Oct. 5, 1965 J. M. LINDER ETAL 3,210,065

HYDRAULIC DOOR OPENER

Filed Oct. 17, 1962 4 Sheets-Sheet 1

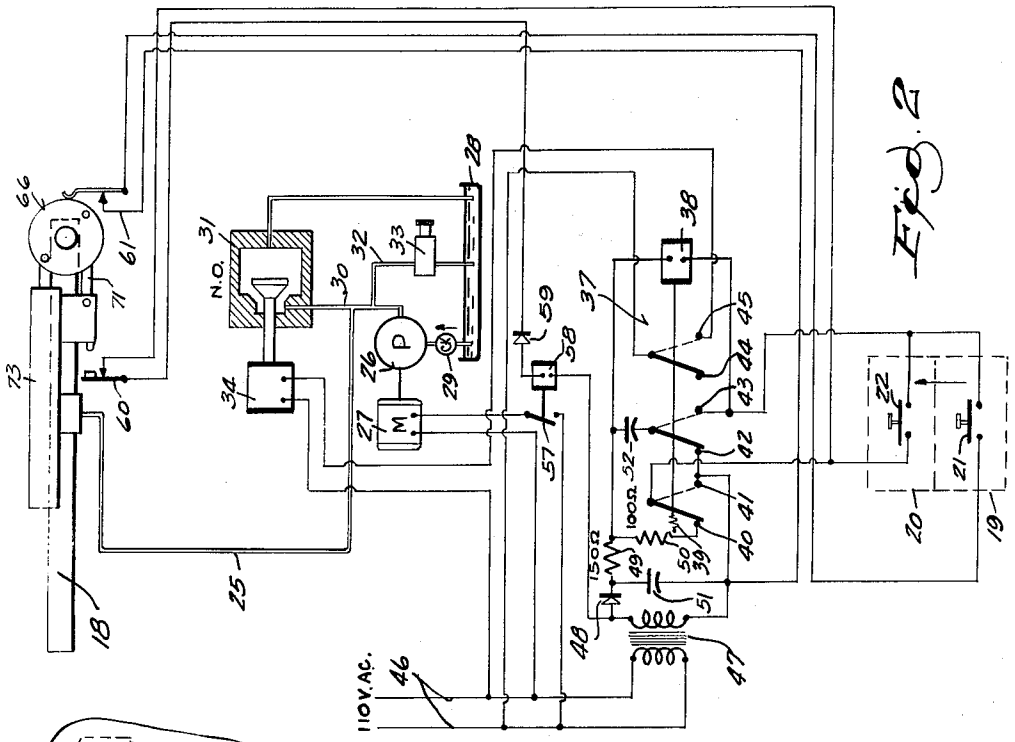


Fig. 2

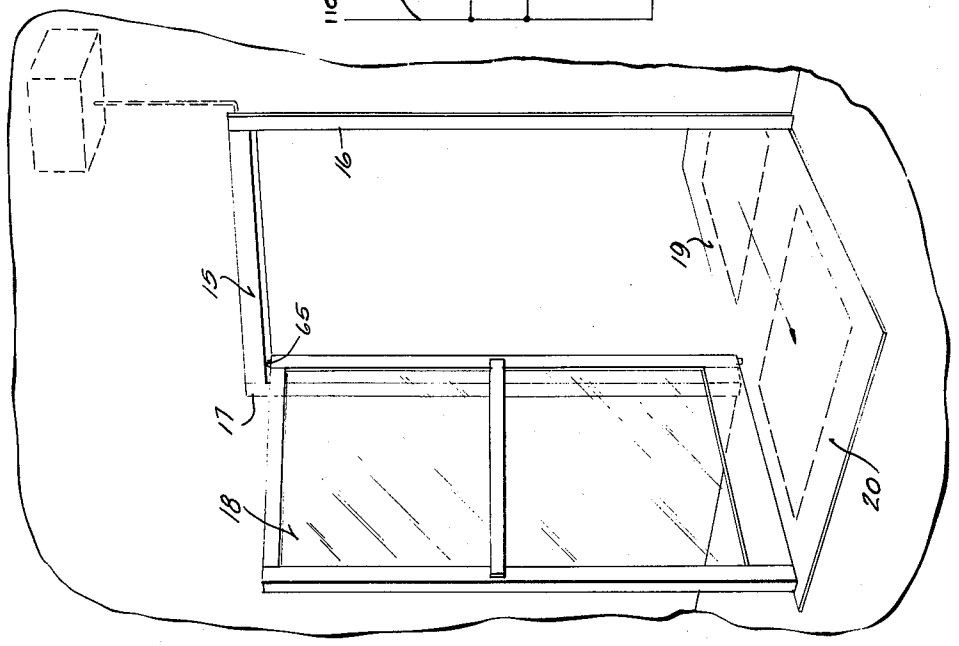


Fig. 1

INVENTORS
JOSEF M. LINDER
RAYMOND H. BOEHM
BY
Wheeler, Wheeler & Wheeler
ATTORNEYS

