Nov. 10, 1959 G. W. HARDY 2,911,917

FLUID-ENERGY TRANSLATING DEVICE

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FIG. 1

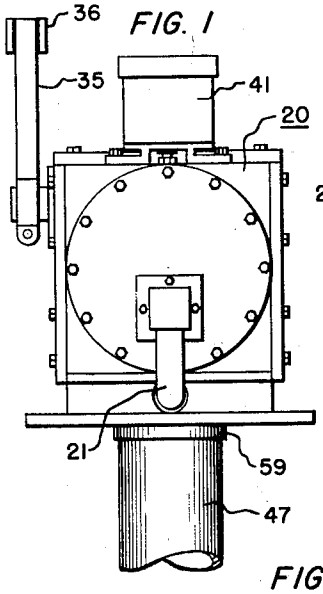


FIG. 2

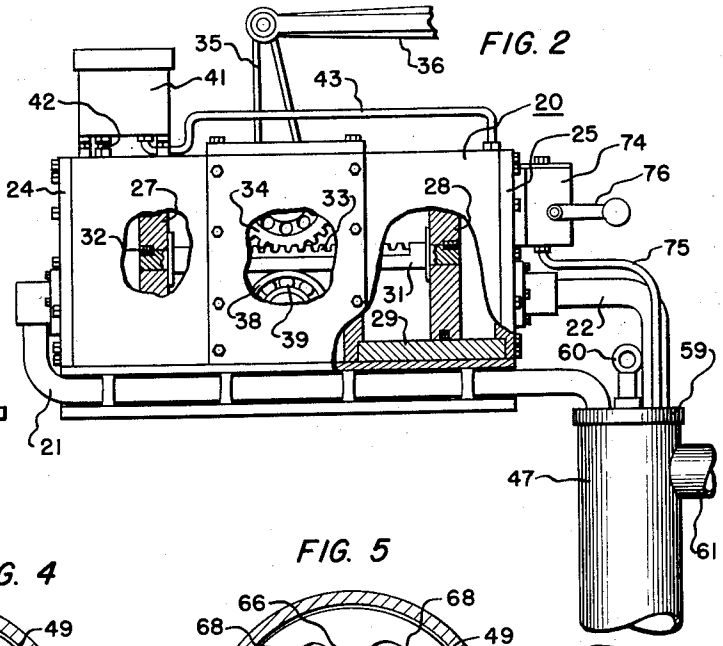


FIG. 4

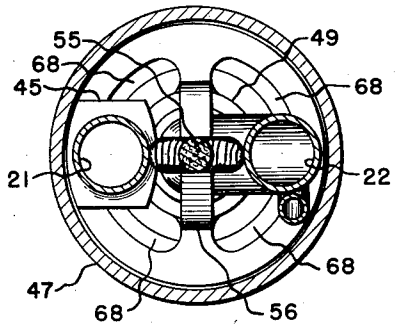


FIG. 5

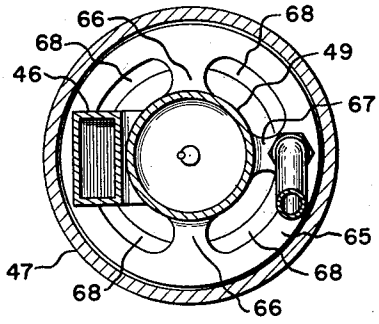


FIG. 6

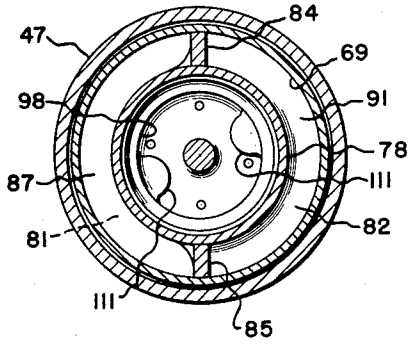
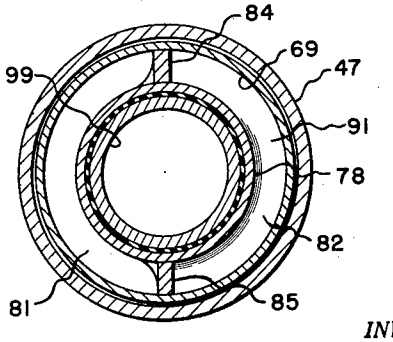


