May 14, 1963 H. J. SHAFER ETAL 3,089,430

SAFETY SHUT-OFF FOR PISTON PUMP AND VALVE UNIT

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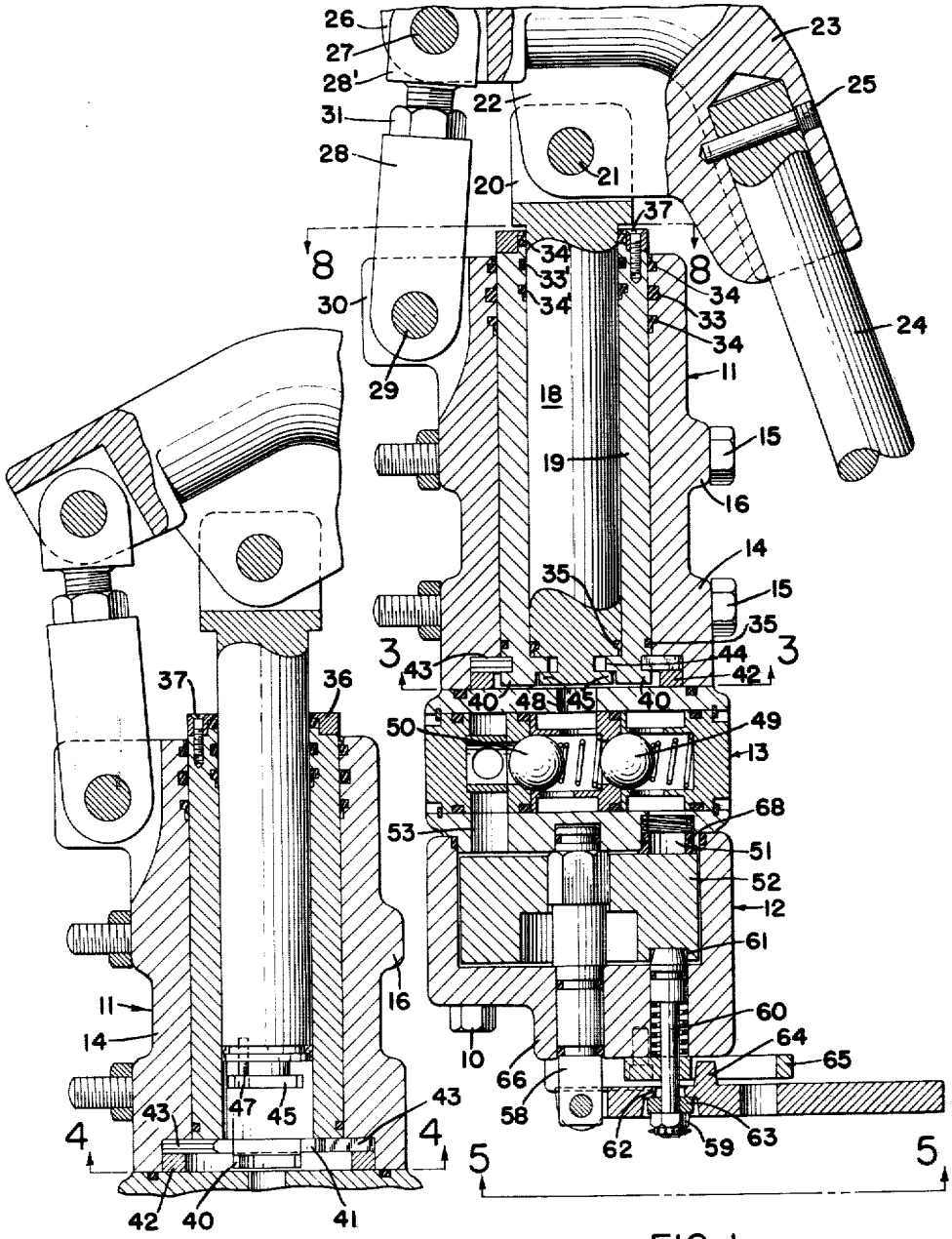


FIG. 2

FIG. 1

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SAFETY SHUT-OFF FOR PISTON PUMP AND VALVE UNIT

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FIG. 3

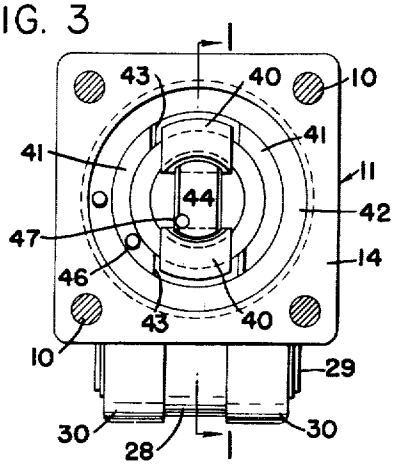
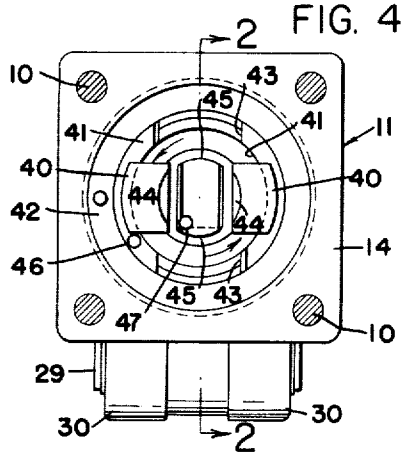