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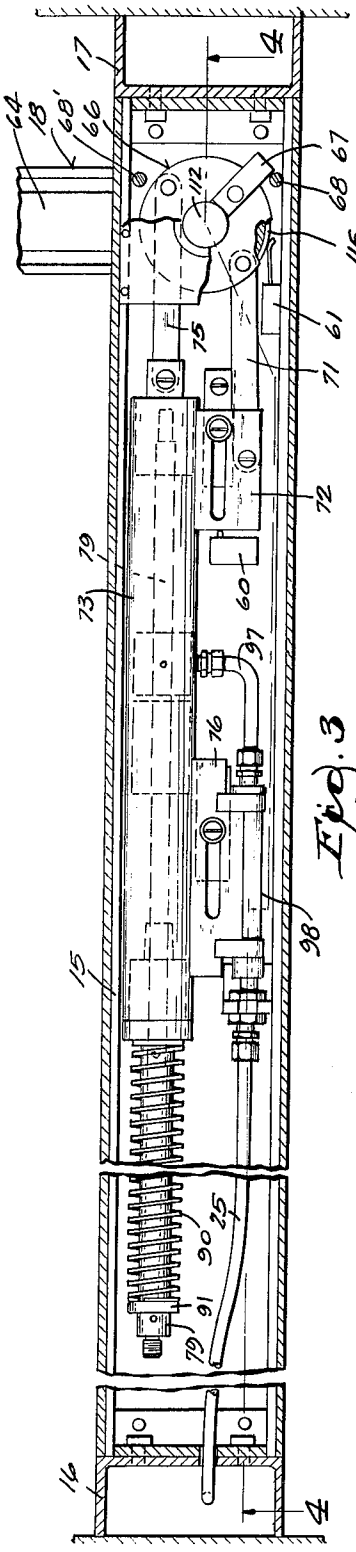


Fig. 3

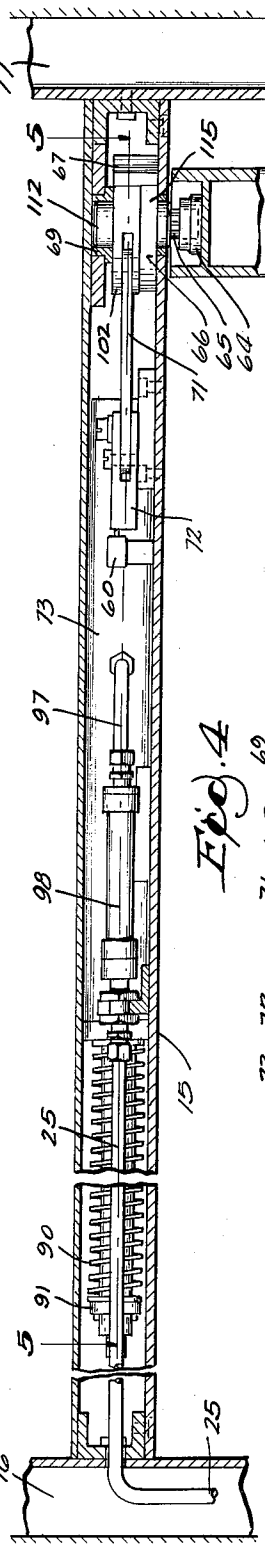


Fig. 4

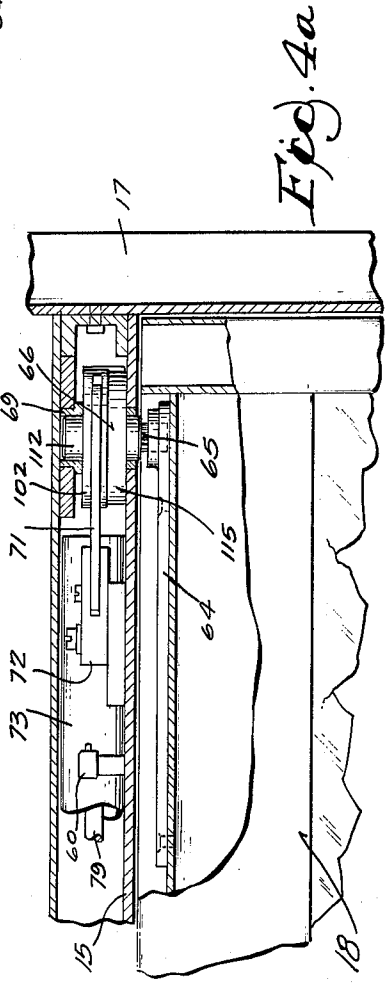


Fig. 4a

INVENTORS
JOSEF M. LINDER
RAYMOND H. BOEHM
BY
Wheeler, Wheeler & Wheeler
ATTORNEYS

