March 6, 1951 R. B. KNOWLES 2,544,094

HYDRAULIC PUMP

Filed April 19, 1947 2 Sheets-Sheet 1

Fig. 1.

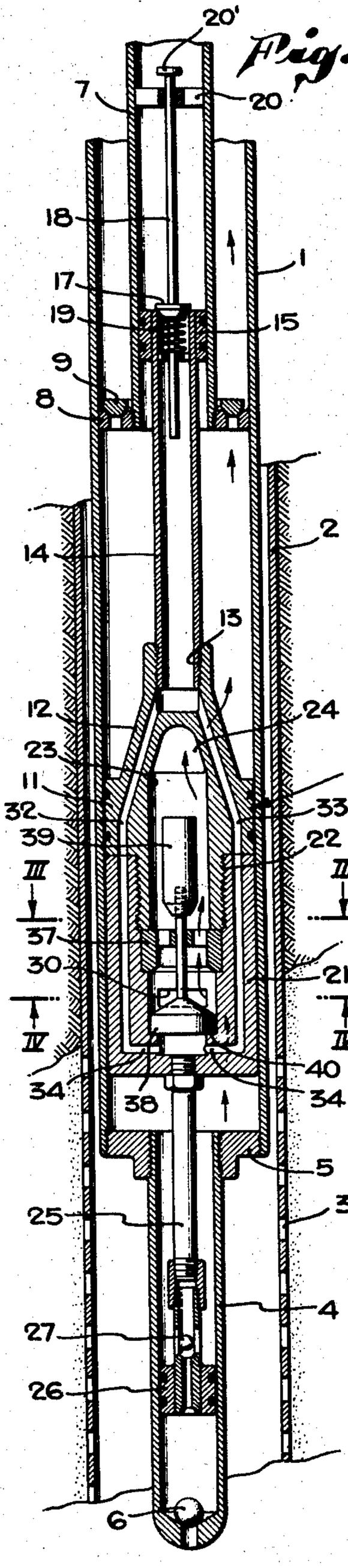


Fig. 2.

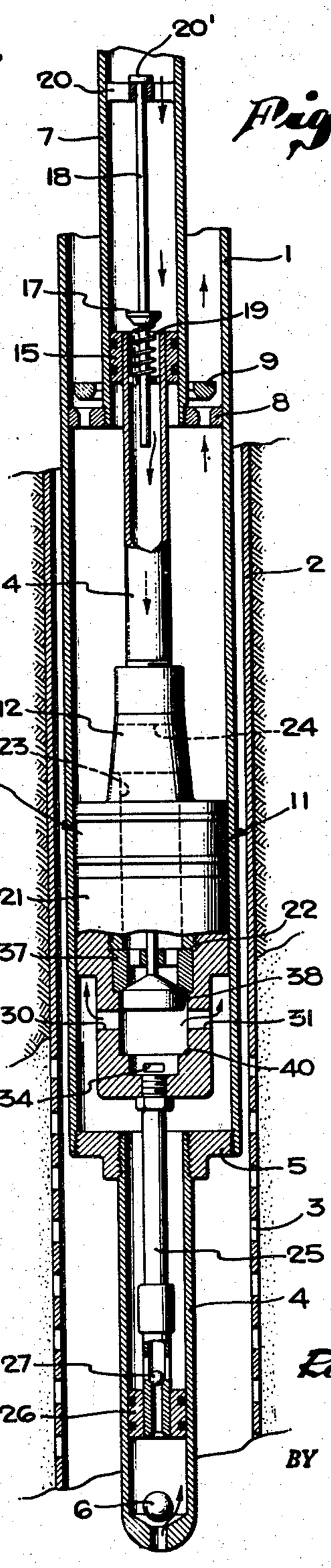


Fig. 3.

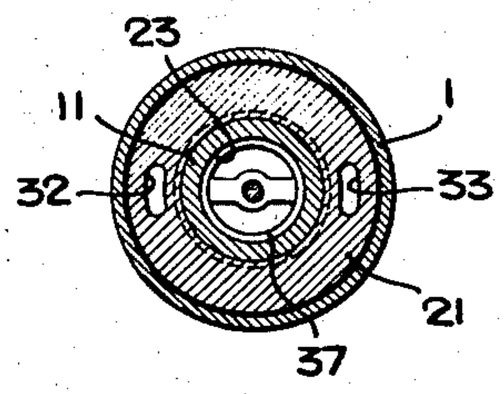
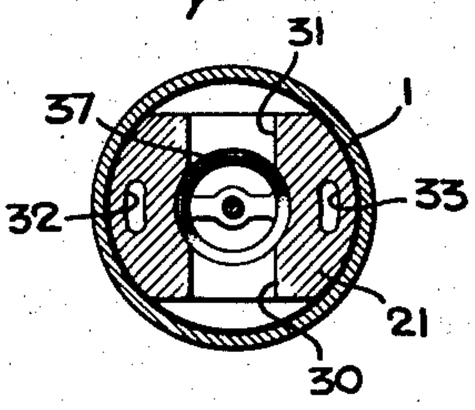


Fig. 4.



