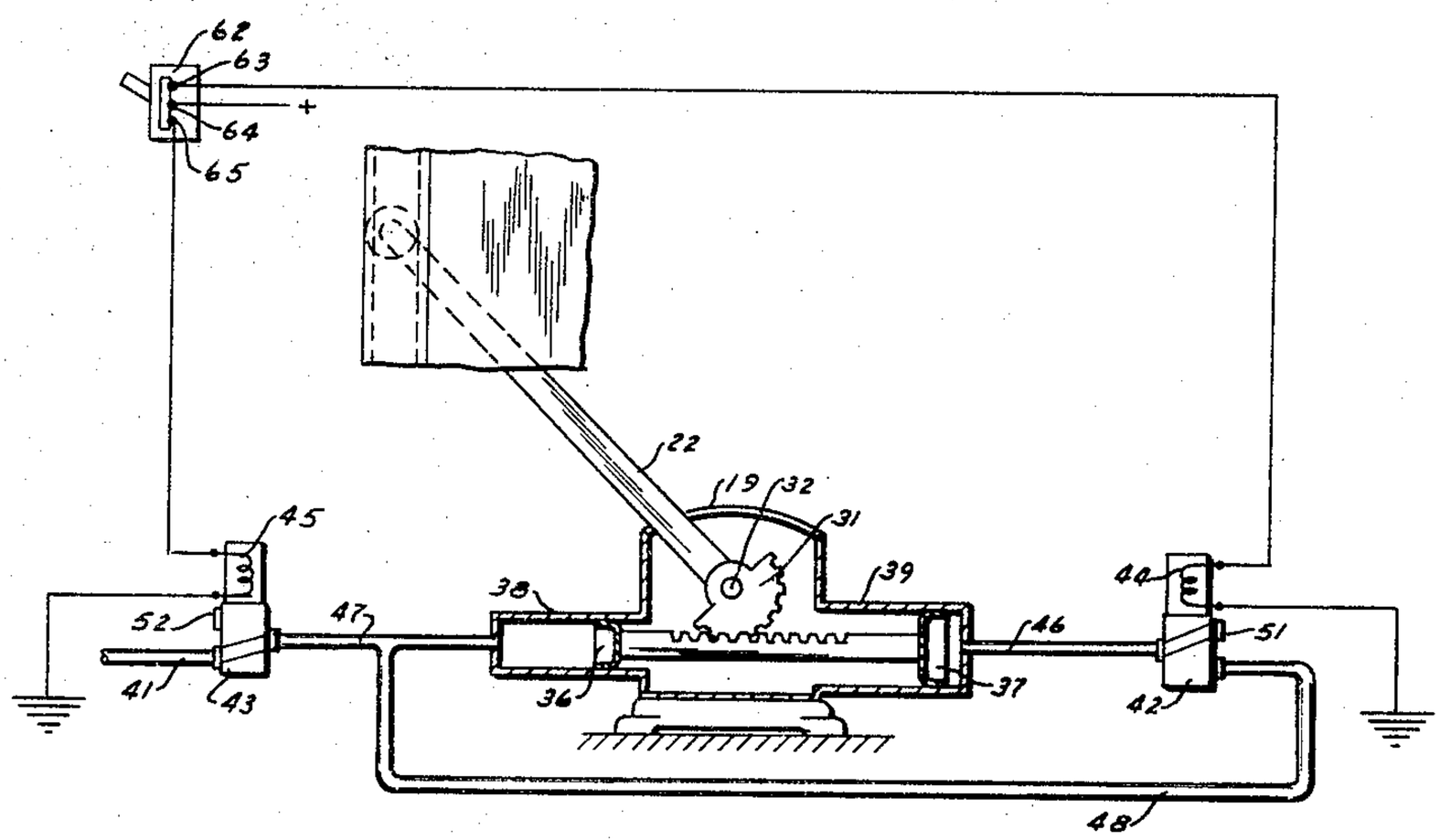
FIG. 5



