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SLIDING SEAL AND VALVE FOR RECIPROCATING PUMP PLUNGER

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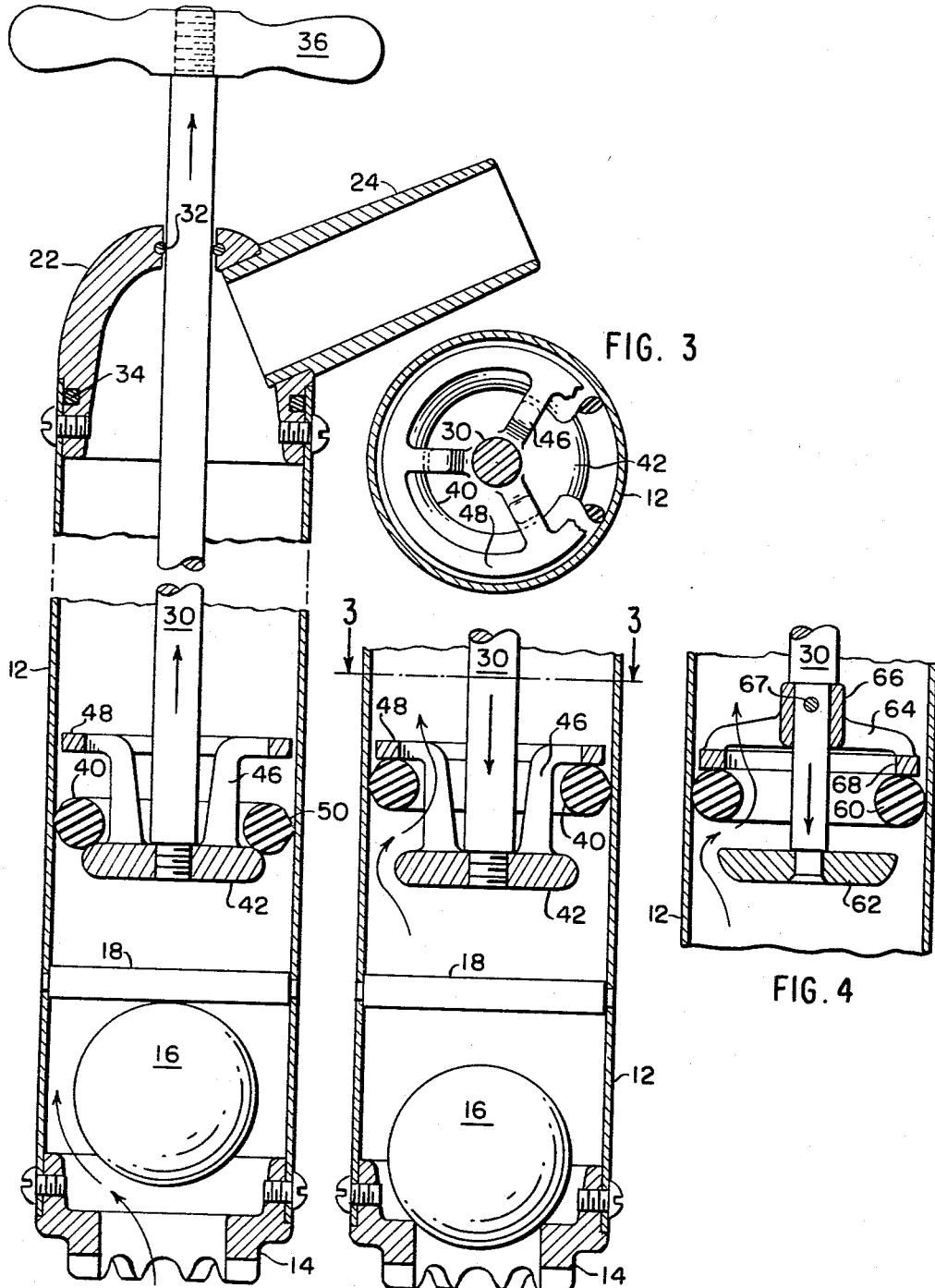


FIG. 1

FIG. 2

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**SLIDING SEAL AND VALVE FOR RECIPROCATING
 PUMP PLUNGER**

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The present invention relates to pumps and more particularly to reciprocating pumps such as hand-operated bilge pumps for boats. The invention is concerned with improvements in the plunger or piston of such pumps.

In conventional types of simple reciprocating pumps, such as those employed for pumping out the bilge of a boat, the piston or plunger which is reciprocated within the pump barrel may employ a cup-shaped element of leather or other resilient material to provide the sliding seal between plunger and barrel. In some instances, this cup-shaped element may also serve as a valve, with the walls of the cup yielding inwardly on the downstroke to enable liquid to flow upwardly between the cup and the barrel. On the upstroke, the walls of the cup, under the weight of liquid above, move outwardly into contact with the barrel to provide a sliding seal. Alternatively, there may be included within the pump plunger a separate check valve which opens on the downstroke and closes on the upstroke, leaving the cup-shaped member to function solely as a sliding seal between piston and barrel.