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March 6, 1951 R. B. KNOWLES 2,544,094

HYDRAULIC PUMP

Filed April 19, 1947 2 Sheets-Sheet 2

Fig. 5.

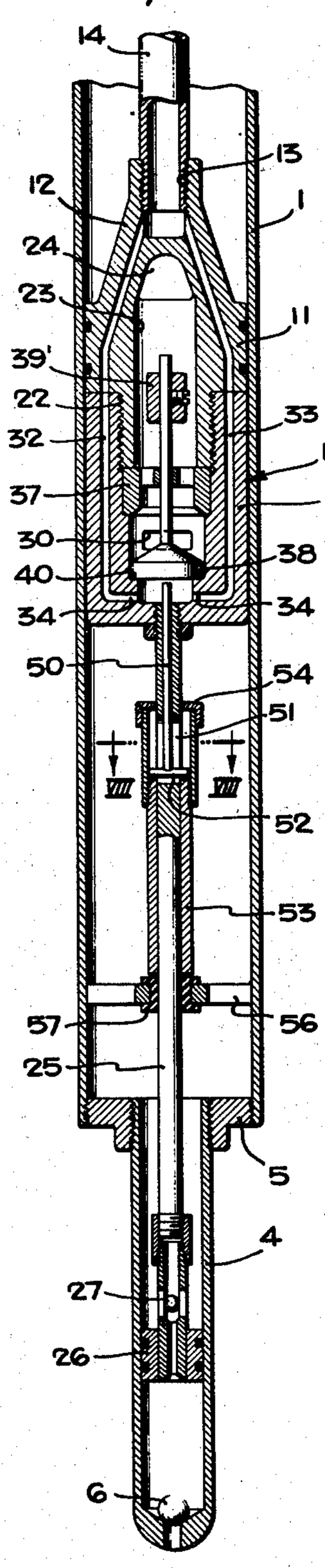


Fig. 6.

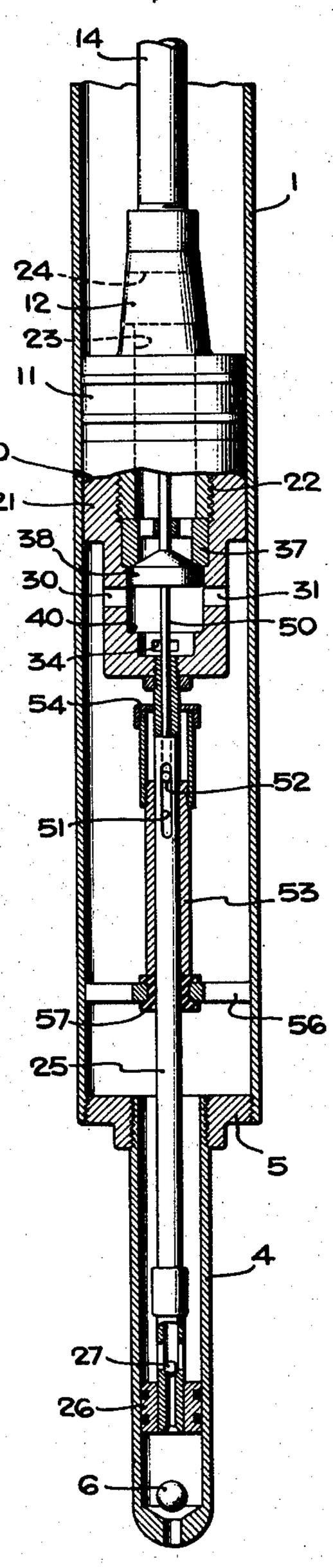


Fig. 7.