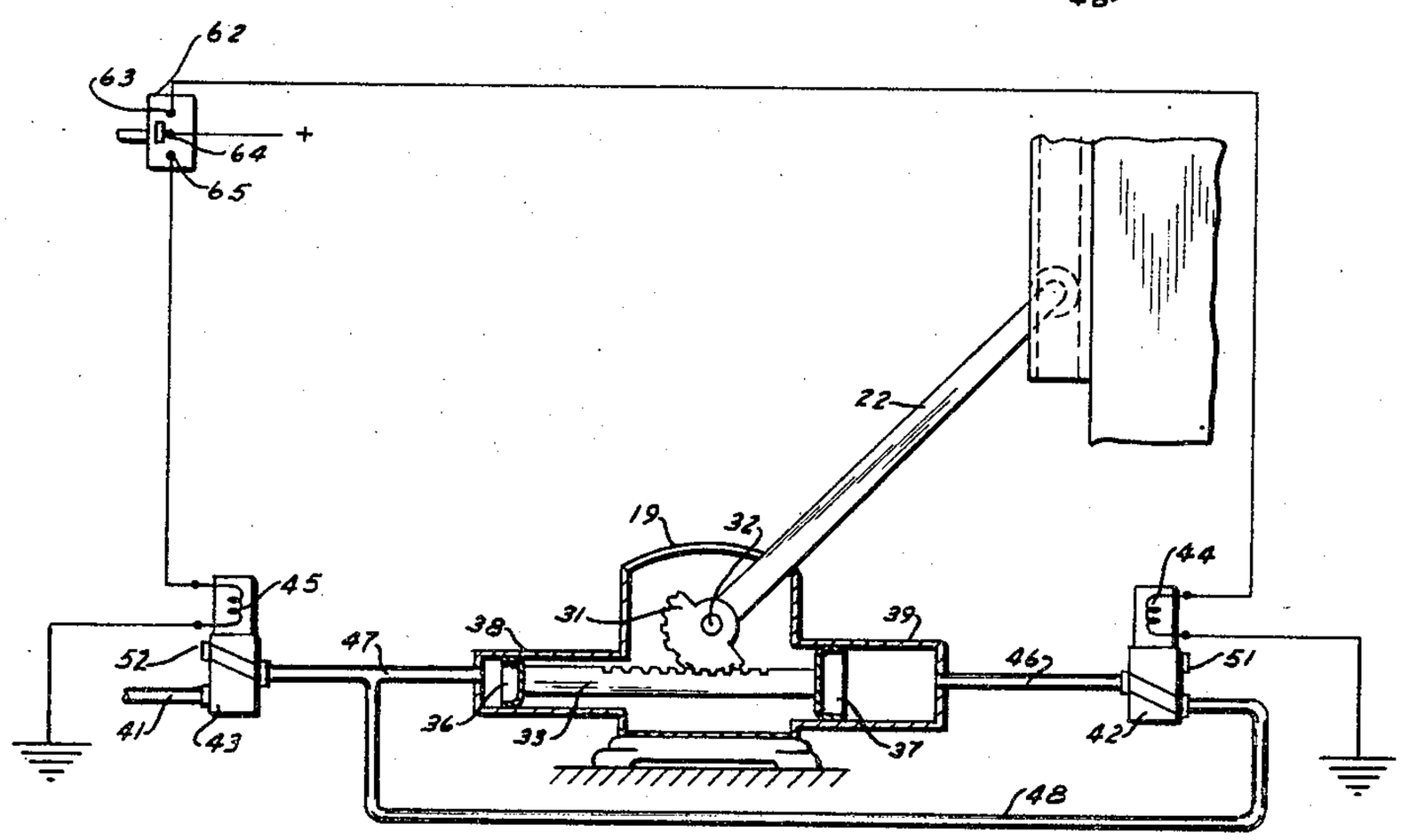


FIG. 6