FIG. 7



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FLUID-ENERGY TRANSLATING DEVICE

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FIG. 3A

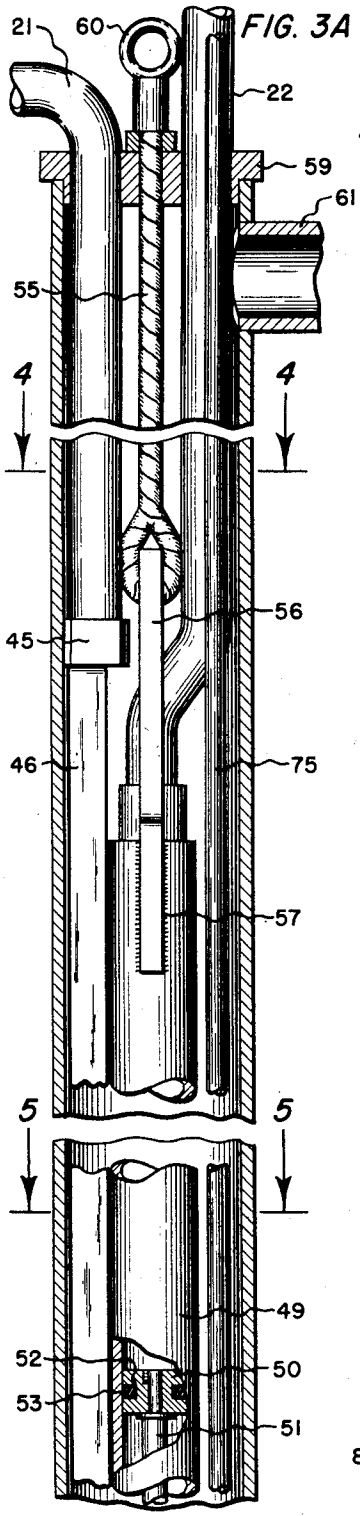


FIG. 3B

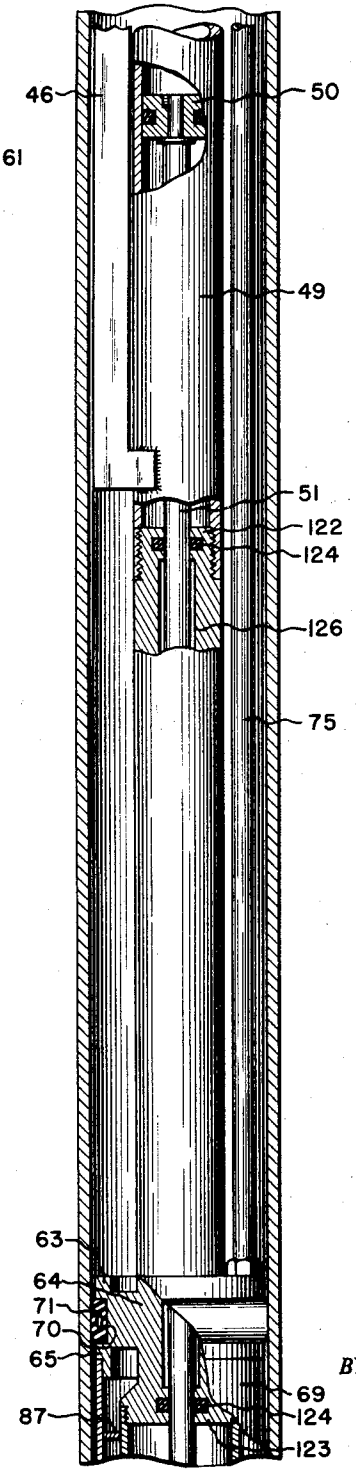
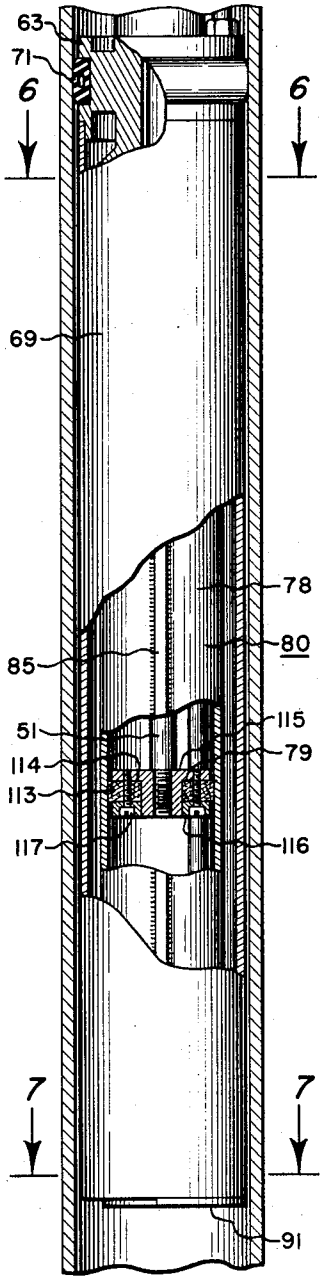