FIG. 4



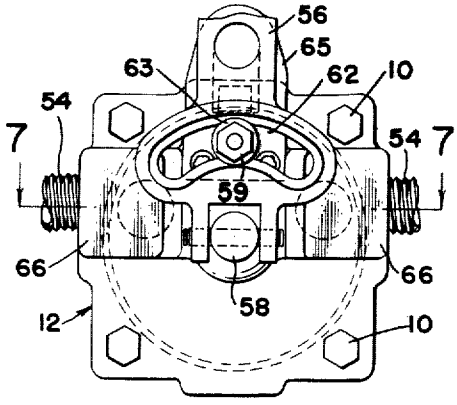
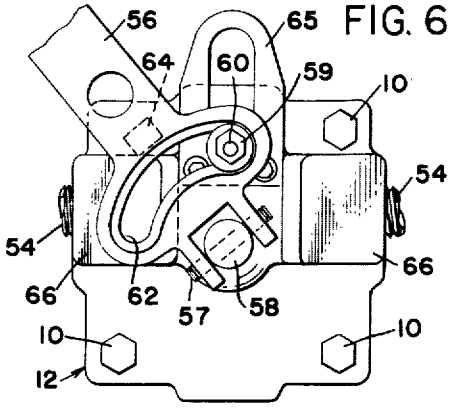


FIG. 5

FIG. 6



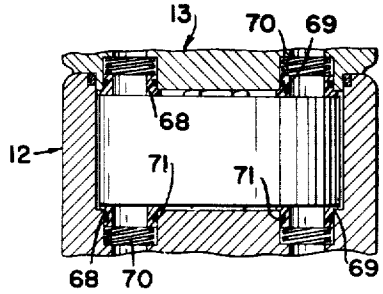


FIG. 7

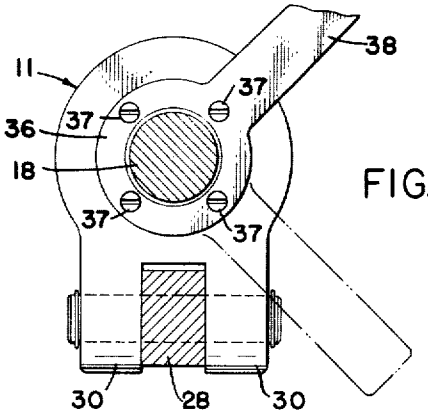


FIG. 8

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SAFETY SHUT-OFF FOR PISTON PUMP AND VALVE UNIT

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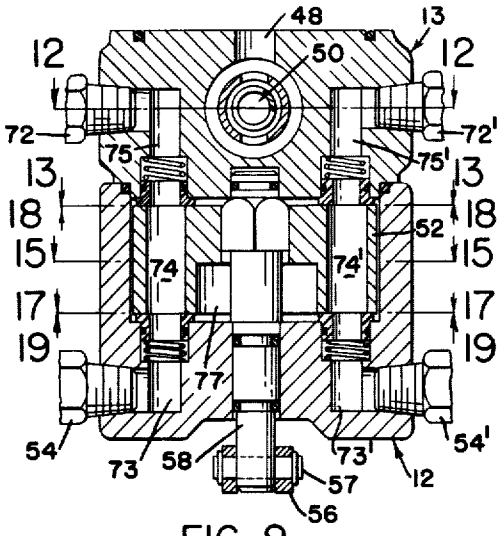