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FIG. 7

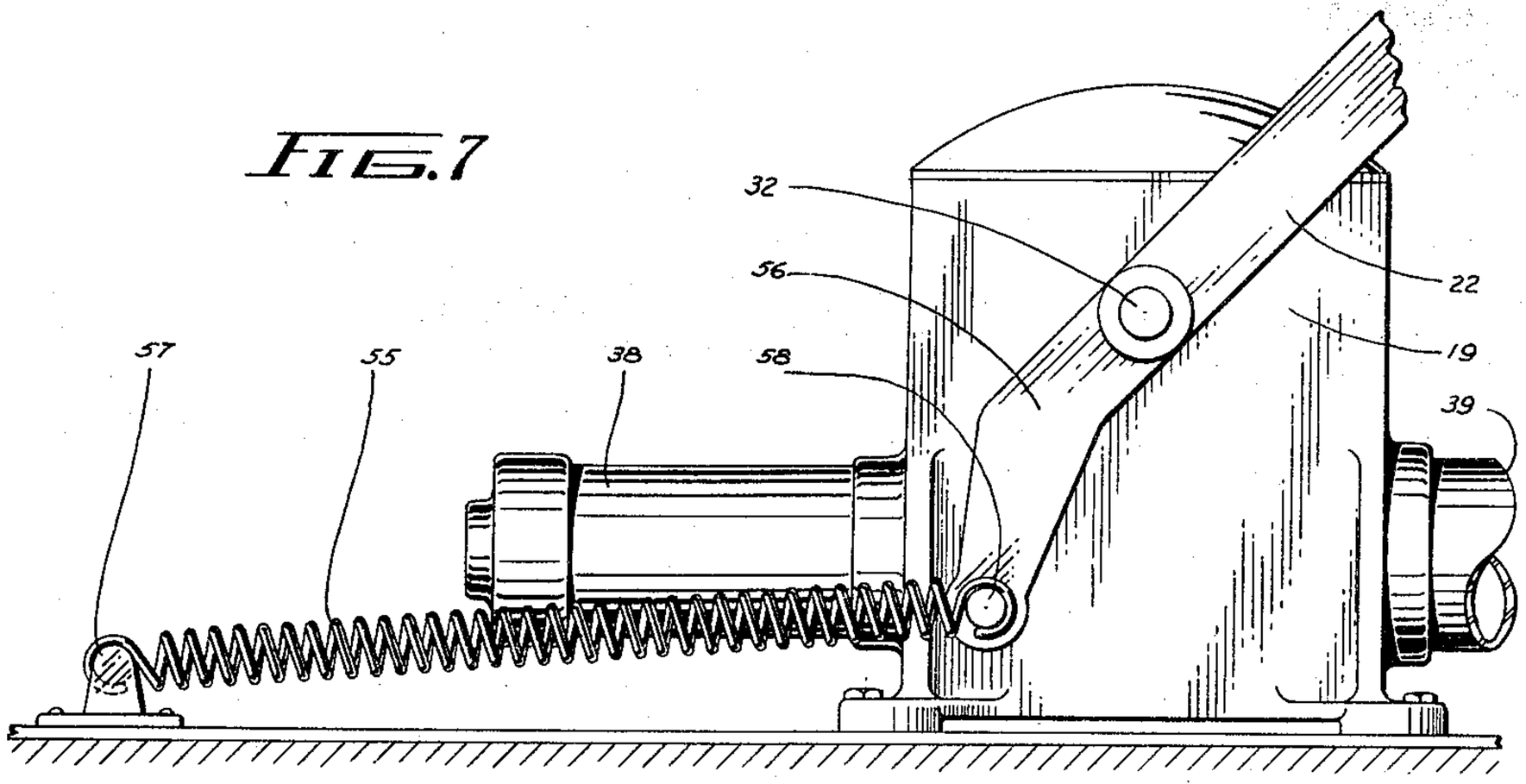