FIG. 3C



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FLUID-ENERGY TRANSLATING DEVICE

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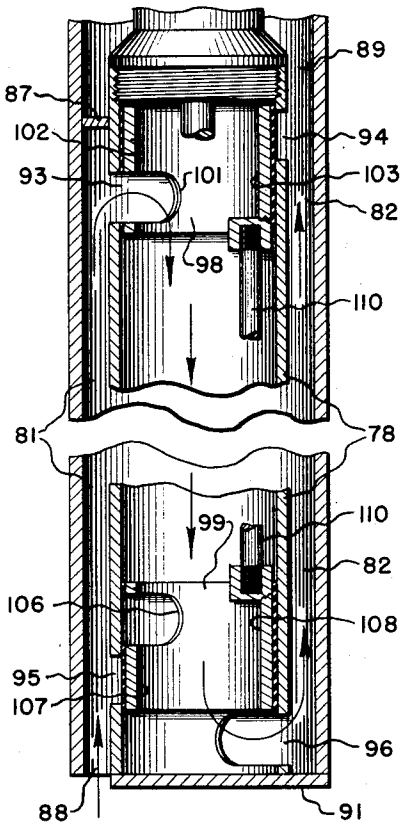

FIG. 8

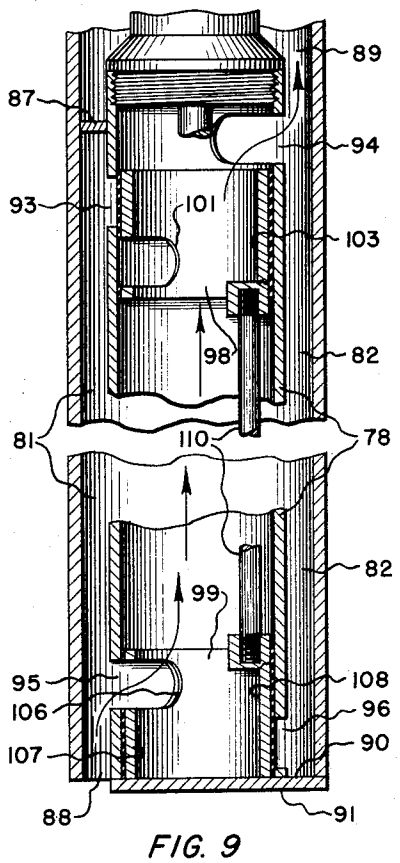

FIG. 9

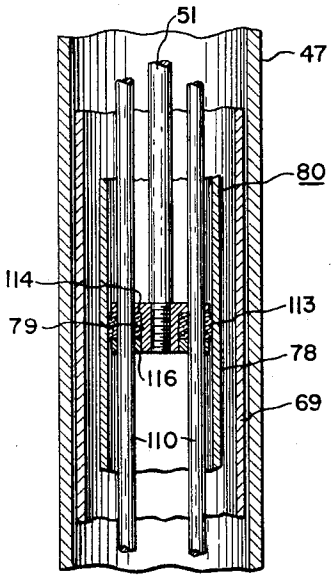

FIG. 11

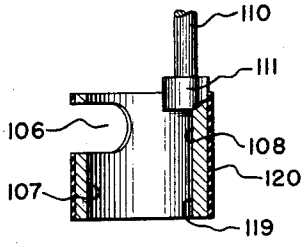

FIG. 10

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2,911,917

FLUID-ENERGY TRANSLATING DEVICE

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Application June 18, 1954, Serial No. 437,789

12 Claims. (Cl. 103—46)

The present invention relates to fluid-energy translating devices such as hydraulic motors and pumps, and more particularly to translating devices of the reciprocating type. I have chosen to embody my invention, for illustrative purpose, in a deep well pump including the actuating mechanisms therefor.