In either of these commonly-employed arrangements, there is considerable difficulty due to clogging. Foreign matter is apt to become caught between sealing surfaces at the sliding seal or in the check valve, requiring that the pump be dismantled and cleaned or temporarily operated at reduced efficiency and later cleaned.

The present invention has an object the provision of a pump plunger or piston of novel construction and configuration, wherein a combined sliding seal and check valve is employed in a manner that provides relatively large flow capacity and is substantially free from clogging by foreign matter.

In particular, the pump piston of the invention employs a resilient seal in the form of an annular ring or torus slidably engaging the pump barrel and loosely mounted on the piston for limited axial movement between predetermined positions, in one of which the resilient ring provides a fluid seal between piston and pump barrel when the piston is moved in one direction and a relatively unobstructed flow of liquid through the piston when the latter is being moved in the other direction.

The several features of the invention will be apparent from the following description, taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a view in sectional elevation of a hand-operated pump such as a bilge pump, showing the seal and valve structure of the invention in closed position.

FIGURE 2 is a view in sectional elevation of the lower portion of the pump shown in FIGURE 1, with the valve of the pump plunger in open position.

FIGURE 3 is a cross-sectional view, partly broken away and taken on the line 3-3 of FIGURE 2, showing details of the seal and valve structure, and

FIGURE 4 is a detail sectional view of an alternative embodiment of the combined seal and valve of my invention.

For purposes of illustration, my invention is shown as embodied in a hand-operated reciprocating pump of a type suitable for removing water from the bilge of a boat. The pump comprises a cylindrical barrel 12 having at its bottom end a centrally-open fitting 14 which serves as the pump inlet and also provides a seat for the check valve ball 16.

A rod 18 extends across the barrel as a retainer for the ball to limit upward movement thereof as shown in FIG. 1.

At the top of the barrel, a bonnet 22 is provided with an outlet passage through sleeve 24, to which a suitable length of hose may be attached. A pump rod or plunger 30 extends through the bonnet into the barrel, with resilient seal ring 32 to prevent leakage. Preferably a resilient seal ring 34 is also employed between the bonnet and the top end of the pump barrel 12. A suitable handle 36 is secured to the upper end of the pump plunger 30.

To enable the pump quickly to remove a relatively large volume of water with a minimum of effort on the part of the operator, a unitary pump piston and valve structure is provided that is distinguished by large, unobstructed flow passage on the downstroke of the pump, and effective sealing with low friction on the lifting stroke. This combined piston and valve employs a seal ring 40, which may be a large O-ring or the like, which functions both as the sliding seal and as a check valve, opening on the downstroke and closing on the upstroke.

The combined sliding seal and check valve operation of the ring 40 is made possible through the utilization of a piston structure which is, in effect, a relatively open cage by which the ring 40 is loosely confined. At one end, this cage-like structure, secured to the lower end of the rod 30, employs a disc 42 of substantially smaller diameter than the pump barrel, so that an annular passage of substantial total area is available for fluid flow around the disc on the downstroke of the pump, as shown in FIG. 3. In general, the diameter of the disc may approximate the mean between the outer and the inner diameters of the seal ring 40. Preferably, the disc 42 will be no larger in size than is necessary to insure that the seal ring cannot slip downwardly past the disc during pumping, nor become wedged in such a way as to create excessive sliding friction with the pump barrel.

To take full advantage of the relatively large annular flow passage between the pump barrel and the periphery of disc 42, the piston structure permits the resilient ring during the pump downstroke to move axially a substantial distance away from the disc and also permits relatively unobstructed flow through the open center of the ring. As shown in FIGS. 1 and 2, the piston cage employs struts or arms 46 which extend axially from disc 42 and then diverge outwardly to join a narrow ring or annular stop member 48 having its periphery close to the pump barrel. This ring 48, open at its center, provides a stop for the resilient seal on the downstroke, during which the seal is in inactive, open position. Preferably the struts are of such length as to permit the seal to move away from the disc 42 far enough to provide a passage between disc and seal approximating the axial width of the seal ring. As a consequence the area of the passage between disc and seal may readily be made at least as large as the area of the annular passage between the edge of disc 42 and the pump barrel.