FIG. 9

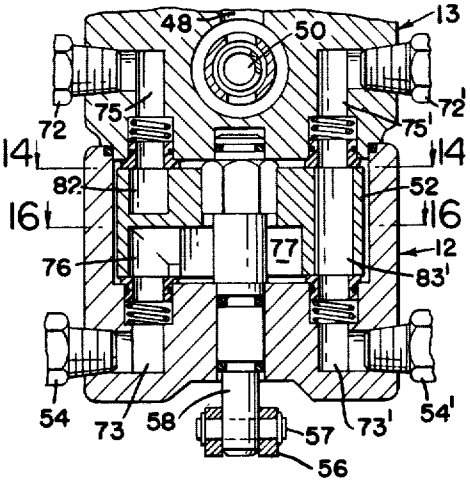


FIG. 10

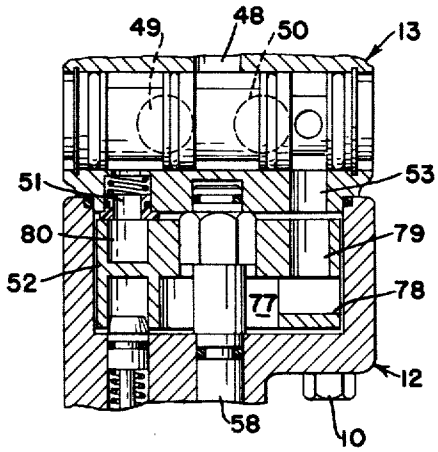


FIG. 11

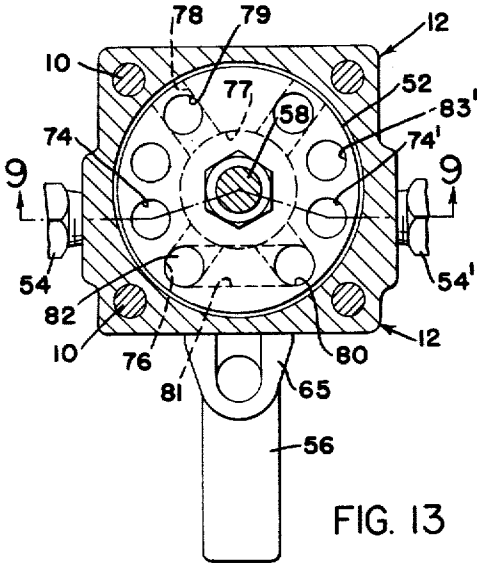


FIG. 13

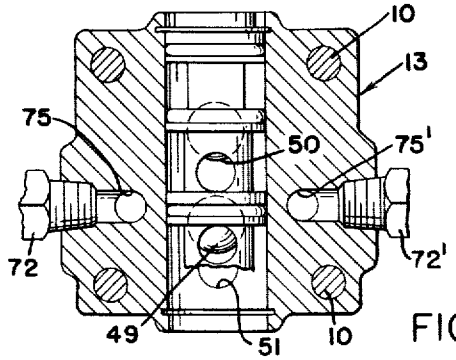


FIG. 12

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SAFETY SHUT-OFF FOR PISTON PUMP AND VALVE UNIT

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FIG. 14

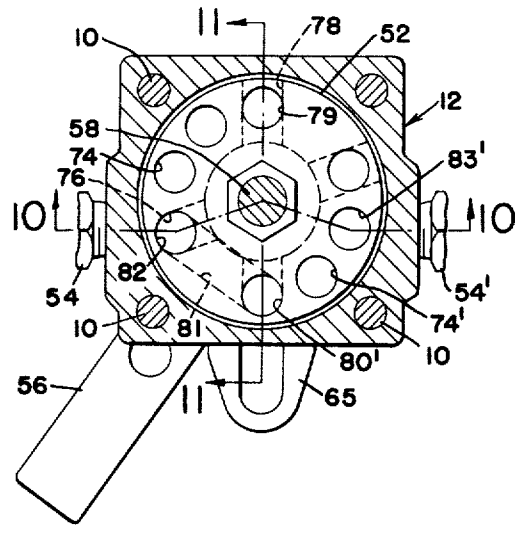
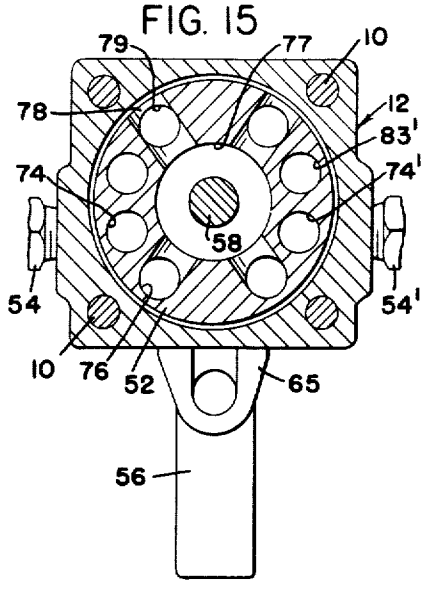