Oct. 5, 1965 J. M. LINDER ETAL 3,210,065

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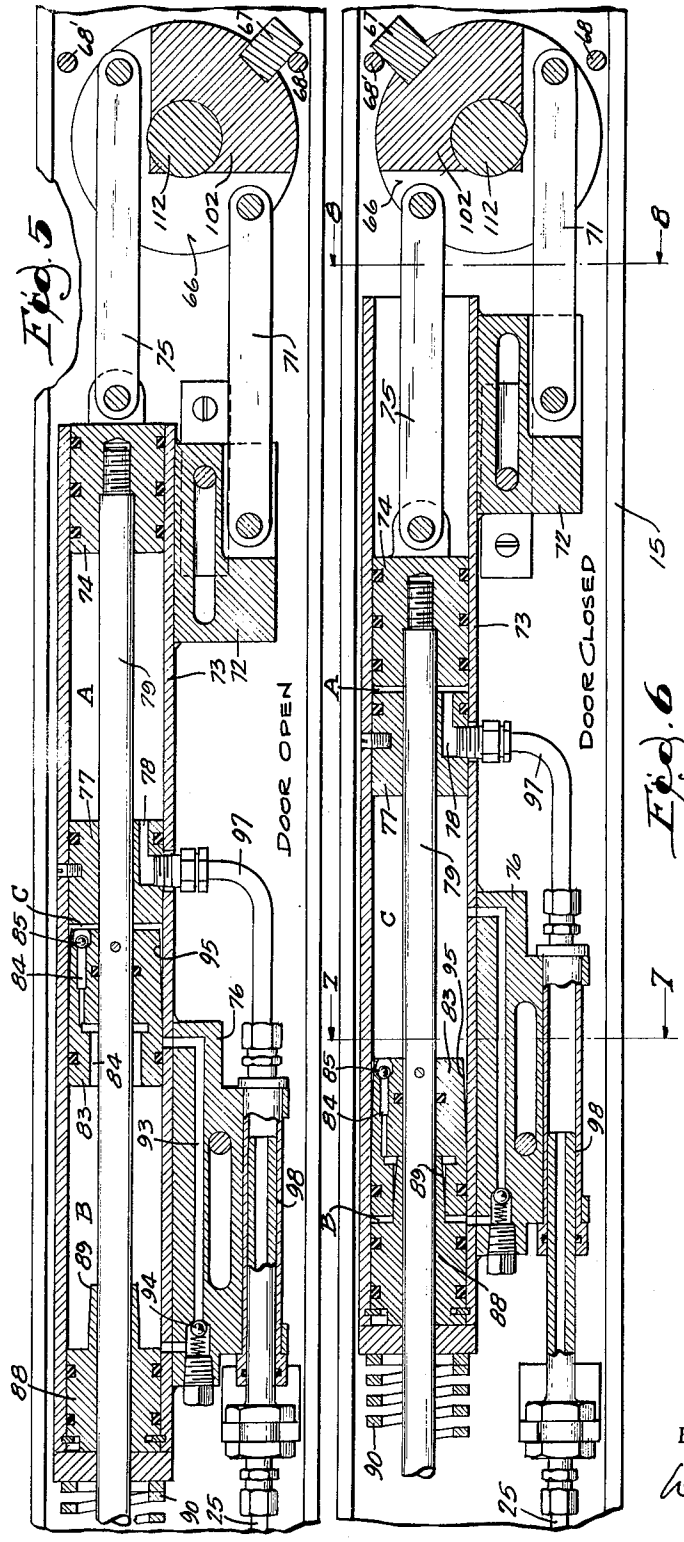


Fig. 5

Fig. 6

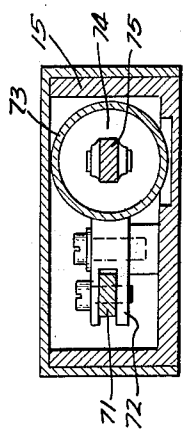


Fig. 8

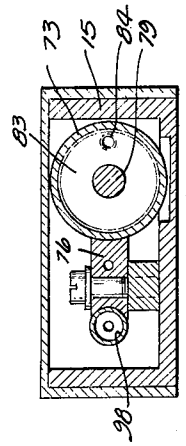


Fig. 7

INVENTORS
JOSEF M. LINDER
RAYMOND H. BOEHM
BY
Wheeler, Wheeler & Wheeler
ATTORNEYS