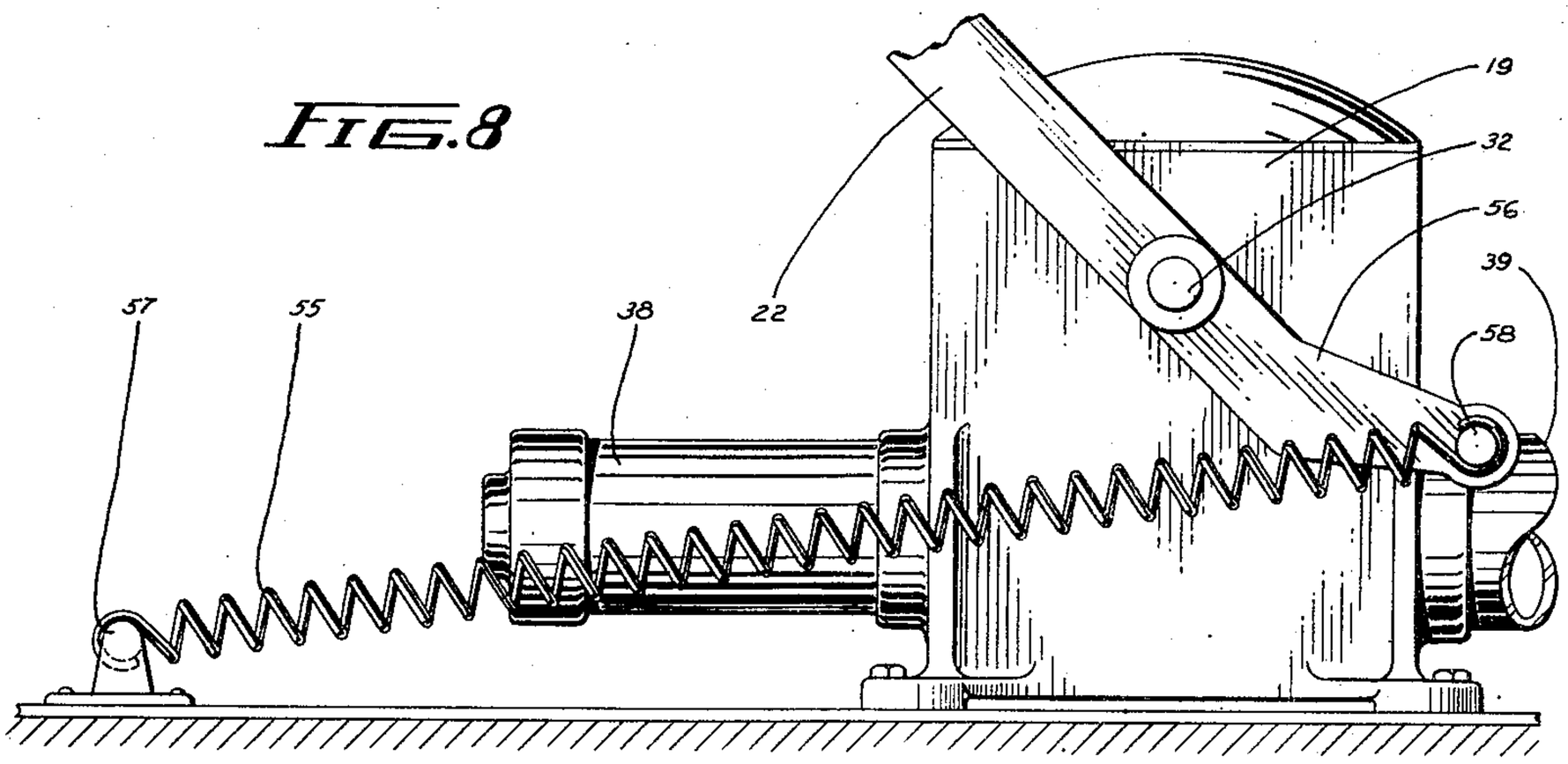