FIG. 15



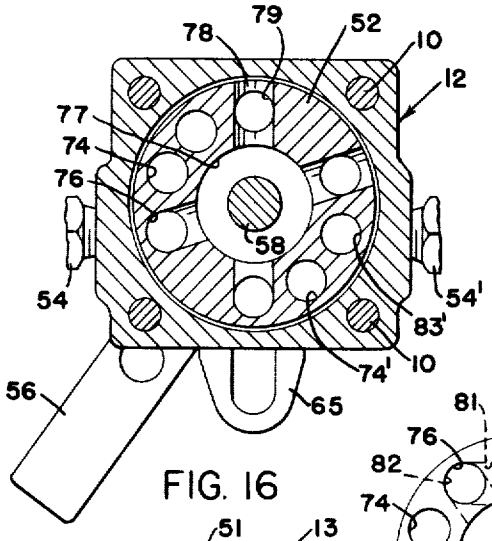


FIG. 16

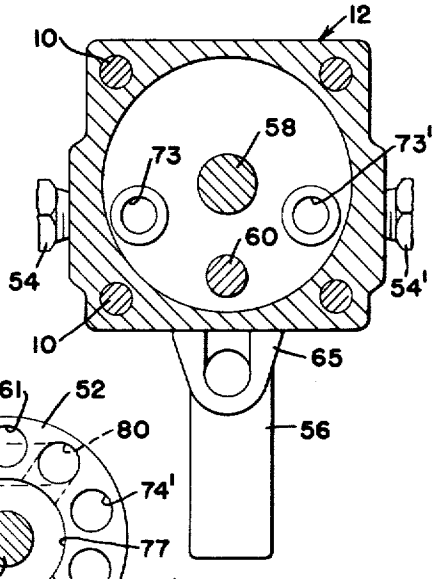


FIG. 17

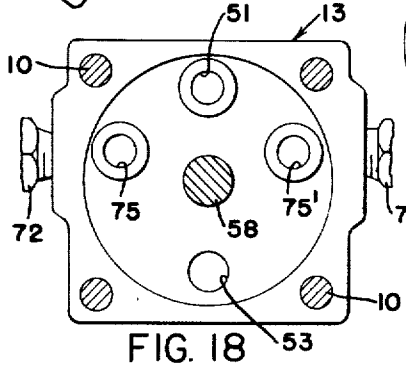


FIG. 18

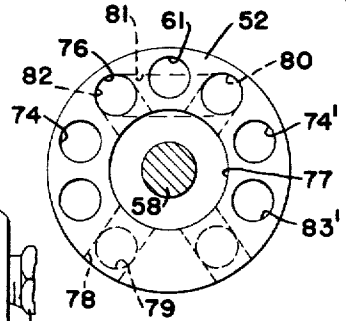


FIG. 19

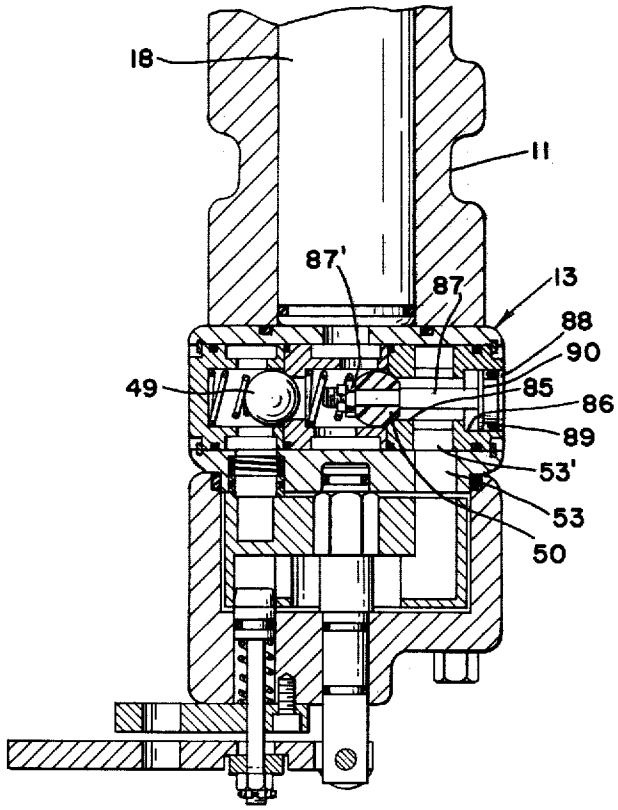
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SAFETY SHUT-OFF FOR PISTON PUMP AND VALVE UNIT

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FIG. 20



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United States Patent Office 3,089,430
Patented May 14, 1963

3,089,430
SAFETY SHUT-OFF FOR PISTON PUMP AND VALVE UNIT

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Filed Aug. 7, 1958, Ser. No. 753,812
3 Claims. (Cl. 103—228)

The invention relates generally to fluid systems for operating hydraulic motors having piston and cylinder means, and more particularly to a hand piston pump having a control valve for controlling the flow between the pump and a hydraulic motor. This application is a continuation-in-part of our copending application Serial No. 580,267, filed April 24, 1956, now Patent No. 2,961,-003.

The improved pump and valve unit is particularly adapted for use as a stand-by device for manually operating a hydraulic operator for a valve in a pipe line when the usual source of power for the operator has failed or is not available for any reason. Prior constructions employing a hand wheel for manual operation are slow and difficult to operate for large pipe line valves, and the change over from power to manual operation usually requires manipulation of several control valves in different locations.