Oct. 5, 1965 J. M. LINDER ETAL 3,210,065

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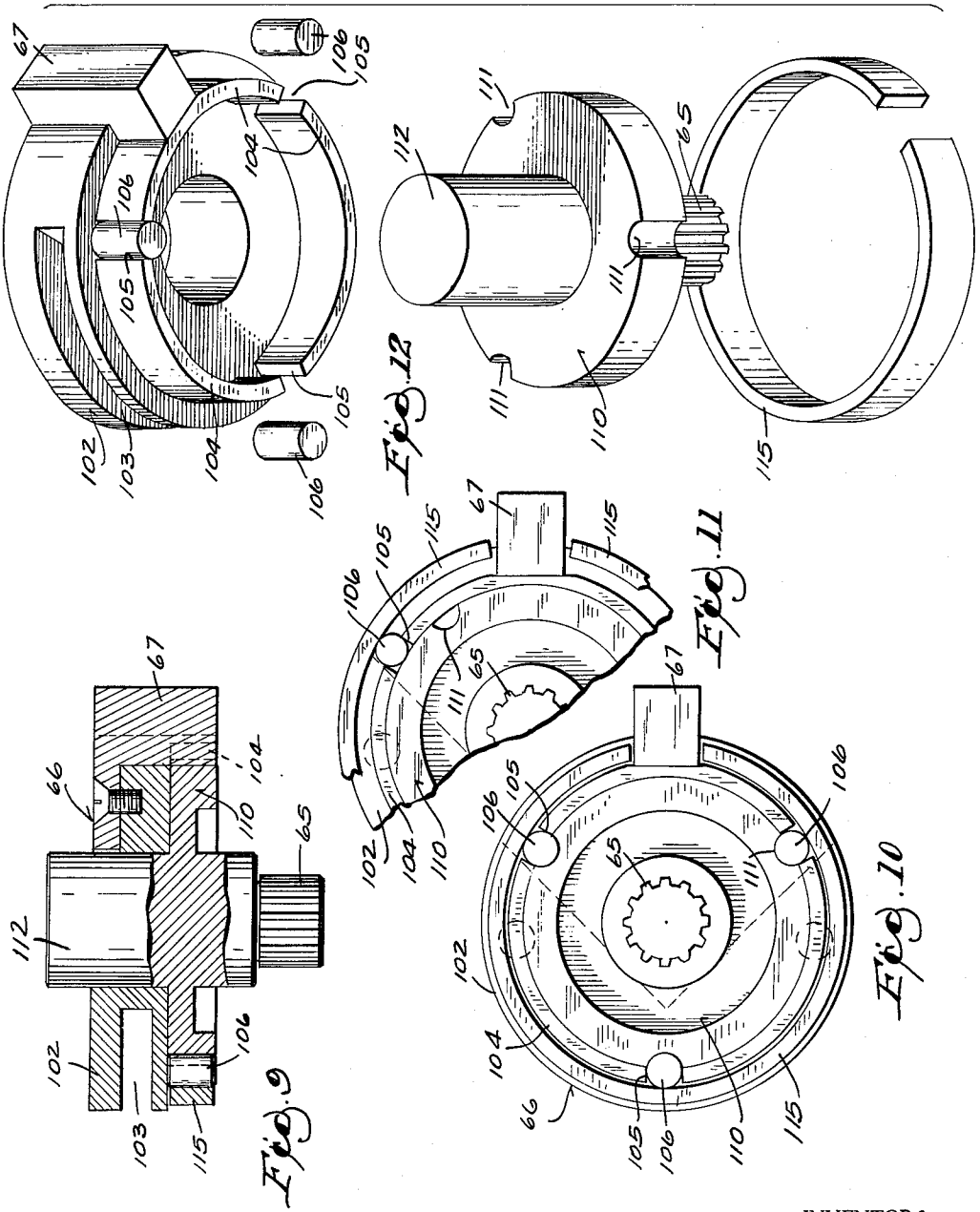


Fig. 12

Fig. 11

Fig. 10

Fig. 9

INVENTORS
JOSEF M. LINDER
RAYMOND H. BOEHM

BY

Wheeler, Wheeler & Wheeler
ATTORNEYS

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HYDRAULIC DOOR OPENER

Josef M. Linder, Delavan, and Raymond H. Boehm, Racine, Wis., assignors to Crown Industries, Inc., Racine, Wis., a corporation of Wisconsin

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7 Claims. (Cl. 268—34)

This invention relates to improvements in automatic hydraulic-powered door operating mechanisms which are normally controlled by switches in two mats laid through the doorway, and in which the mechanism is connected directly to a door by a crank-clutch releasing the door when a force acts in a direction to reverse the swing of the door.