FIG. 8



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DOOR OPERATION AND CONTROL

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Original application July 21, 1948, Serial No. 39,961, now Patent No. 2,578,894, dated December 18, 1951. Divided and this application November 19, 1951, Serial No. 257,003

3 Claims. (Cl. 268—50)

This invention relates to door operation and control, and particularly to a system providing mechanical power for automatically opening a door, and mechanical power for automatically closing the door, after an interval of definite or indefinite duration, according to the selection of the person supervising the operation.

One object of the invention is to provide a novel method of controlling the operation of a door, which novel method involves the utilization of two power applying agencies conjointly under normal circumstances, with one of said power applying agencies being adapted to operate the door in one direction independently of the other power applying agency, in the event of temporary absence of an energy supply for the latter agency.

In the embodiment of the invention chosen for exemplification purposes, one power applying agency is a fluid motor so constructed and connected as to apply operating power in two directions alternately, while the other power applying agency is a spring of lesser capacity than the fluid motor, and effective to apply door operating power in the door closing direction only; the spring normally assisting the fluid motor in closing the door, but being readily yieldable during operation of the fluid motor to open the door, or on any occasion of manual opening of the door, so that there is only a relatively slight increase of power necessary to offset the effect of the spring during the opening stage of the cycle.

Another object of the invention, therefore, is to provide a door operating motor assembly including a spring of insufficient capacity to be an appreciable obstacle to easy opening of the door, either by the motor or by hand, while at the same time being capable of effectively closing the door, independently of any other agency, on any occasion when the motor is not functioning normally.

A further object is to provide a door operating assembly including an operating linkage normally actuated by two power applying agencies during the door closing stage of the cycle, and by only one of said power applying agencies during the door opening stage of the cycle.

Another object is to provide an assembly including a fluid motor, and a spring to assist the motor in one direction of operation.

A further object is to provide, in a motor-spring combination of the character indicated, a novel inter-relationship between the motor and spring, including a door operating linkage to which said motor and spring are both connected, but at different locations, affording different leverage effects for each.

Other objects and features of the invention will be apparent upon examination of the following description of the embodiment illustrated in the accompanying drawings, this being one of many embodiments to which the invention lends itself; it being understood that all such alternative embodiments, including all or any lesser number of components which may incorporate any of the

principles of the disclosed invention, are embraced herein.

In the drawings:

Fig. 1 is an elevation view of a door operating motor and spring combination, embodying the invention, the motor and spring being shown in operating relationship to a door to be operated;

Fig. 2 is a sectional view along line 2—2 of Fig. 1;

Figs. 3 to 6, inclusive, are schematic illustrations showing how the motor responds to changes in the setting of a three-position control element;

Fig. 7 is a view, on a larger scale, of a portion of the motor and door actuating linkage, with the spring shown contracted; and

Fig. 8 is a similar view, but with the spring shown extended.

Referring first to Fig. 1, the door 11 is shown as equipped with hangers 12 including rollers movable along a rail 13, whereby the door may move between the closed position shown in full lines and the fully open position indicated by dash line 14 in Fig. 1. The door 11 also carries two finger-grip plates 17, 18 secured near its forward edge, each having a recess (see Fig. 2) facilitating manual sliding of the door to the open position, from either side thereof, in the event of non-functioning of the motor 19. Other parts carried by the door include a channel plate 21 receiving one end of line 22, a switch 23 for initiating operation of the motor 19, and a cable connection box 24 to which one end of cable 26 is attached; the said cable housing the leads 27, 28 of the electrical connections shown more completely in Figs. 3 and 4.

Motor 19 is shown as including a gear sector 31 secured to a rock shaft 32, to which is also secured the link 22 above referred to; also a rack 33 meshing with the teeth of sector 31 and reciprocable with a pair of pistons 36, 37 housed in cylinders 38, 39, respectively, the latter being attached to opposite sides of the central motor housing 19. Cylinders 38, 39 are illustrated as receiving compressed air or other operating fluid from a common feed line 41, the feeding and exhausting of such fluid being under the control of a pair of valves 42, 43, the former being spring-biased to a fluid feeding position and shiftable to a fluid exhausting position upon energization of solenoid winding 44, and the valve 43 being spring-biased to a fluid exhausting position and shiftable to a fluid feeding position upon energization of solenoid winding 45. Conduits 46, 47 lead from valves 42, 43, to the cylinders 39, 38 respectively, and a third conduit 48 connects valve 43 with the supply port of valve 42. The exhaust ports of the two valves are indicated at 51 and 52.