The hand pump of the improved unit is single-acting because the greatest amount of manual power is obtained on the downstroke, and a novel single control valve is part of the same unit so that the pump operator can quickly and easily change the direction of flow to and from the pump. The control valve must be capable of repeated operations in which the direction of flow is changed or reversed, without leakage between the valve ports and the ports leading to and from the pump, and without marring the valve surfaces. A disk or plate type valve is preferable to insure maintaining a positive seal between the various connections.

Another condition to be met is that during a certain part of the manual operation cycle more power with less volume may be required. For example, in opening a large gate valve more power is required to crack the gate open, after which less power with more volume is desirable to accelerate the remainder of the opening cycle, and during the closing cycle the power requirements are reversed.

It is an object of the present invention to provide an improved manual pump and valve unit which obtains maximum efficiency, is easily adjustable to different power requirements, and adjustably controls the direction of flow of fluid to and from the pump.

Another object is to provide an improved pump and valve unit for manually operating a hydraulic motor, said valve unit having a rotatable disk valve and novel port connections selectively making liquid-tight sealing connections with opposite sides of the disk leading to the pump and motor, without scratching or marring the disk.

Another object is to provide a safety shut-off construction preventing accidental ejection of the pump piston by a surge of fluid pressure when the pump is connected to the fluid pressure supply for manual operation.

These objects, and others which will appear from the following specification, are attained by the construction comprising the present invention, a preferred embodiment of which is shown by way of example in the accompanying drawings and described in detail herein. Various modifications and changes in details of construction are comprehended within the scope of the appended claims.

The improved pump and valve unit has a handle lever

at one end for applying power on the downstroke to a pump having concentric pistons, with latch means for selectively operating the inner piston alone or in combination with the outer piston, a rotatable disk valve at the other end for controlling fluid flow to and from the pump, and nylon bushings in the connecting ports on opposite sides of the valve disk slidably engaging the valve disk to make liquid-tight sealing connections with the ports in the valve disk.

Referring to the drawings:

FIG. 1 is a longitudinal sectional view of the improved pump and valve unit, with parts in elevation, showing the two pistons interlocked for operating together and taken on line **1**—**1** of FIG. 3.

FIG. 2 is a fragmentary sectional view similar to FIG. 1, taken on line **2**—**2** of FIG. 4, showing the inner piston released from the outer piston for operating alone, and partly raised.

FIG. 3 is a bottom plan view of the pistons in interlocked position, taken on line **3**—**3** of FIG. 1.

FIG. 4 is a bottom plan view of the pistons in separated position, taken on line **4**—**4** of FIG. 2.

FIG. 5 is a bottom plan view of the unit taken on line **5**—**5** of FIG. 1, showing the valve control handle in neutral position.

FIG. 6 is a similar view, showing the valve control handle in an operating position.

FIG. 7 is a fragmentary sectional view as on line **7**—**7** of FIG. 5, showing the nylon bushings slidably abutting opposite sides of the valve disk.

FIG. 8 is a plan sectional view on line **8**—**8** of FIG. 1.

FIG. 9 is a fragmentary vertical sectional view taken at right angles to FIG. 1, as on line **9**—**9** of FIG. 13, with the valve disk in neutral position.

FIG. 10 is a similar view, with the valve disk rotated to an operating position, as on line **10**—**10** of FIG. 14.

FIG. 11 is a sectional view on line **11**—**11** of FIG. 14.

FIG. 12 is a plan sectional view on line **12**—**12** of FIG. 9.

FIG. 13 is a plan sectional view on line **13**—**13** of FIG. 9.

FIG. 14 is a similar view with the valve disk rotated to the operating position, as on line **14**—**14** of FIG. 10.

FIG. 15 is a plan sectional view on line **15**—**15** of FIG. 9.

FIG. 16 is a similar view with the valve disk rotated to the operating position, as on line **16**—**16** of FIG. 10.

FIG. 17 is a plan sectional view on line **17**—**17** of FIG. 9.

FIG. 18 is a bottom plan sectional view on line **18**—**18** of FIG. 9.

FIG. 19 is a bottom plan sectional view on line **19**—**19** of FIG. 9.

FIG. 20 is a view similar to FIG. 11, showing the safety shut-off construction applied to the suction check valve of the pump.

The housing of the unit is preferably made in three sections held in abutting relation by means of four bolts **10** passing through the corner portions of the sections. The upper section **11** constitutes the pump cylinder, the lower section **12** comprises the housing for the control valve disk, and the intermediate section **13** houses the check valves for the pump suction and discharge and the connections thereto. As shown in FIGS. 3 and 4, the bottom flange portion **14** of the pump housing is substantially square in cross section, as in the intermediate section **13** and the lower section **12** (FIGS. 4 and 5).