As has been indicated, the seal ring 40 which also serves as the check valve element in the piston, may be a conventional O-ring of the proper outside diameter and cross-section to provide, of its own resiliency, an effective sealing engagement with the pump walls without undue friction. If desired, the normally-circular shape of section of the ring may be modified slightly by providing oblique flattened regions 50 around the periphery, so as to leave a relatively narrow band of material in resilient contact with the barrel. Also, it may be observed that by rounding the edge of the disc 42, to provide oblique engagement between disc and seal ring as illustrated in FIG. 1, there will be developed during the upward stroke a force component tending to enhance the sealing engagement of the

ring with the barrel, but that no such supplemental force will be imparted to the ring on the downstroke, when no fluid sealing action is needed.

The operation of the pump resembles in general that of conventional hand-operated lift or bilge pumps. On the upward stroke, the parts are as shown in FIG. 1 with the seal ring in engagement with the disc 42 to provide a substantial fluid-tight sliding piston, the upward or suction stroke of which serves to draw water into the pump barrel past the open check valve at the bottom. At the top of the stroke, the ball 16 drops to close the check valve at the inlet and prevent the escape of water from the barrel. As the pump rod starts its downward movement, the piston cage lowers freely through the seal ring which tends to remain stationary with respect to the pump barrel until engaged by the open-ended portion of the cage structure. Upon continued downward movement of the piston, the seal ring is carried along, as shown in FIG. 3, with the water below the piston flowing freely around the disc 42, then inwardly between disc and seal ring and upwardly inside the ring into the open region above the piston. With the next upward stroke of the pump, the water above the piston is ejected through the discharge while the barrel below the piston is filling, as before.

By reason of the relatively open structure of the piston cage and the large area of the flow passages, the pump has little tendency to clog. Should any chip, piece of string or other foreign matter likely to be present in bilge water get caught between seal ring and disc at the commencement of an upstroke, such obstruction will almost always be flushed free by the rush of water through the piston as soon as the check valve opens on the following downstroke.

Due to the squeegee action of the seal ring, which remains in contact with the pump barrel at all times, foreign matter rarely gets caught between seal and barrel; should anything become caught in such fashion, it will generally be quickly dislodged as the pumping proceeds.

An alternative embodiment of the invention is illustrated in FIG. 4, showing a form of piston which requires only a single member, the piston rod, to extend through the open center of the O-ring for minimum obstruction of the flow passage. The disc 62, against which the seal ring 60 seats during pump upstroke, is secured to the reduced end of piston rod 30. The struts 64 for the support of the seal ring on the downstroke, extend radially outward from a hub 66 which may be secured to the rod 30 by a pin 67. A narrow rim 68 extends around the outer ends of the struts to aid in centering the piston within the pump barrel and to engage and retain the seal ring on the piston during the downstroke, although it will be appreciated that a rim is not essential either to the centering of the piston or to the retention of the seal ring and may be omitted if desired.

It will be appreciated from the foregoing description and accompanying drawings that I have provided a combined pump piston and check valve means wherein a resilient seal element in the form of a large O-ring is loosely confined on a relatively-open cage-like piston structure so as to close off flow through the piston during the suction stroke and to permit substantially unobstructed flow past the piston on the reverse stroke. The flow pas-

sages are so substantial in area and so free from obstructions that the pump, when used as a bilge pump for boats, is not only much easier to operate than conventional pumps of comparable barrel size but is notably free from clogging.

It will be understood that my invention is not limited to the particular embodiments shown and described and that other forms and arrangements of loosely-confined seal ring and free-flow cake-like piston structure are possible and are contemplated within the scope of the appended claims.

I claim as my invention:

1. In a pump for liquids, the pump having a cylindrical barrel and a reciprocable plunger rod therein, a pump piston on said rod having combined sliding seal and check valve means comprising an annulus of resilient material in peripheral sliding engagement with the interior of the pump barrel, a piston cage loosely confining said annulus for limited axial movement relative to said cage, the cage including an annular stop member and a disc against which the annulus seats on the suction stroke of the pump, the disc having a diameter approximating the mean diameter of the annulus, said piston cage including a small number of independent supporting arms each secured at one end to said annular stop member and at the other end to said disc and spaced from each other a distance substantially greater than the width of said arms and serving as sole support of said annular stop member in spaced relation to said disc for supporting said annulus during the reverse stroke of the pump and to provide a large space for free flow of fluid between said arms during said reversal stroke of the pump.

2. In a pump as defined in claim 1, wherein said annular stop member has an inner diameter of opening at least equal to that of the inner diameter of said annulus, and wherein said arms support said annular stop member axially spaced from said disc a distance such that on the return stroke of the pump said annulus is spaced from said disc a distance approximating the spacing between the edge of said disc and the inner surface of said cylindrical barrel.

3. In a pump as defined in claim 1, wherein said arms extend from said disc through said annulus and outwardly behind said annulus and are connected at the outer ends thereof to said annular stop member.

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