The reciprocating device comprises a pump which includes an elongated cylinder, a plunger therein, and valve mechanism which is actuated by the relative reciprocation of the plunger and cylinder for causing the mechanism to function as a double-acting pump. As is herein disclosed, the plunger is the driven element for the valve mechanism, the valve mechanism being held in the position to which it is shifted by its frictional relationship with the cylinder.

Another feature of my invention lies in the novelty of a valve in which the valve comprises a metallic base and a valve facing of resilient material such as rubber or synthetic rubber.

Another feature of the invention lies in the novel manner in which I seal the pump cylinder head in the well casing. This feature embodies a circumferential recess in the valve head and an inflatable sealing ring in the recess, together with a pump for inflating the ring into sealing relationship with the interior wall of the well casing.

Still another feature of the invention resides in forming the combination guide and stuffing box for the piston rod of such length that no single portion of the piston rod can enter both rod guides at the opposite ends of the stuffing box.

Further objects and advantages will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the invention is illustrated.

In the drawings:

Fig. 1 is an end view of the hydraulic pump, and also a fragmentary view of the well casing;

Fig. 2 is a side view of the hydraulic pump, part thereof being broken away to show details of construction; the view also including the well casing;

Fig. 3 is divided into three sections, 3A, 3B, and 3C, showing the well casing in section, and the various parts in operative position; the lower part of Fig. 3A is duplicated in the upper part of Fig. 3B; and the lower part of 3B is duplicated in the upper part of Fig. 3C;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 3A;

Fig. 5 is a sectional view taken on line 5—5 of Fig. 3A;

Fig. 6 is a sectional view taken on line 6—6 of Fig. 3C;

Fig. 7 is a sectional view taken on line 7—7 of Fig. 3C;

Fig. 8 is a fragmentary sectional view showing the position of the sleeve valves when the pump plunger in the pump in the well is moving downwardly;

Fig. 9 is a view similar to Fig. 8, showing the position of the sleeve valves when the plunger is moving upwardly; and

Fig. 10 is a view in section, showing detail of one of the sleeve valves.

Fig. 11 is a cross-sectional view showing one of the plungers, the view being similar to that of the plunger shown in Fig. 3C, the section however being taken through the actuating rods for the sleeves.

Referring generally to the drawings, the main hydraulic pump is shown at 20 and is utilized to oscillate a fluid such as oil in pipes 21 and 22. Pipe 21 is connected through one head 24 at one end of the pump, and pipe 22 is connected through head 25 at the other end of the pump. Two plungers 27 and 28 are contained within the cylinder 29 of the pump. These plungers are connected rigidly with one another through a toothed rack 31, the rack being attached to these plungers as by key screws 32. The teeth of the rack are indicated at 33 and are driven by an oscillating gear 34. This gear is oscillated by an arm 35, which is driven by a reciprocating element 36. The rack is supported by the outer race 38 of a ball bearing 39. This ball bearing is disposed directly below the axis of the gear 34. It will be seen that as the reciprocating element 36 moves to the right, imparting clockwise movement to the gear 34, the rack 31 will be moved to the left and the plunger 27 will force fluid through the head 24 into the pipe 21; also plunger 28 will draw fluid from the pipe 22 through the head 25. The reverse occurs when the reciprocating element 36 moves to the left, that is, the rack will be moved to the right causing the plunger 28 to force fluid through the head 25 into the pipe 22, and fluid will be withdrawn from pipe 21 through the head 24 by the plunger 27.

A casing 41 on the top of the cylinder 29 of the pump houses two small pumps (not shown) by which fluid is fed to the left and right ends of the cylinder 29 by pipes 42 and 43 respectively.