As previously indicated, the invention includes the use of auxiliary door closing means of lesser capacity than the motor 19, yet of sufficient capacity to close the door independently of said motor in the event of absence of pressure fluid for energization of the latter. As shown best in Figs. 7 and 8, the link 22 extends beyond the point of connection with motor shaft 32, and the extension 56 is made in the form of a bellcrank so that its outer end is off-set laterally from the longitudinal axis of the major portion of the link, to provide progressively increasing leverage action about the axis of shaft 32, which is the pivotal point of the linkage, as the linkage is shifted (by spring 55) from the "Door-open" position (Fig. 8); the locations of spring anchorage pins 57, 58, in relation to point 32 and to each other, being such that the applied closing force of the spring and lever combination is a minimum, at the commencement of the door closing swing of the lever, and increases progressively as the swing continues, reaching a maximum value as the door approaches the fully closed position. This mode of operation is of advantage, not

only when the spring is acting as the sole closing instrumentality (in emergencies when the motor **19** is not functioning normally) but also in the normal functioning of the spring as an auxiliary agency to supplement the action of the motor **19**; for in executing such auxiliary function it is desirable that the spring provide greatest assistance toward the end of the stroke of the door closing piston **37**, at which time the fluid pressure resistance to the piston's continued motion is greatest, as will appear more clearly hereinafter.

The application of pressure fluid to the pistons **36** and **37**, of the motor **19**, is under the direction of a delayed-action relay **61** (Figs. 3 and 4) operating in conjunction with the solenoid windings **44**, **45**, the initiating switch **23**, and a three-position control switch **62**; the latter permitting manual selection of one of three distinct modes of operation.

The three possible modes of operation of the apparatus, as illustrated and described above, will be described in sequence, as follows:

Operation A.—Opening and closing of the door by power applied to motor **19**. Control switch **62** in "Automatic" position, bridging contacts **64**, **65** (Figs. 3 and 4).

With control switch **62** in the "Automatic" position bridging contacts **64**, **65**, a circuit is completed from the source to the winding 45 of "pressure" magnet valve **43** to direct pressure fluid through the valves **43** and **42** in succession, and thus into both cylinders **38** and **39**, through conduits **47** and **46**, respectively, thus placing the system in condition for successive automatic opening and closing movements of the door **11**; the door being now in the closed position, as the differential of pressure on pistons **36** and **37** is such as to hold said pistons in their extreme leftward position (Fig. 3).

Let it be supposed that, with the parts in the positions just indicated, a person desiring passage through the closed door **11** moves the door switch **23** to the closed position. This action produces a flow of current to the winding of relay **61**, by way of conductors **27** and **28**. Energization of the relay winding is immediately effective to snap the bridging members **66** and **67** of the relay into bridging relationship to contacts **68** and **69** respectively, which bridging relationship continues for three, four, five, or more seconds, according to the adjustment (not shown) of the delayed action dash-pot or other mechanism governing the return of the bridging member to their normal (non-bridging) position.

During the continuance of this bridging relationship of parts **66** and **67** to contacts **68**, **69** respectively, current flows from the source to the winding **44** of "exhaust" magnet valve **42**, the path of flow being by way of conductor **70**, parts **69** and **67**, and conductor **71**. The result of this activation of valve **42** is to exhaust pressure fluid from cylinder **39**, by way of conduit **46**, whereupon pistons **36**, **37** move from left to right (the pressure on the left side of piston **36** being now dominant) and causes the door **11** to swing from the closed position to the open position. Upon reaching such open position, striker **72** moves the switch **73** to the open position as shown in Fig. 4, thus breaking the holding circuit from the relay **61**, whereupon (after the time delay has run its course) member **67** drops away from contact **69**, thus de-energizing exhaust magnet **44**. Pressure fluid instantly re-enters the line **46** and the cylinder **39**, to the right of piston **37**, moving the piston assembly **36**, **37** to the left and thus returning the door **11** to its closed position. During such return spring **55** assists the piston **37**, the amount of such assistance progressively increasing as the door progresses toward fully closed position as previously noted.