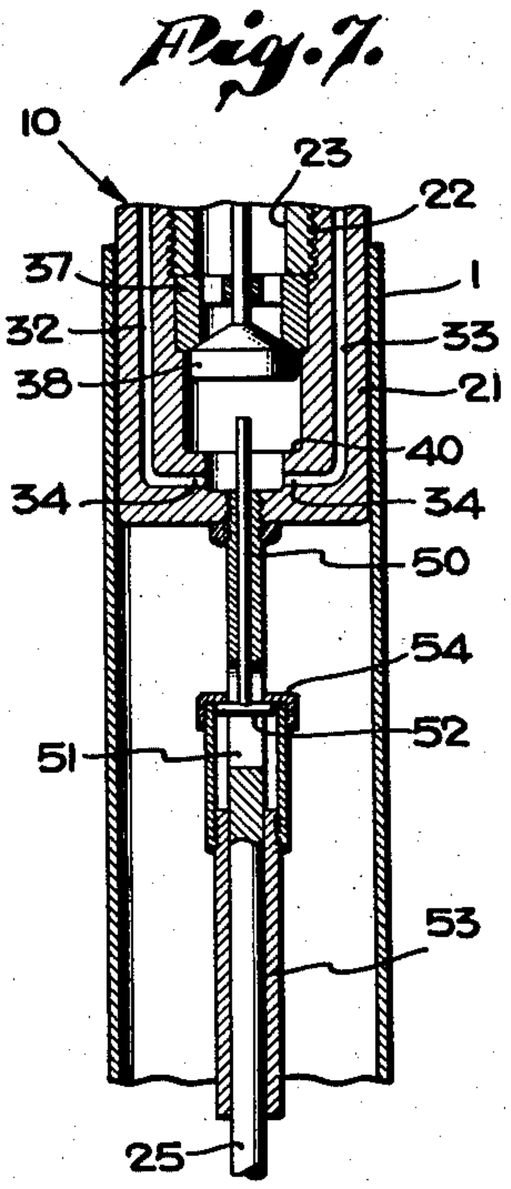
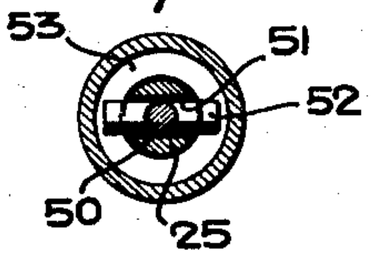


Fig. 8.



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HYDRAULIC PUMP

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Application April 19, 1947, Serial No. 742,495

5 Claims. (Cl. 103—46)

1

This invention relates to a fluid pump of the hydraulic type which may be automatically operated in a sub-surface position by the circulation of pressure fluid supplied to the pump through pressure tubing from a position above the surface. The pump is particularly adapted for use in oil wells, but may be used for raising other liquids.

Ordinarily, sub-surface pumps either include a motor closely adjacent to the pumping elements or, in the case of well pumps, the sub-surface pump is operated by a long string of sucker rods. Pumps operated by a reciprocating string of sucker rods are of a low mechanical efficiency and require relatively heavy, cumbersome actuating machinery on the surface. Such strings of sucker rods stretch appreciably during the lifting stroke and since they come into sliding contact with the casing or pipe through which they extend, the rods are subject to wear and breakage.

The pump of the present invention is rodless and consists of a piston movably positioned in a production pipe extending into the well hole. Fluid under pressure is supplied to the piston through a string of pressure tubing and means are provided for automatically discharging the pressure fluid on opposite sides of such piston alternately so as to cause the piston and its associated pump plunger to reciprocate within the production pipe.

One of the advantages of the present invention is that the construction is simple and efficient and it is impossible for the pump to assume a dead center position from which it cannot be readily moved by the application of fluid pressure.

An object of the present invention is to disclose and provide a deep well pump capable of automatic operation by fluid pressure supplied to the well head.

A further object of the invention is to disclose and provide a fluid-operated well pump which has but few movable elements and no constrictions capable of being clogged with sand or other foreign matter.

These and other objects of the invention will become apparent to those skilled in the art from the following detailed description of certain exemplary forms embodying the inventive concepts here contained. In order to facilitate understanding, reference will be had to the appended drawings, in which:

Fig. 1 is a longitudinal section through the lower portion of a well hole illustrating one form of pump embraced by this invention, this figure

2

illustrating the position of the parts as the pump approaches the end of a down stroke.

Fig. 2 is a longitudinal section taken at a plane at right angles to that of Fig. 1, showing the position of the pump at the beginning of its upward stroke.

Fig. 3 is a horizontal section taken along the plane III—III of Fig. 1.

Fig. 4 is a horizontal or transverse section taken along the plane IV—IV of Fig. 1.