The present mechanism presents a casing having the shape and dimensions of the lintel in a modern door frame and which can serve as the lintel or be placed therein or be placed alongside the lintel. A hydraulic power cylinder and a control cylinder are aligned or are made in one piece, and the control piston is attached to the power piston. The control piston is under fluid pressure on two sides thereof and fluid flow between such piston sides is progressively reduced as the power piston moves. A compression spring aligned with the power-control cylinder recloses the door and the entire operator mechanism requires so little adjustment that it can be put within the door frame excepting for the source of fluid pressure and its valves and electrical parts, which can be placed at any desired location remote from the door.

Both the cylinder and the piston slide in the casing so that their movements are additive and total movement is obtained which is two times the length of the stroke of the power piston alone. Hence, a 2:1 mechanical advantage is obtained and the fluid pressure need be only one-half the pressure otherwise required, but double the amount of oil is used as compared to higher pressure units. A balance push-pull thus acts on the door swinging shaft and reduces side stresses and torque on the shaft. Lower pressure and the placing of only simple control means within the door operating mechanism casing makes the placing of such mechanism in the door frame lintel completely practical and allows direct connection of the operating mechanism with the door.

A crank-clutch oscillates in the casing and is connected to both the cylinder and the power piston to swing the door through 90° in a given direction. The clutch releases when sufficient manual pressure is put on the door in reverse of the normal swinging direction, to flex a garter spring and allow dogs to move from a seat in one clutch member while remaining seated in the other clutch member. Relative movement between the clutch parts is then possible and the door can open regardless of the spring pressure tending to keep it closed. When the manual pressure is released, the clutch parts remain in their released position, and the door remains open, until the door is manually swung back to its position before release of the clutch.

Generally, the hydraulic pressure supply unit may be remotely located and is connected with the door operator only by a single line of piping for hydraulic pressure and a number of electrical lines. The operating cylinder has an intermediate fixed partition and a power piston acting

from one cylinder end so that the partition and piston define a first or power chamber. A control piston moves between the partition and the other end of the cylinder to define two other chambers each of which acts as a dashpot to regulate movement of the power piston during automatic operation. In one condition, the control piston co-acts with a bypass externally of the cylinder to exchange fluid between two control chambers, and in another condition, the fluid passes directly through the control piston. The combined power and control cylinder is slidably mounted so that the cylinder movement doubles the piston movement. A spring is compressed as the door is opened and expands as the door is closed so that there is a piston power stroke in only one direction.

The power cylinder and power piston are each connected at one end of a diameter of the release clutch which acts between stops spaced 90° severally determining door opened and door closed position. The pressure supply line is constantly filled with fluid but the door may be operated manually in case of power failure. The release clutch includes an outer member connected with both the power cylinder and the power piston for movement of the outer clutch member between the stops. Dogs engage in gaps in a skirt on the outer member and seat in pockets in an inner member under pressure of a spring. The dogs are released from their seats when force is put on the door for swinging in reverse direction, so that the dogs roll between the inner member periphery and the spring and relative movement is possible between the two clutch members. When the door is again swung in its normal arc of movement, the dogs again seat in the inner member and the clutch again acts as a unit.

In the drawings:

FIG. 1 is a perspective view showing the present door operator applied to the door.

FIG. 2 is a diagram showing electrical circuits and hydraulic circuits of the present device.

FIG. 3 is a top plan view of the door operator in its casing and forming a part of the door frame.

FIG. 4 is a side view of the door operator and a partial view of a door with parts broken away to illustrate the connection between the door and the door operator.

FIG. 4*a* is a fragment similar to FIG. 4 but showing the associated door operator and door parts in closed position.

FIG. 5 is a longitudinal section on line 5—5 of FIG. 4, of the door operator showing the parts in position when the door is opened.

FIG. 6 is a view similar to view in FIG. 5 but showing the parts in position when the door is closed.

FIG. 7 is a cross section on the line 7—7 of FIG. 6.

FIG. 8 is a cross section on the line 8—8 of FIG. 6.

FIG. 9 is a side elevation, partially in section, of the crank-clutch of the present invention.

FIG. 10 is a bottom view of the clutch showing the dogs thereof engaging both the inner and outer clutch members.

FIG. 11 is a fragment of a view similar to FIG. 10 and showing the position of dogs when there may be relative movement between the two clutch parts.