When used for operating a hydraulic operator for a pipe line valve, the unit is mounted in an upright position on the operator, and for this purpose transverse mounting bolts **15** may be tapped into the flange **14** and an upper flange **16** on the pump cylinder.

The pump has an inner piston **18**, longitudinally slidable in an outer concentric piston sleeve **19**, which is longitudinally slidable in the housing **11**. The upper end of piston **18** has a clevis **20** formed thereon which is pivoted by a pin **21** to an ear **22** on the handle connector **23**. A handle bar **24** is secured by a screw **25** in a socket in one end of connector **23**, and the other end has a clevis **26** formed thereon which is connected by a pin **27** to one end of a link **28** pivoted at its other end by pin **29** to ears **30** on one side of the housing **11** at its upper end. Preferably, the length of the link **28** is made adjustable to vary the stroke of the handle, by screwing the upper part **28'** into the lower part **28** and providing a locknut **31** on the upper part.

Around the outer piston **19** in the upper end of the housing **11** are three longitudinally spaced rings, the inner ring **33** being an O-ring to provide a seal, and the upper and lower rings **34** being wiper rings preferably L-shaped in cross section and made of oil-resistant material such as neoprene. Around the lower end of piston **19** is a felt wiper ring **35**. Similarly, the inner piston **18** is encircled by three longitudinally spaced rings **33'** and **34'** set in grooves in the upper end of the outer piston **19**, the middle ring **33'** being an O-ring and the upper and lower rings **34'** being wiper rings, and the piston has a felt wiper ring **35'** around its lower end.

The upper wiper ring **34'** is positioned under a metal cap ring **36** secured on the upper end of piston sleeve **19** by screws **37**. A handle lever **38** extends laterally from cap ring **36**, as shown in FIG. 8, for rotating the piston **19** through 90° to interlock its lower end with the housing **11** and at the same time release it from piston **18** to allow piston **18** to be operated alone.

Normally, the pistons **18** and **19** are operated in unison to pump a maximum volume of fluid, and the normal position is shown in FIGS. 1 and 3. The bottom end of piston sleeve **19** has diametrically opposite L-shaped projections **40** which are adapted, in the position of FIGS. 2 and 4, to engage circumferential flanges **41** on a ring **42** secured in the bottom end of the pump cylinder and which register with slots **43** in flanges **41** in the position of FIGS. 1 and 3. Thus, in the normal position the piston sleeve **19** is free to slide axially in the pump cylinder and in the position of FIGS. 2 and 4 it is interlocked therewith.

On their inner surfaces the projections **40** have segmental recessed ribs **44** which, in the position of FIGS. 1 and 3, engage and interlock diametrically opposite flanges **45** forming the bottom of an inverted T-shaped projection on the bottom of piston **18**. When the piston **19** is rotated 90° to the position of FIGS. 2 and 4, the projection is movable axially of piston **19** between the segmental ribs **44**, so that piston **18** operates alone, as shown in FIG. 2. A stop pin **46** in one of the flanges **41** limits rotary movement of the outer piston **19** in the direction of the arrow in FIG. 4 by engaging one of the projections **40**. A stop pin **47** in one of the flanges **45** limits rotary movement of the outer piston **19** in the opposite direction, by engagement with one of the ribs **44**.

Accordingly, if it is desired during any part of the operation cycle to produce more pressure with the pump at the sacrifice of less volume, the operator need only complete a downstroke of the pump handle **24** and then rotate the lever **38** 90° in a clockwise direction, as viewed in FIG. 8, which locks or latches the outer piston **19** to the housing and releases the inner piston **18** to operate alone as in FIG. 2.

During each downstroke of the pump fluid is forced through port **48** in housing section **13**, unseating ball check **49** and closing ball check **50**. Fluid passing around ball check **49** passes through port **51** to the valve disk **52** which is suitably ported to conduct the fluid to an exhaust connection **72'** on the exterior of the housing. On the upstroke of the pump fluid is sucked from the valve disk compartment port **53**, unseating ball check **50** and closing ball check **49**, and thence into the pump cylinder. Suction connections **54** and **54'** (FIGS. 5 and 6) supply the valve disk compartment with fluid. If desired, the ball checks **49** and **50** can be made of nylon which has sufficient resiliency to improve the seal of the ball on its seat.

The pump pistons are single-acting so that the pressure is delivered on the downstroke of the pump handle during which the greatest manual force is exerted. This simplifies the fluid connections to and from the pump.

The particular porting arrangement in valve disk **52** forms no part of the present invention, because such arrangement may be varied to suit particular requirements. For example, the valve disk may have two positions for controlling flow to and from the pump through separate suction and exhaust connections, and an intermediate neutral position in which flow to and from the pump is shut off. Such an intermediate position is shown in FIGS. 1, 9 and 13.