Figs. 5 and 6 are longitudinal sections in planes at right angles to each other of a slightly modified form of pump.

Fig. 7 is a view of the shuttle valve mechanism at an intermediate position.

Fig. 8 is a somewhat enlarged transverse section taken along the plane VIII—VIII of Fig. 5.

The form of pump shown in Figs. 1 to 4, inclusive, comprises a production pipe 1 extending downwardly into the well hole which is lined with a casing 2, lower sections of the casing being perforated as indicated at 3. It will be understood that the production pipe 1 extends upwardly to the surface. The lower end of the production pipe is provided with a working barrel 4 attached to the pipe 1 as by means of the shoe 5. The lower end of the working barrel is shown provided with a ball check valve 6.

Extending downwardly into the production pipe 1 is a string of pressure tubing 7. The lower end of such pressure tubing is shown attached to a spider 8 welded or otherwise suitably attached to the production pipe 1 at a point spaced above the working barrel 4. The spider 8 carries an annular seat upon which the valve ring 9 may rest, this structure acting as a check valve and supporting a column of oil in the annular space between the production pipe 1 and the string of tubing 7.

Slidably positioned within the production pipe 1, between the spider 8 and the working barrel 4, is a piston, generally indicated by the numeral 10. The body of such piston may include the upper portion 11 having a yoke 12 terminating in an internally threaded socket 13 in which the hollow tubular rod 14 is firmly seated. The tubular rod 14 is connected to a plunger 15 which is slidable within the lower portion of the pressure tube 7 and includes a biased valve 17 which closes the open end of the tubular rod 14 during a down stroke of the main piston and opens on the up stroke.

The last-mentioned valve 17 is mounted upon a rod 18 extending slidably through a ported spider within the tubular rod 14, a spring 19 be-

ing carried between the spider and the valve 17. The upper end of the rod 18 slidably extends through a ported spider 20 carried by the pressure tubing 7 and the end of the rod 18 is provided with a head 20'. On the down stroke of the main piston 10 and plunger 15, pressure fluid acts upon the upper surface of the valve 17 and the end of the plunger 15 and the valve is closed.

The main piston 10 also includes a lower body portion 21. The two body portions 11 and 21 may be threadedly connected as at 22 and jointly form an axial chamber 23 which is open at the top or in communication with a transverse port 24 which places the chamber in communication with the space within the production pipe 1 above the piston 10. The lower portion of the piston is closed and carries the pump rod 25 provided with the pump plunger 26 reciprocably mounted within the working barrel 4. The lower end of the pump rod 25 may be hollow, ported, and carry the check valve 27.

The lower portion of the axial chamber 23 is connected as by means of ports 30 and 31 to the space within the production pipe below the piston 10. The body portion of the piston is provided with passageways 32 and 33 extending through the yoke 12 and connecting the hollow tubular rod 14 with the axial chamber 23 through ports such as 34 below the ports 30 and 31.

A valve seat ring 37 is positioned within the axial chamber 23, such ring including a ported spider through which the stem of a shuttle valve 38 extends. The stem of this valve may be seated as by the seat 39. A lower seat 40 is provided for the shuttle valve 38, such seat being between the ports 30 and the ports 34, the seating ring 37 furnishing a seat for the shuttle valve in its upper position above the ports 30 and 31.

In actual operation, pressure fluid from a suitable pressure source is supplied through the pressure tubing 7 and downward motion is transmitted to the piston 10 by the action of the pressure fluid against the closed end of plunger 15. During downward motion of the piston 10 the shuttle valve 38 is in the position indicated in Fig. 1 upon the lower seat 40. Oil within the lower portion of the working barrel 4 passes upwardly through the pump plunger 26 into the space above such pump plunger. Oil in the space within the production pipe 1 and below the piston 10 passes through the ports 30 and 31 into the axial bore 23 and upwardly through the port 24 into the space above the piston 10. The check valve 9 is upon its seat as shown in Fig. 1.

When the piston 10 reaches the bottom of its stroke, head 20' of valve stem 18 contacts the spider 20, causing the valve 17 to open. This causes the pressure fluid to rush down through the hollow tubular rod 14 and passageways 32 and 33 and be discharged through ports 34 beneath the shuttle valve 38, causing such shuttle valve to move upwardly into the position indicated in Fig. 2. The pressure fluid is then discharged through ports 30 and 31 into the space within the production pipe 1 and below the piston 10. Since the diameter of the pump plunger 26 is appreciably smaller than the diameter of piston 10, the pressure fluid, acting upon the lower surface of the piston 10, causes said piston to rise. The upward motion of piston 10 causes the oil in the space within the production line above the piston to be raised through the ported spider 8, the check valve 9 rising from its seat. Simultaneously oil within the upper portion of the working barrel is being elevated and fresh oil is being drawn into the lower portion of the working barrel, as indicated in Fig. 2.