FIG. 12 is an exploded perspective of the clutch parts.

Referring specifically to the drawings, FIGS. 1, 3 and 4 show that the casing **15** for the door operating mechanism together with the hollow vertical members **16, 17** form a frame for the door **18**. The usual electrical door opening mat **19** and door closing-safety mat **20** are laid

through the doorway and respectively provide electrical switches 21 and 22 which complete electrical circuits as will be described. The source of fluid pressure for the door operating mechanism is pump 26 (see FIG. 2) driven by an electrical motor 27 and drawing liquid from a sump 28 through a check valve 29. The liquid is discharged from the pump by way of a pipe 25 directly to the door operating mechanism, or may flow by way of line 30 through a valve 31 or by way of line 32 and a relief valve 33 back to the sump. The valve 31 is operated by a solenoid 34.

Mat door switches 21 and 22 act through a main switch 37 operated in one direction by a solenoid 38 and normally operated by a spring 39 in the other direction, and having contacts 40–45. An electric current source 46 is connected by a secondary winding of transformer 47 to a control circuit including solenoid 38, rectifier 48, resistors 49 and 50, and capacitors 51 and 52. Power from the electric line 46 is connected to motor 27 through switch 57 having its solenoid 58 connected to the secondary of transformer 47 and through a rectifier 59 with a switch 60 which is opened when the door operator has fully opened the door. The valve solenoid 34 is also connected with the power source 46 under control of contact 45 and the main switch 37. A switch 61 is placed where it is opened by expansion of a part of clutch 66 to disengage the clutch and both the normal opening and closing circuits are opened by the switch.

If persons stand on mat 20 on the inner side of the doorway and press on the door to swing it in reverse direction (in case of fire or the like), the circuits of mat 19 must be opened. If a person stands on mat 20 and another person steps on mat 19, a circuit is established between contacts 40 and 41. But resistors 49 and 50 reduce the resulting current surge to solenoid 38 so that the remaining current is too low to activate the solenoid. Hence the door remains closed.

The door 18 has attached thereto a plate 64 with an internally toothed boss to form part of a splined connection with a spline 65 on a panic release clutch 66 which is rotatively mounted in casing 15 in a bearing 69. The clutch 66 normally rocks in its bearing as a whole as far as its arm 67 permits before engagement with stop 68 or 68' in casing 15. The release clutch disengages the door from the door operating mechanism whenever pressure above a given amount is exerted on the door in an attempt to swing it open in the reverse direction of one pivot providing connection for a rod 71 pivotally connected at its other end to a block 72 slidably mounted on a bolt in the casing and connected with a hydraulic cylinder 73. The cylinder 73 contains a power piston 74 (see FIGS. 5 and 6) which is connected by a rod 75 to a pivot diametrically across clutch 66 from the pivot for rod 71. The cylinder 73 has affixed thereon another block 76 which is also slidably mounted on a bolt in the casing 15 so that movement of cylinder 73 is guided at the two points. The block 76 provides a passageway therein and carries a pipe connection to be described.

The cylinder 73 has a partition 77 therein which is held in a fixed location and which co-acts with power piston 74 to define a power chamber in the cylinder, which is marked A in FIG. 5. The partition is sealed to the cylinder wall and has a passage 78 therethrough by which fluid under pressure is delivered to and discharged from the power chamber A. Partition 77 has a bore therethrough for a rod 79 connected with the power piston 74 and such rod has pinned thereto a control piston 83 with a passage 84 therethrough. Control passage 84 has a check valve 85 at one end thereof so that fluid cannot flow through the passage 84 toward the left as shown in FIGS. 5 and 6, but can readily flow through such passage toward the right. The other end of passage 84 is cylindrical and surrounds the rod 79. The rod 79 passes through an end head 88 which is sealed and locked in the cylinder 73 and such end head has a conical plug 89 entering the partition cylindrical passage 84 as the control piston 83 moves toward the end of the cylinder and thereby defines a first control chamber between the cylinder partition 77 and the control piston 83. The first control chamber is marked B in FIG. 5 and the cylindrical end of passage 84 and the end of the head plug 89 are so related that the chamber B is never entirely eliminated. Hence the cylinder 73 has three chambers of which two are shown in full volume in FIG. 5 and a third one is shown in full volume in FIG. 6 and is designated C.