As seen in Fig. 3A, the cylindrical pipe 21 merges at a junction 45 with a rectangularly-shaped conduit 46, within the well casing 47; as shown by Fig. 3B, the lower end of the conduit 46 is connected as by welding to the lower end of a hydraulic motor cylinder 49. Referring again to Fig. 3A, it will be seen that the lower end of pipe 22 is connected with the upper end of cylinder 49. This cylinder contains a piston 50 and piston rod 51 which extends downwardly from the piston and is connected therewith as by a key screw similar to that shown at 32 in Fig. 1. This piston is provided with a circumferential groove 52 containing an O-ring 53.

Obviously, as fluid is forced downwardly through the pipe 21 and conduit 46, the piston 50 will be moved upwardly, the fluid thereabove being free to move upwardly by reason of the movement of the plunger 28 of the hydraulic pump 20 to the left, the fluid flowing freely through the pipe 22. Conversely, when the fluid is being forced downwardly through the pipe 22, the piston 50 will be forced downwardly and the fluid therebelow will be free to flow upwardly through the conduit 46 and pipe 21 by reason of the movement of the plunger 27 of the pump 20 to the right. Thus, the piston 50 and piston rod 51 are caused to reciprocate by the reciprocation of the reciprocating element 36. The motor cylinder 49 and the parts therebelow, to be described, are supported by a cable 55 through a hairpin-shaped element 56, the legs of which are welded to the opposite sides of the upper end of the cylinder 49, as shown at 57. This cable 55 is supported by a cap 59 for the top of the well casing 47. The upper end of the cable 55 is connected with a ring 60, by which the elements within the well are lifted therethrough by means of a derrick or the like.

The outlet for the well casing 47 is shown in the form of a pipe 61.

A combination guide and stuffing box 63 is provided for the piston rod 51. It includes an elongated cylindrically-shaped portion 64 and a sleeve portion 65 connected with the cylindrical portion by webs 66 and 67, spaces between the webs forming passages 68 for the

passage of fluid. The lower end of the sleeve 65 of guide 63 carries a cylinder 69. A circumferential recess in the form of a groove 70 is formed in the periphery of the sleeve 65 and contains an inflatable ring 71 which, when inflated, bears sealingly against the inner wall of the well casing 47 to prevent the leakage of fluid from above the same to the space between the cylinder 69 and the well casing 47. The ring 71 is inflated by a pump 74, it being connected with the pump by a pipe 75. This pump may be actuated to inflate and deflate the ring by the handle 76. This pump is carried by the end wall 25 of the main hydraulic pump 20.

The lower end of the cylindrical portion 64 of guide 63 carries a pump cylinder 78 which is substantially coextensive, at its lower end, with the cylinder 69. The piston rod 51 extends into this cylinder 78 and carries, at its lower end, a plunger generally indicated at 79. This cylinder 78 and plunger cooperate with valves to form a pump generally indicated at 80.

Obviously, as the piston 50 and piston rod 51 are reciprocated, the plunger 79 will be reciprocated. For best results, the mechanism within the well casing 47 is lowered so that the entire cylinder 78 is contained in the fluid within the well.

The space between the cylinders 69 and 78 is divided into longitudinally-extending compartments 81 and 82, and the pump is valved so that, in cooperation with the compartments 81 and 82, a double-acting pump is provided. That is, fluid will be lifted not only when the plunger 79 moves upwardly, but also when the plunger moves downwardly. To form the compartments 81 and 82, there are provided two longitudinally-extending partition walls 84 and 85 which are welded to the inner wall of cylinder 69 and the outer wall of cylinder 78. The compartment 81 is closed at the top by an arcuately-shaped wall 87. The bottom of this compartment 81 is open, as shown at 83. The top of compartment 82 is open, as shown at 89, and the bottom of this compartment 82 is shown as closed by an arcuately-shaped portion 90, which is formed integrally with the closure or cap 91 of the bottom of the cylinder 78.

The valves for the pump 80 comprise an inlet port 93 and an outlet port 94 at the top of the cylinder 78, and inlet port 95 and outlet port 96 at the bottom of said cylinder, and two sleeves 98 and 99 are disposed respectively at the top and bottom of the cylinder 78 for respectively controlling the ports 93 and 94, and 95 and 96. The upper sleeve 98 is provided with a port 101 and a land portion 102 for controlling the flow of fluid through the port 93, while the diametrically opposite side 103 controls the flow of fluid through the port 94. The lower sleeve 99 is provided with a port 106 and a land portion 107 for controlling the flow of the fluid through port 95, while the diametrically opposite side 108 controls the flow of fluid through the port 96. These sleeves operate in unison, that is, they are shiftable concomitantly since they are connected by two diametrically disposed rods 110. These rods 110 are suitably secured to bosses 111 in the sleeves.