When the piston 10 reaches the top of its stroke, the valve 17 contacts the spider 20, thereby positively closing the open end of the tubular rod 14 and thereby initiating downward movement of the piston. As soon as upward movement of the piston ceases and the supply of pressure fluid to the space beneath the shuttle valve 38 is discontinued, such shuttle valve drops under the influence of its seat 39.

A slightly modified form of pump is illustrated in Figs. 5 to 8, inclusive, and similar numbers to those used in describing the device if Figs. 1 and 2 are applied to corresponding portions and elements of the modified device. For purposes of simplification, the pressure tubing 7 and the annular check valve 8—9 are not shown and it is to be understood that the tubular rod 14 is again provided with the plunger 15 slidably mounted within the pressure tubing and carries the valve 17.

The primary distinction between the device of Figs. 1 and 2 and that illustrated in Figs. 5, 6, and 7 can be found in the means for insuring movement of the shuttle valve 38, the device of Figs. 1 and 2 showing the shuttle valve being raised into seating engagement with the seat 37 by the supply of pressure fluid through passageways 32 and 33, such seating made more positive by a mechanical means carried by and forming a part of the pump rod 25.

As shown in Figs. 5, 6, and 7, the upper portion of the pump rod 25 is axially bored so as to slidably receive a lift rod 50 extending into the chamber in which the shuttle valve 38 is movably positioned. The upper end of the pump rod 25 is also provided with a transverse slit 51 through which a transverse arm 52, carried by the lower end of 50, may extend. Slidably mounted upon the pump rod 25 is a tubular member 53 provided with a head 54. The head 54 will contact and engage the transverse arm 52 at the bottom and at the top of a sliding movement of 53 upon the pump rod 25.

Within the production pipe 1 and immediately above the working barrel 4, there is a fixed ported spider 56, preferably provided with a centrally disposed, resilient bushing 57 through which the pump rod 25 may slidably extend. The precise position of the spider 56 with respect to the lower limit of travel of pump rod 25 is correlated with the downward movement of the plunger 15 carried by the hollow tubing 14 within the pressure tubing 7 and the length of the rod 18 between valve 17 and head stop 20'.

As the main piston 10 moves downwardly within the production pipe 1, and before it reaches the lowermost point in its travel, the lower end of tubular sleeve 53 contacts the resilient bushing 57. Continued downward movement of piston 10 and pump rod 25 may take place but the arm 52 of lift rod 50 engages the upper shoulder of tubular member 53, causing the lift rod 50 to bear against the bottom of shuttle valve 38 and initiate upward movement of such shuttle valve. Such upward movement of the shuttle valve continues until the shuttle valve is in virtual contact with its seat 37. At that time, or immediately prior thereto, the valve 17 is opened (at the upper end of tubular rod 14) and pressure fluid is discharged through the passages 32 and 33 into the chamber beneath the shuttle valve, causing such shuttle valve to firmly seat

in the upper position indicated in Fig. 6 and reverse the movement of piston 10.

Fig. 6 therefore shows the position of the elements at the beginning of the upward movement of the main piston 10, whereas Fig. 7 shows the shuttle valve still seated against the seat 37 while the lift rod 50 is being retracted, such retraction being due to the upward travel of pump rod 25 while the tubular member 53, and particularly the head 54 thereof, are preventing upward motion of the lift rod 50.

The shuttle valve 38 is provided with a weight 39' and at the top of the stroke of piston 10, when the supply of pressure fluid through passages 32 and 33 is automatically discontinued, the shuttle valve 38 returns to the down position of Fig. 5 under the influence of gravity and unimpeded by the lift rod 50.

From the description given hereinabove, it will be evident that an efficient well-pumping apparatus has been provided, the pump itself being actuated by a supply of fluid under pressure from a surface position. From a contemplation of the various operations, it will be evident that the pump can be started at any time and cannot sink within the production pipe to an inoperative, dead-center position. If, for example, the device illustrated in Figs. 5 and 6 were to be permitted to slide down the production pipe until it reaches its lowermost position, the lift rod 50 will firmly hold the shuttle valve 38 against its seat, while the upper valve 17 is open. When, at some later date, pressure fluid is sent down the pressure tubing 7, such pressure fluid will immediately raise the main piston 10 and initiate pumping.