The rod 79 extends through the cylinder end head 88 and bears a flanged nut 91 which seats one end of a compression spring 90 bearing at its other end on the end of the hydraulic cylinder 73. It is especially noted that FIG. 5 shows the position of the control piston 83 when the door is opened. The sliding block 76 on the cylinder 73 has a passage 93 therethrough with a check valve 94 under spring pressure and the passage can connect the residue of chamber B with chamber C to allow fluid flow from C to B and through passage 84 from chamber B to chamber C. As the plug 89 enters the passage 84, a progressive damping action of control piston 83 to left takes place due to the entry of conical plug 89 of end head 88 into control piston passage 84 until such plug reaches the position shown in FIG. 6 when the door is closed. Flow from C to B is by way of passage 93 and valve 94 as control piston 83 moves toward the right from its position in FIG. 5. The control piston has a conical portion 95 which progressively reduces the opening into passage 93 and thus progressively damps movement of the control piston to the right into the position shown in FIG. 5 when the door is open. The power chamber A is connected by way of partition passage 78 with a fluid pipe line 97 having a sliding connection 98 with the pipe 25 from the pump 27. Hence fluid pressure always acts to and from the chamber A by way of the pipe line 97, 98 and 25 and fluid in the chambers B and C flows through the passages 84 and 93 dependent upon the direction of movement of the control piston.

Referring now to FIGS. 9–12, the clutch 66 is rotatably supported in bearing 69 (see FIG. 4) in casing 15. The crank-clutch comprises an outer member 102 which is substantially annular in shape and has a slot 103 into which cylinder rod 71 and piston rod 75 extend for pivotal connection at the ends thereof. Outer member 102 has a skirt 104 extending from one side and such skirt has gaps 105 at three points for receiving cylindrical dogs 106. An inner member includes a disk-like portion 110 with three pockets 111 for seating the dogs 106 and such member can be brought to the position at which the pockets are opposite the gaps 105 in the skirt so that the dogs seat in both the pockets and the gaps, and are effective to prevent relative rotation of the two clutch members. A stub shaft 112 from one side of the disk of the inner member, extends through the central hole in the outer member for entry into the bearing 69 while the end of the shaft on the other side of the disk is splined at 65 to engage the splined boss on the plate 64 on the door.

A relatively heavy garter spring 115 fits around the dogs 106 and there is no possibility of relative movement of clutch members when the dogs are seated in the pockets and in the skirt gaps of the clutch as shown in FIG. 10. The spring 115 is held against rotation relative the outer clutch member 102 by engagement of the end of the spring with the clutch arm 67. In normal operation of the door, the parts are in the relative positions shown in FIG. 10, that is, the dogs seat in the pockets in the periphery of the inner clutch member and extend through the skirt gaps 105 of the outer clutch member and put the spring 115 under stress. When only normal forces are applied for opening and closing the door, the clutch parts remain in the above position and the clutch acts as one piece in transmitting the motion of the power piston 74 to the door. When the door is closed, fluid

pressure acts in the cylinder **73** and the parts therein are as shown in position FIG. 6 in which the door is held closed. Now, if persons inside the building press on the door to swing it in the reverse direction for opening, the spring **115** is expanded to release dogs **106** from pockets **111** so that clutch members **102** and **110** can now rotate relative to the other member. Thereafter inner clutch member **110–112** is rotated in opposite direction so that the dogs **106** are carried to and reseat in the pockets **111**. The spring **115** now bears on dogs **106** and relative rotation between the two clutch parts is restrained so that the door may again open dependent on automatic operation of the door operating mechanism.

The diagram of FIG. 2 shows the electrical circuits open so that the pump **26** is at the rest and the door is closed. When a person steps on the mat **19**, the switch **21** therein is closed and a circuit is completed from the transformer **47** through the switches **61** and **21**, main solenoid **38** and resistor **49** and rectifier **48** back to the transformer. Main switch **37** is now drawn to the dotted line position to complete circuits from power line **46** through main contact **45** to the solenoid **34** which closes valve **31** to cause pressure fluid to act in the chamber A of the cylinder **73**. The main switch contact **41** is also now in circuit from the transformer **47** through main switch contact **41**, switch **60**, solenoid **58** of the motor switch **57** and back to the transformer to energize the motor **27** and operate the pump **26**. Fluid pressure continues to act in the power chamber A to move the power piston to the position shown in FIG. 5 where the door is fully open and remains open as long as the person is standing on the mat **19** so that the switches **21** are closed. Door opening movement of the operating mechanism has also moved the cylinder **73** toward the left so that the switch **60** is now opened which opens the circuit of the motor **27**. As a person moves off the mat **19**, its switches **21** are opened and switches **22** of mat **20** are closed. The switches **22** complete a circuit from the transformer **47** through main switch contact **41** and main solenoid **38** back to the transformer secondary. Hence the door remains open as long as switch **22** is closed.