Fig. 8 shows the position of the valve sleeves as the plunger 79 is moving downwardly, and Fig. 9 shows the position of the sleeves as the plunger is moving upwardly. When the plunger is moving downwardly, port 93 will register with port 101 in the upper sleeve 98, and the opposite side 103 of said sleeve will be in position to close the port 94; and side 108 of lower sleeve 99 will be raised to clear port 96 in cylinder 78 while the land 107 will be in a position to close the port 95. When the valves are in this position and the plunger 79 is moving downwardly, fluid will enter through the ports 93 and 101 into the upper part of the cylinder 78, and the fluid below the plunger 79 will be forced through the port 96 into compartment 82, whence it will flow upwardly through the open top 89 of compartment 82 through the passages 63 in the guide 63 into the well casing above the ring 71, then upwardly through the pipe 61, the fluid entering compartment 71 through the open end 88.

When the plunger 79 is moving upwardly, the valves will be in the position as shown in Fig. 9, and fluid will enter the cylinder 78 below the plunger 79 through the registering ports 95 and 106; the fluid above the plunger will be ejected through port 94 and flow into the compartment 82, whence it will flow as previously described, through the open end 89. The arcuately-shaped wall 87 at the top of cylinder 78 prevents the fluid from returning to the compartment 81. It will be observed that when the valves are in the position shown in Fig. 9, the land portion 102 closes port 93 to prevent the fluid from returning from the upper part of the cylinder to the open bottom compartment 81, and also the side 109 on sleeve 99 closes port 96 so that the fluid being lifted by the plunger 79 cannot escape downwardly through the compartment 82 to below the plunger 79.

The sleeves 98 and 99 are shifted by plunger 79 through the rods 110. The bosses 111 on the sleeves 98 and 99 lie in the path of movement of the plunger 79. As the plunger nears the end of its downstroke, the lower ends thereof engage the top sides of bosses 111 on sleeve 99 and moves the same from the position shown in Fig. 8 to that shown in Fig. 9, and when the plunger nears the end of its upstroke, the upper end thereof engages the bottom of bosses 111 on sleeve 98 to move the latter from the position shown in Fig. 9 to that shown in Fig. 8. The rods extend through the plunger 79. To prevent leakage of fluid from one side of the plunger to the other at the places where rods 110 extend through the plunger, I provide a seal, and, to accomplish this I provide for frictionally and yieldingly engaging the plunger 79 and rods 110. I utilize the compressible washer-type ring 113 as the element for sealingly engaging the rods 110. This ring 113 may be formed of leather, rubber, or synthetic rubber, which is squeezed in place between shoulder 114 on the main disc 115 and ring 116—the ring 116 being held in place and compressed by screws 117. The rods 110 extend through the disc 115, the compressible ring 113 and the metallic ring 116, the opening in the compressible ring 113 being normally of smaller diameter than the diameter of the rods 110 whereby the ring 113 frictionally grasps the rods 110.

I insure the retaining of the valve mechanism in either position to which it is shifted, and, I insure sealing relationship between the land portions on the sleeve and the ports in the cylinder 78 by the novel arrangement more specifically shown in Fig. 10. The sleeves each include a cylindrical metallic portion 119, which also carries a coating of rubber or synthetic rubber 120. These portions 120 are sufficiently resilient to be yieldably engageable with the wall of the cylinder and thereby yieldingly retain the valve mechanism in either of the two positions and prevent leakage between the ports and the lands.

Referring now to Figs. 3B and Fig. 3C, it will be seen that the guide 63 for the piston rod 51 is also the stuffing box for the rod. Guide 63 is provided with an upper guide portion 122 and a like low guide portion 123. Each of these portions is provided with a circular groove containing an O-ring 124 which closely embraces the rod 51. The portion between guide portions 122 and 123 is circularly recessed as at 126, so as to provide a space between the rod and interior of the guide. Thus, any foreign material which may be forced through the lower O-ring packing 124 will not be dragged upwardly by the rod into contact with the upper O-ring packing. Moreover, the distance between the guide portions 122 and 123 is such that no portion of the rod enters both packings.

