Jan. 9, 1951 C. M. HOWARD 2,537,410

HYDRAULICALLY OPERATED WELL PUMP

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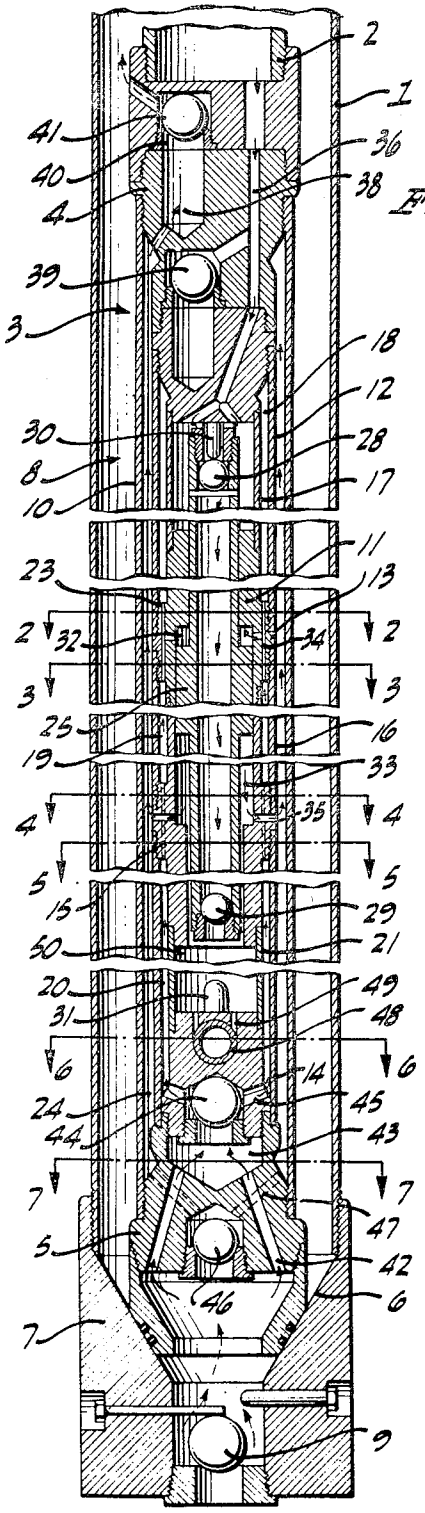


FIG. 1.

FIG. 2.

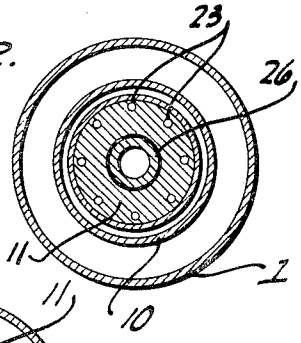


FIG. 3.

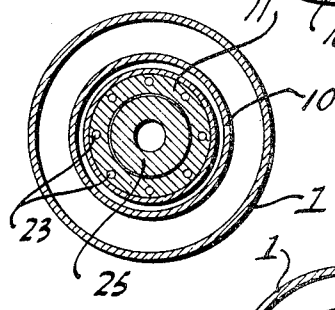


FIG. 4.

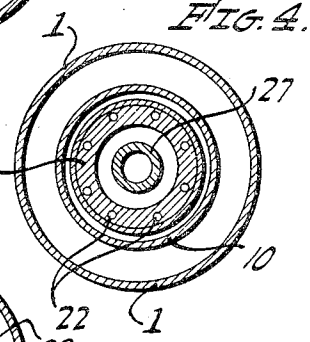


FIG. 5.

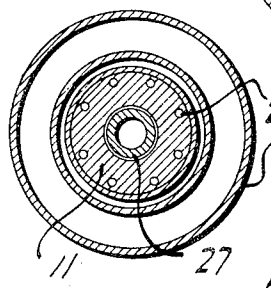


FIG. 6.