When a person moves off the mat **20**, switch **22** is opened and solenoid **38** could be de-energized to allow the main switch to re-open unless a time delay is provided. Hence capacitor **52** has been kept energized and is now allowed to discharge by way of contact **43** through the main solenoid **38** which thus remains energized to keep the main switch in "door open" position until the capacitor is fully discharged (and the person has had time to move out of the path of door swing). The main solenoid **38** is now de-energized and the blades of the switch **37** return to the full line position shown in FIG. 2. Motor **27** stops and valve **31** moves to the position shown in FIG. 2 so that the fluid is drained from the cylinder **73** through valve **31** into the sump. Spring **90** now expands and pushes cylinder **73** toward the right into the position shown in FIG. 2 in which the door is closed. Pipe **32** and relief valve **33** are always connected with the sump **28** to relieve any excess pressure developed by the pump.

If a person steps on mat **20** while the door is closed, main switch **37** is in the position of FIG. 2, and no circuit can be completed to energize main solenoid **38**.

If a person wishes to open the door in reverse direction, the release clutch **66** is disengaged as above described and the spring **115** is expanded. The expanded spring bears on a part of switch **61** to open the switch and open the circuits controlled by mat switches **21** and **22**. The circuit to the motor **27** is now also opened and the door operator cannot work against the manual pressure on the door even though the person is standing on mat **20** and has closed switch **22**.

We claim:

1. In a fluid pressure actuated door operator, a casing adapted to serve as the lintel portion of a door frame, a clutch mounted in the casing for oscillation and provided with means to engage and oscillate a door, a cylinder slidably mounted in the casing and having a power chamber therein, a power piston movable in the cylinder, a rod pivotally connecting the cylinder with one side of the clutch, a rod pivotally connecting the power piston with the other side of the clutch, the two rods exerting balanced push and pull on the clutch for oscillation thereof substantially without side thrust, fluid pressure in the power chamber moving both the cylinder and the power piston for oscillation of the clutch.

2. The door operating mechanism of claim **1** in which said cylinder is partitioned into a power chamber within which the power piston moves and a control chamber, said mechanism being further provided with a control piston movable in the control chamber, means for moving the control piston in response to movement of the power piston, said control piston having a passage therethrough which is at least partially cylindrical in cross-section, a conical plug extending from an end of the control chamber to enter said passage for retricting the fluid flow therethrough to damp movement of the control piston in a plug-engaging direction, the wall of said control chamber of said cylinder being provided with a passage through which fluid flows upon movement of the control piston, said control piston having a conical portion adapted to co-act with the wall of said chamber and with said passage to damp movement of said piston in a passage-covering direction, the partition dividing the cylinder into a power chamber and a control chamber having a passage therein for fluid flow to and from the power chamber, and a rigid pipe which conducts fluid to the passage and has a joint sliding as the cylinder slides in the casing.

3. The door operating mechanism of claim **1** in which a rod on the power piston extends through the cylinder, the power piston being single-acting, and a spring mounted surrounding and seating at one end on the rod, the other end of the spring seating against the end of the cylinder, said spring being effective for moving the power piston in door closing direction upon interruption of fluid pressure supplied to the cylinder.

4. In a fluid pressure actuated door operator, a casing adapted to serve as the lintel portion of a door frame, a door mounted for swinging into open and closed position, a plate with a splined socket on the door, a clutch mounted in the casing for oscillation and engageable with the door plate socket, a cylinder slidably mounted in the casing and having a power chamber therein, a single acting power piston movable in the cylinder, a rod pivotally connecting the cylinder with the clutch, a rod pivotally connecting the power piston with the clutch, the two rods exerting balanced push and pull on the clutch for oscillation thereof without side thrust, a rod connected with the piston and extending through and beyond the cylinder, and a spring acting between an end of the cylinder and an end of the last said rod, fluid pressure in the power chamber moving both the cylinder and power piston for door opening oscillation of the clutch and spring pressure moving the cylinder relative to the power piston for door closing oscillation of the clutch upon interruption of the fluid pressure.

5. The door operator of claim **4** in which the rod through the cylinder is co-axial therewith and the spring is co-axial with the rod whereby fluid pressure and spring pressure act in alinement.

6. The door operator of claim **4** in which a partition divides the cylinder into a power chamber and a control chamber and a control piston divides the control chamber into two portions, movement of the control piston causing interchange of equal quantities of liquid between the control cylinder portions for damping door opening and closing movements.

7. The door operator of claim **6** in which the control piston is attached to the rod acting on the spring and interaction of one cylindrical and one conical surface of

the cylinder co-act respectively with one conical and one cylindrical surface of the control piston for severally and progressively controlling damping of the door movement in two directions.

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HARRISON R. MOSELEY, *Primary Examiner.*