Moreover, it will be evident to those skilled in the art that the entire device is foolproof, inexpensive to manufacture, consists of but a relatively few parts, and employs only one spring, namely, the spring surrounding the valve stem 18, and even this spring may be dispensed with, if desired. As a result, breakage and wear or the necessity for frequent repairs have been virtually eliminated.

All changes and modifications coming within the scope of the appended claims are embraced thereby.

I claim:

1. In a fluid motor means adapted for use in a well-pumping apparatus including a production pipe provided with a working barrel at its lower end and a pressure tubing within the production pipe, the combination of: means including a check valve for holding the lower end of the pressure tubing spaced above the lower end of the production pipe; a piston movably positioned in the production pipe below the end of the pressure tubing, an upwardly extending yoke from the piston, a hollow tubular rod connected to the yoke, and a plunger carried by the rod and slidable within the lower portion of the pressure tubing; an axial chamber within the piston; ports connecting the upper end of the chamber with the space within the production pipe; lower ports connecting the space within the production pipe below the body of the piston with the chamber; a valve seat within the chamber and between said ports; a movable shuttle valve within the chamber and below said seat, said shuttle valve being movable between a seated position upon said seat to a position below the lower ports; and passageways in the yoke and piston connecting the pressure tubing with the axial chamber below the lower position of said shuttle valve.

2. In a fluid motor means of the character

stated in claim 1, the provision of: a normally closed valve in the hollow tubular rod; and means for opening said valve when said rod and plunger carried thereby are at the bottom of their stroke to admit pressure fluid from the pressure tubing into the passageways and below the shuttle valve to raise the same against its seat.

3. In a fluid motor means adapted for use in a well-pumping apparatus including a production pipe provided with a working barrel at its lower end and a pressure tubing within the production pipe, the combination of: means for holding the lower end of the pressure tubing spaced above the lower end of the production pipe; a piston movably positioned in the production pipe below the end of the pressure tubing, an upwardly extending yoke from the piston, a hollow tubular rod connected to the yoke, and a plunger carried by the rod and slidable within the lower portion of the pressure tubing; valve means in the hollow tubular rod, means rendered effective when the piston approaches the bottom of the stroke for opening said valve; an axial chamber within the piston; ports connecting the upper end of the chamber with the space within the production pipe; lower ports connecting the space within the production pipe below the body of the piston with the chamber; a valve seat within the chamber and between said ports; a movable shuttle valve within the chamber and below said seat, said shuttle valve being movable between a seated position upon said seat to a position below the lower ports; and passageways in the yoke and piston connecting the pressure tubing with the axial chamber below the lower position of said shuttle valve.

4. In a fluid motor means of the character stated in claim 1 the provision of: a pump rod carried by the piston and adapted to be provided with a pump plunger operably movable in the working barrel, a lift rod within the upper end of the pump rod and extending into the axial chamber beneath the shuttle valve; means for limiting the travel of said lift rod including a headed member slidably mounted upon said pump rod; a stop member positioned within the production pipe below the piston and above the working barrel; and means for releasably engaging the lift rod with said member to raise the lift rod into operative engagement with the shuttle valve when the member contacts said stop.

5. In a fluid motor means including a pressure tubing within a production pipe the combination of: means for holding the lower end of the pressure tubing spaced above the lower end of said pipe; a piston movably positioned in the production pipe below the end of the pressure tubing, said piston being provided with a pump rod, an upwardly extending yoke from the piston, a hollow tubular rod connected to the yoke, and a plunger carried by the tubular rod and slidable within the lower portion of the pressure tubing; a valve in the hollow tubular rod, means rendered effective when the piston approaches the bottom of its stroke for opening said valve; an axial chamber within the piston; ports connecting the upper end of the chamber with the space within the production pipe between the end of the pressure tubing and the piston; lower ports connecting the space within the production pipe below the body of the piston with the chamber; a valve seat within the chamber and between said upper and lower ports; a movable shuttle valve within the chamber and below said seat, said shuttle valve being movable between a posi-

tion upon said seat to a position below the lower ports; passageways in the yoke and piston connecting the pressure tubing with the axial chamber below the lower position of said shuttle valve; and means carried by said pump rod below said piston for cooperative engagement with said shuttle valve to positively seat said shuttle valve.

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