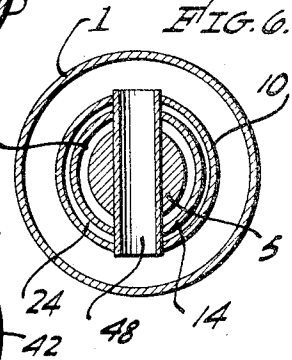
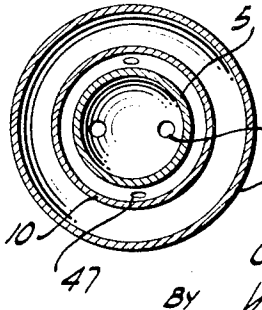


FIG. 7.



INVENTOR.
CLIFFORD M. HOWARD,
BY H. A. Duckman
ATTORNEY.

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Fig. 8.

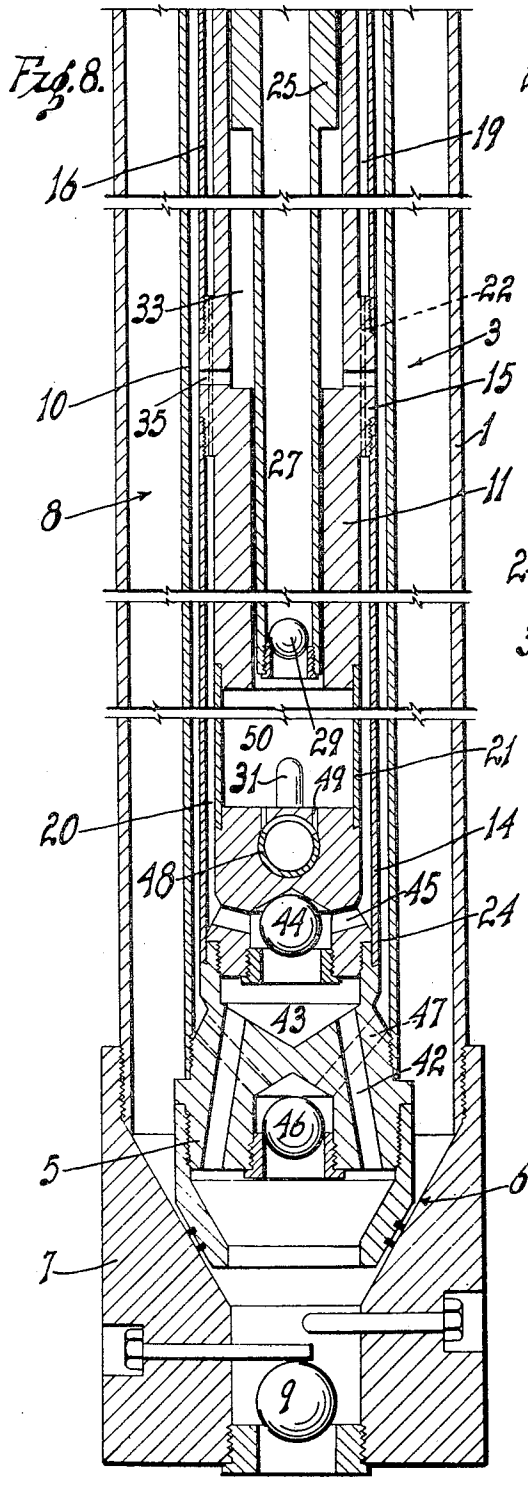
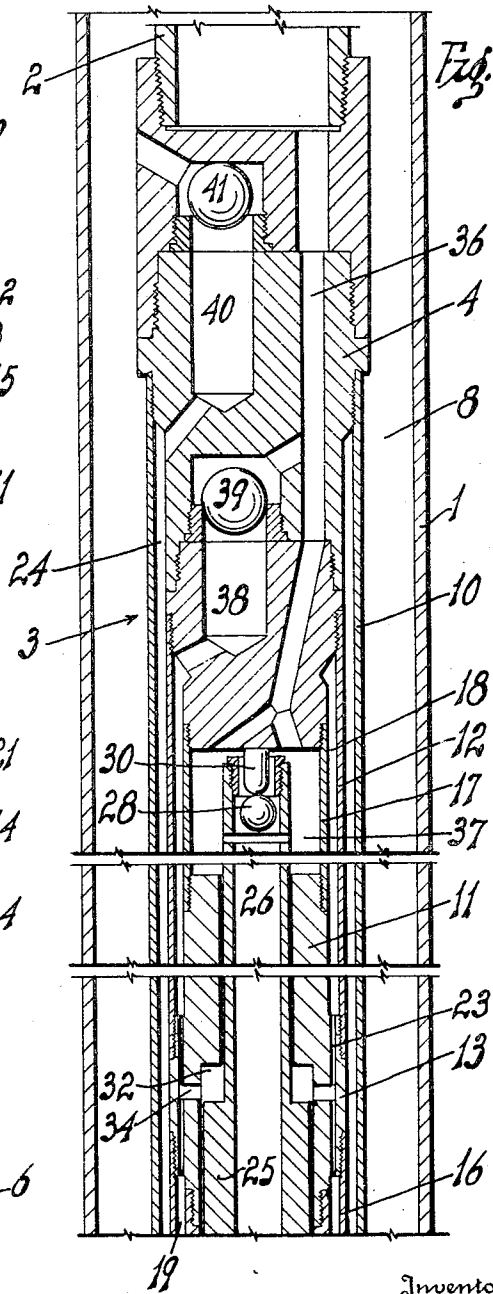