Operation B.—Causing the door to be held in the open position. Control switch **62** in "Remain open" position, bridging contacts **63**, **64**, **65** (Fig. 5).

When a train porter, or other person, desires to have the door open, and remain open for a period of unmeasured duration, the switch **62** can be thrown to the "Remain open" position, thus establishing a circuit from the source direct to the exhaust valve magnet winding **44**, by way of bridged contacts **63**, **64** of said switch **62**. As this circuit maintains the valve **42** in a position which continuously vents cylinder **39** to the atmosphere, by way of conduit **46** and port **51**, it will be apparent that once the door has been opened (as previously described) it will remain open because of the absence of any closing pressure fluid in cylinder **39**; the spring **55** being of insufficient capacity to close the door of itself, so long as full air pressure is applied to piston **36**.

Operation C.—Closing the door by the spring **55** alone. Control switch **62** in "manual opening" position, in which all three contacts **62**, **63** and **64** remain unbridged (see Fig. 6).

Placing control switch **62** in its third position (Fig. 6) breaks the normally closed circuit from the source to the winding **45** of "pressure" magnet valve **43**. This causes a shift of valve **43** to the fluid exhausting position, whereupon spring **55**, after any manual opening of the door **11**, will move the door back to the closed position, through the agency of the link **22**, the latter also acting to move the pistons **36** and **37**, all of which are now free of fluid pressure influences. As a result of this action of spring **55**, the door is moved back to the closed position without any fluid pressure assistance, following any opening thereof manually, so long as switch **62** remains in this third position.

The spring **55** will also function as an automatic power closing agency for the door during any absence of effective electric current, for in either of these situations there will be no fluid-pressure inducted restriction on the free expansion of spring **55**, following each compression thereof.

This application is a division of applicant's application Ser. No. 39,961 of July 21, 1948, now Patent 2,578,894 entitled "Door Operation and Control."

What I claim is:

1. In a door operating system, in combination, a door, a movable linkage connected thereto, operating means normally freely movable in either of two directions and connected to said linkage and, through said linkage, to said door, movement of said operating means in a first direction causing said door to open and movement of said operating means in a second direction causing said door to close, a spring positively connected to said linkage so as to constantly resiliently urge it to move so as to close said door and having a strength sufficient to close said door when no force is applied to said operating means, a source of power operatively connected to said operating means, and control means operatively connected to said source of power to selectively condition the latter to (*a*) exert a force on said operating means capable of overcoming the resistance of said spring and causing said operating means to move in said first direction until said door is open and then automatically exerting a force on said operating means causing said operating means to move in said second direction to close said door, (*b*) exert on said operating means a continuous force capable of overcoming the resistance of said spring and causing said operating means to move in said first direction until said door is open and then remain in said open position, and (*c*) exert no appreciable force on said operating means either to cause or to oppose motion in either direction, said operating means being then free to move in said second direction under the influence of said spring.

2. The door operating system of claim 1, in which said control means is electrically energized and includes a manually settable switch to condition said source of power to conditions (*a*) or (*b*), failure of electrical power thereto causing said source of power to be conditioned to condition (*c*).

3. The door operating system of claim 1, in which

said control means is electrically energized and includes a manually settable switch to condition said source of power to conditions (*a*), (*b*) or (*c*), failure of electrical power thereto causing said source of power to be conditioned to condition (*c*).

References Cited in the file of this patent

UNITED STATES PATENTS

2,254,388 Olcott ---------- Sept. 2, 1941
2,388,182 Redding et al. ---------- Oct. 30, 1945
2,504,408 Griffin ---------- Apr. 18, 1950
2,558,867 May et al. ---------- July 3, 1951
2,573,160 Norman ---------- Oct. 30, 1951
2,578,894 Maurer ---------- Dec. 18, 1951
2,578,909 Turner ---------- Dec. 18, 1951
2,586,442 Seagren ---------- Feb. 19, 1952
2,606,022 Vander Veer et al. ---------- Aug. 5, 1952