The means for rotating the valve disk **52** to a selected position preferably includes a hand lever **56** having a clevis pivoted on a cross pin **57** in the lower projecting end of the shaft **58** on the upper end of which the valve disk **52** is non-rotatively mounted. Downward swinging movement of lever **56** is resisted by a nut **59**, on the bottom end of a spring-pressed plunger **60**, the upper end of which enters a socket **61** when the valve disk **52** is in neutral position. The plunger **60** extends through an arcuate slot **62** in the lever **56** and a washer **63** above the nut **59** is slidable laterally on a ledge surrounding the slot. Thus, the lever can be rotated in either direction from neutral position to selected positions determined by the ends of the slot. One such position is shown in FIG. 6. When the washer **63** is at either end of the slot **62**, the upper end of plunger **60** registers with another hole or socket (not shown) in the valve disk circumferentially spaced from socket **61**, to maintain the disk in selected position.

Means for maintaining the hand lever **56** in any selected position is provided. An upwardly projecting lug **64** on the lever **56** extends into a slotted plate **65** secured on the bottom of the housing when the valve is in the neutral position of FIGS. 1 and 5. In order to swing the lever **56** in either direction it is necessary to press downwardly on lever **56** sufficiently to withdraw the lug **64** from plate **65** and to continue to hold the lever **56** down while swinging it laterally. After lever **56** is swung to a position such as shown in FIG. 6 and released, the lug **64** will be positioned between plate **65** and one of the bosses **66** on the bottom of housing section **12**, and thus prevent lateral swinging of the lever **56** without first pressing it downwardly against the action of the spring plunger **60**.

As shown in FIGS. 1 and 7, the connecting ports on opposite sides of the valve disk **52** have nylon bushings slidably abutting the surfaces of the disk. The bushings **68** preferably have annular flanges **69** on their inner ends abutting the disk surface, and are backed up by springs **70** urging them against the disk. The bushings have a loose or sloppy fit in the ports in which they are positioned, and small O-rings **71** are located around the bushings behind the annular flanges **69** and form seals between the bushings and the ports.

The nylon bushings have a certain amount of resiliency and their loose fit in the ports allows the flanges **69** to conform to slight irregularities on the surfaces of the valve disk, when urged against the disk by the springs. Moreover, the nylon has the property of picking up and absorbing tiny particles of grit on the metal surface of the valve disk, which grit would otherwise mar the metal surface, and ultimately affect the seal between the valve disk and connecting ports. After a prolonged period of use, the nylon bushings may be easily replaced without requiring refacing or replacement of the valve disk.

As shown in FIG. 7, the valve disk is abutted on opposite surfaces by the nylon bushings, so that the disk

always rotates slidably between the annular flanges of the nylon bushings, thus preventing metal-to-metal contact with the surfaces of the valve disk.

The construction and operation of the valve disk **52** is illustrated in FIGS. 9 to 19. Referring first to FIGS. 9 and 13, assume that connection **54** is connected to the normal operating fluid under pressure, and connection **72** is connected to the pressure side of a hydraulic motor for operating it in one direction, while connection **72'** is connected to the exhaust side of the motor and connection **54'** is connected to the exhaust line. Fluid under pressure enters connection **54** and passes through the port **73** in housing **12**, the port **74** in the valve disk, and thence through port **75** in housing section **13** to pressure connection **72**. Fluid exhausting from the motor passes into connection **72'**, and through ports **75'**, **74'** and **73'** to exhaust connection **54'**. Thus, in this position of the valve disk, the hand pump is by-passed. When the hydraulic motor is operated in the reverse direction, the flow through the housing and valve disk is reversed.

When the lever **56** is shifted to the position of FIGS. 14 and 16 for manually operating the motor by means of the hand pump, the valve disk **52** is rotated to the position of FIGS. 10, 11, 14 and 16. On the upstroke of the pump piston, ball valve **50** is open and ball valve **49** is closed, and fluid from the operating supply line passes through connection **54**, port **73** and right-angled port **76** in the valve disk to the central annular chamber **77** therein around shaft **58** (see FIG. 10). From the chamber **77** fluid is sucked through radial port **78** and vertical ports **79** and **53** directly past the ball valve **50** into the pump, as best shown in FIG. 11.

On the downstroke of the pump piston, ball valve **50** closes and ball valve **49** opens, allowing fluid to pass from the pump through port **51** of housing section **13** into port **80** of the valve disk (FIG. 11). Port **80** is connected substantially circumferentially of the disk by a chordal passageway **81** (FIG. 14) with port **82** in the upper part of the disk, and in this position of the disk port **82** is connected to port **75** in housing section **13**. Thus the fluid expelled by the pump on the downstroke is delivered to connection **72** and thence to the pressure side of the motor.