Fig. 9.



Inventor

Clifford M. Howard.

By K. A. Brueckman

Attorney

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HYDRAULICALLY OPERATED WELL PUMP

Clifford M. Howard, Fontana, Calif.

Application February 24, 1948, Serial No. 10,313

8 Claims. (Cl. 103—46)

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This invention relates to a hydraulically operated well pump, which is particularly adapted to the pumping of oil although other fluids such as water and the like, may be pumped if desired.

An object of my invention is to provide a novel hydraulically operated well pump, in which the pressure on the fluid actuating the piston of the pump is relieved when the pump reaches the end of its stroke. By noting the pressure drop in the actuating fluid, it is possible to accurately determine the end of the piston stroke.

A feature of my invention is to provide a novel hydraulically operated well pump, in which the piston is hydraulically moved in two directions, the pump operating to eject fluid on both strokes of the piston.

Other objects, advantages and features of invention may appear from the accompanying drawing, the subjoined detailed description, and the appended claims.

In the drawing

Figure 1 is a diagrammatic longitudinal fragmentary sectional view of my well pump.

Figure 2 is a sectional view taken on line 2—2 of Figure 1.

Figure 3 is a sectional view taken on line 3—3 of Figure 1.

Figure 4 is a sectional view taken on line 4—4 of Figure 1.

Figure 5 is a sectional view taken on line 5—5 of Figure 1.

Figure 6 is a sectional view taken on line 6—6 of Figure 1.

Figure 7 is a sectional view taken on line 7—7 of Figure 1.

Figure 8 is a fragmentary vertical sectional view of the lower portion of my pump.

Figure 9 is a fragmentary vertical sectional view of the upper portion of my pump.

Referring more particularly to the drawing, the numeral 1, indicates the casing which extends from the surface into the well for the desired distance. The numeral 2, indicates the tubing which is mounted inside of the casing 1, and extends from the surface, and is attached to the top of the pump assembly 3. The pump assembly includes an upper cage 4, and a bottom cage 5. The bottom cage rests on a seat 6, in the sub 7, which is secured to the lower end of the casing 1. Thus, an annular space 8, is provided between the casing 1, and the outside of the tubing 2, as well as the outside of the pump assembly 3. This space is sealed at the bottom by the cage 5, and provides a space for the pumped fluid to move upwardly to the surface, as will be further

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described. The space 8, provides one column of fluid, the other column of fluid being within the tubing, 2.

A foot valve 9, is mounted in the sub 7, and the incoming fluid moves past this foot valve as it is urged into the pump, as will be further described, and as is shown by the dotted arrows in Figure 1. An outer barrel 10, is threaded onto the upper cage 4, and also onto the lower cage 5, thus assembling these cages in their spaced position. A pump barrel 11, is positioned between the upper and lower cages, 4, 5, and is held in proper spaced relation by a liner tube 12, which screws onto the cage 4, at its upper end, and onto the ring 13, on the pump barrel. This ring is an enlargement of the outer diameter of the pump barrel so as to provide an annular fluid passage, as will be further described.