While the form of embodiment herein shown and described constitutes a preferred form, it is to be under-

stood that other forms may be adopted falling within the scope of the claims that follow:

I claim:

1. In a pump, in combination, a cylinder means having an intake port and an outlet port; valve means movable to one position for opening the intake port and closing the outlet port and movable to another position for closing the intake port and opening the outlet port; a plunger means in the cylinder; mechanism for reciprocating the first and third means relative to one another, said valve means having a portion lying in the path of movement of the means which is reciprocated for alternately-intermittently shifting the valve means to its two positions; and a resilient element interposed between the cylinder means and valve means for frictionally retaining the valve means in the position to which it was shifted.

2. In a pump, in combination, a cylinder means having an intake port and an outlet port at one end thereof and an intake port and an outlet port at the other end thereof; valve means movable to one position for opening certain of said ports and for closing certain other of said ports and movable to another position for closing the previously opened ports and for opening the previously closed port; a plunger means in the cylinder; mechanism for reciprocating one of said first and third means relative to the other, said valve means having portions lying in the path of movement of the said reciprocated means for alternately-intermittently shifting the valve means from one of its positions to the other of its positions; and a resilient element interposed between the cylinder means and valve means for frictionally retaining the valve means in the position to which it was shifted.

3. A device as defined in claim 1, characterized in that the valve means is in the form of sleeve means having a port.

4. A device as defined in claim 1, characterized in that the valve means includes ported sleeves at opposite ends of the cylinder; and further characterized in that the plunger element is the movable element and that the sleeves are connected with one another by a rod extending through the plunger means.

5. A device as defined in claim 1, characterized in that the valve means includes ported sleeves at opposite ends of the cylinder; a compressible washer-type ring frictionally engaging the interior wall of the cylinder means; and a rod passing through the washer-type ring, said rod operatively connecting the sleeve valves with one another.

6. A device as defined in claim 1, characterized in that the valve means includes ported sleeves at opposite ends of the cylinder; further characterized in that the plunger element is the movable element; a compressible washer-type ring frictionally engaging the interior wall of the cylinder means; and a rod passing through the washer-type ring, said rod operatively connecting the sleeve valves with one another.

7. In a pump, in combination, a cylinder having an intake port and an outlet port at one end thereof and an intake port and an outlet port at the other end thereof; ported sleeve valves for opening and closing said cylinder ports; a plunger reciprocating in the cylinder, said plunger having a compressible washer-type ring frictionally engaging the interior wall of the cylinder; and a rod passing through the washer-type ring, said rod operatively connecting the sleeve valves with one another.

8. A device as defined in claim 7, characterized in that the sleeve valves are of the reciprocating type.

9. In a deep well pump, in combination, a vertically-extending pump cylinder; a cylinder surrounding and spaced from the pump cylinder; spaced vertically-extending partition walls connected with the outer surface of the pump cylinder and the inner surface of the surrounding cylinder for dividing the space between said cylinders into two vertically-extending compartments, one of said compartments having an open top and the other of said compartments having an open bottom; means forming a closed bottom for the first compartment; and means forming a closed top for the second compartment, said cylinder having valve ports at the top, one connected with one compartment and the other with the other compartment, and having valve ports at the bottom, one connected with one compartment and the other with the other compartment.

10. In a deep well pump, a vertically-extending well casing; a hydraulic motor in the casing including a vertically-extending cylinder; a reciprocating piston within the cylinder; an elongated piston rod guide attached to the lower end of the cylinder; a pump cylinder attached to the lower end of the guide; a plunger in the pump cylinder; a piston rod extending longitudinally through the guide and connected at its upper end with the piston and at its lower end with the plunger, said guide having rod-guiding surfaces at its upper and lower ends and being recessed longitudinally between said guiding surfaces to provide a chamber within the guide and surrounding the rod and of a length greater than the length of the stroke of the rod.

11. Mechanism as defined in claim 10, characterized in that the guide is provided with a circumferential recess and further characterized in that there is provided an inflatable sealing ring in the recess in sealing relationship with the inner wall of the casing.

12. Mechanism as defined in claim 10, characterized in that the guide is provided with sealing means about the rod adjacent the upper and lower guiding surfaces thereof.

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