Fluid exhausting from the motor passes through exhaust connection **72'** and port **75'** in the housing section **13**, through port **83'** in the disk and port **73'** to the exhaust line connection **54'**. (See FIG. 10.)

When the lever **56** is shifted to the opposite position from that in FIGS. 14 and 16, to reverse the flow through the motor for hand pump operation, the unnumbered ports in the valve disk function in a similar manner to the corresponding numbered ports to control the flow.

The improved pump and valve unit is compact and easy to assemble and disassemble, and provides easily accessible means for adjusting the power delivered by the pump and for controlling the direction of fluid flow to and from the pump.

In the construction of FIG. 20, when the lever **56** is shifted to the position of FIGS. 14 and 16, rotating the valve disk to the position of FIG. 11, the pressure fluid from connection **54** passes through the port **79** of the valve disk and suction port or passageway **53** to unseat the ball check **50** on the suction stroke of the pump, in the manner previously described. However, when the parts are in this position for manual operation of the pump, the pressure in the supply line to connection **54** has constant access to the ball check **50** and a sudden surge of pressure may blow the pump piston or pistons upwardly in pump cylinder **11** with great force, throwing the pump piston and handle and connecting parts upwardly and outwardly in all directions. This condition thus presents a dangerous hazard.

Accordingly, in the construction of FIG. 20, the transverse suction duct **85** in the intermediate housing section **13** intersects the port communicating with the pump in a first chamber and intersects the extension **53'** of suction passageway **53** at right angles to form a second chamber, has at one end the annular seat for ball check **50**, and at its other end terminates in the enlarged bore **86** opening through the exterior of the housing.

The ball check **50** is connected by a rod **87** extending through the duct **85** to a piston **88** slidable in the bore **86**. Preferably, the ball **50** is held against a shoulder on the rod **87** by a nut **87'** screwed on the end of the rod. The piston has an O-ring seal **89** around its outer periphery, and the groove **90** for the O-ring seal is substantially wider than the O-ring in sealing position for a purpose to be described. The annular effective area of the inner face of the piston is substantially greater than the annular effective area of the ball check within its seat, so that in the event of a pressure surge in passageway **53**, the piston will hold the ball check on its seat and prevent blowing out the pump piston.

On a suction stroke of the pump piston, the O-ring **89** is permitted to roll in the oversize groove **90** sufficiently to allow the differential pressure to pull the piston **88** inwardly in the bore **86** and break the ball **50** away from its seal, the atmospheric pressure on the outer face of the piston aiding in opening the ball check.

What is claimed is:

1. In a valve unit housing having suction and discharge passageways at one end and fluid pressure and exhaust connections at the other end, and a valve element between said ends for selectively connecting the suction passageway with the fluid pressure connection, said housing having a suction duct connected to said suction passageway at an angle thereto and opening through the housing at one end, an annular seat in the opposite end of said duct, a ball check normally seated on said seat for opening away from said suction passageway, a piston movably mounted in the open end of said duct and having an effective area greater than the effective area of the ball check within said seat, an O-ring seal for the piston, said piston having an annular groove receiving said O-ring of substantially greater axial width than said ring in sealing position, and means rigidly connecting said piston to said ball check.

2. In combination, a safety shut-off valve and a positive displacement pump of the reciprocating piston type, said pump having a displacement cylinder, said safety shut-off valve having a first chamber in said safety shut-off valve communicating with the pump cylinder, a second chamber in said safety shut-off valve communicating with a fluid source subject to surging pressure, a duct connecting said first chamber to said second chamber, a valve seat in the first chamber side of said duct, a check valve normally seated on said seat but movable to lift off said seat inwardly of said first chamber in response to a drop in pressure in said pump cylinder, a rod connected at one end to said check valve and extending through said duct and across said second chamber, a piston having an inner and outer side, said piston being attached to the other end of said rod, the inner side of said piston being exposed to the pressures in said second chamber, the outer side of said piston being exposed to atmosphere, the effective area of the inner side of said piston being greater than the effective area of said check valve exposed to the pressure in said second chamber through said duct.

3. In combination, a safety shut-off valve and a positive displacement pump of the reciprocating piston type, said pump having a displacement cylinder, said safety shut-off valve having a first chamber in said safety shut-off valve communicating with the pump cylinder, a second chamber in said safety shut-off valve communicating with a fluid source subject to surging pressure, a duct connecting said first chamber to said second chamber, a valve seat in the first chamber side of said duct, a check valve normally seated on said seat but movable to lift off said

seat inwardly of said first chamber in response to a drop in pressure in said pump cylinder, a piston having an inner and outer side, the inner side of said piston exposed to the pressures in said second chamber, the outer side of said piston exposed to atmosphere, means rigidly connecting said check valve to said piston, the effective area of the inner side of said piston being greater than the effective area of said check valve exposed to the pressure in said second chamber through said duct.

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