Another outer liner tube 14, is threaded onto the lower cage 5, at its lower end, and to a ring 15, at its upper end, the ring 15, being formed on the pump barrel 11. A third liner tube 16, is threaded onto the rings 13, and 15, thus in substance forming a continuous liner tube with the elements 12, 14, and 16. A pipe section 17, is threaded onto the lower end of the cage 4, and also onto the upper end of the pump barrel 11. This provides an annular fluid chamber 18, between the liner 12, and the coupling pipe 17. An annular fluid chamber 19, is provided between the liner section 16, and the outer wall of the pump barrel 11.

A third annular chamber 20, is provided between the lower liner 14, and the outer wall of the pump barrel 11. A lower coupling pipe 21, is attached to the bottom of the pump barrel 11, and the upper end of the cage 5. The annular chambers 20, 19, and 18, form a continuous passage from the cage 5, to the cage 4. The fluid passes through the ring 15, through a plurality of ports, 22. The ring 13, is also provided with a plurality of longitudinal ports 23. An annular fluid chamber 24, extends from the cage 5, to the cage 4, between the outer barrel 10, and the liner tube consisting of the elements 12, 16, and 14.

A pump piston 25, is reciprocally mounted in the barrel 11. The pump barrel has an upper tubular extension 26, and a lower tubular extension 27. These tubular extensions extend out of the barrel 11, at the top and bottom respectively, and each extension has a ball valve therein, the upper ball being indicated at 28, and the lower ball at 29. A pin 30, extends downwardly from the cage 4, and at the top of the stroke this pin engages and unseats the ball 28. A pin 31, ex-

tends upwardly from the cage 5, and this pin engages and unseats the ball 29 on the completion of the downward stroke of the pump piston.

A pumping chamber 32, is provided above the piston 25, and a second pumping chamber 33, is provided below the piston 25. The chamber 32, opens into the ports 23, through a plurality of holes 34. The lower pumping chamber 33, opens into the annular passage 24, through ports 35.

Considering now the upper cage 4, a channel 36, extends from the top of the cage and opens into the tubing 2, and the lower end opens into the space 37, between the bottom of the cage 2, and the top of the pump barrel 11. A by-pass conduit 38, extends from the annular flow chamber 20, to the passage 36, and a ball check 39, is seated in this passage and opens upwardly. A second by-pass channel 40, is formed in the cage 4, and this channel extends from the annular fluid passage 24, and the casing 1. A ball check 41, is seated in this channel and opens upwardly. The lower cage 5, includes a plurality of vertical ducts 42, which extend from the bottom of the cage and into a chamber 43. A ball check 44, closes the upper end of the chamber 43, and seats downwardly. A plurality of ports 45, extend from above the ball 44, and thence into the annular fluid passage 20.

A check valve 46, is seated in the lower end of the cage 5, and seats downwardly. A plurality of channels 47, extend through the cage from above the ball 46, and into the lower end of the fluid passage 24. A transverse tube 48, extends through the cage 5, at its upper end, and this tube also extends through the inner tube 14, and the liner 10, so that the tube 48, is open to the casing. A plurality of ports 49, extend into the tube 48, and these ports open into the chamber 50, below the pump barrel 11, and above the cage 5.

Assuming that the piston 25, is at the top of its stroke and is about to be moved downwardly, pressure is exerted on the fluid column in the tubing 2, and this pressure is exerted through the port 36, and passes the ball 28, which has been unseated by the pin 30. The pressure is then exerted against the ball 29, which is seated, and the piston 25, moves downwardly. The fluid in the pumping chamber 33, is forced out through the ports 35, and into the annular passage 24, and moves upwardly in the direction shown by the dotted arrows.

The fluid then passes into the duct 40, unseats the ball 41, and then passes out into the casing and thence upwardly to the surface. In the completion of the downward stroke, the ball 29, is unseated by the pin 31, which releases the pressure urging the pump piston 25 downwardly, and the piston stops. While the piston 25, is moving downwardly, fluid is drawn into the upper pumping chamber 32, in the following manner: fluid from the formation moves past the unseated ball 9, thence upwardly through the ports 42, then past the ball 44, which is unseated by upward pressure, and passes out through the ports 45, into the annular passage 20, then upwardly through the ports 22, and 23, and flows through the ports 34, into the pumping chamber 32. On the upward stroke of the piston 25, pressure is exerted on the column of fluid in the casing 1, this pressure being exerted through the tube 48, and thence through the ports 49. The ball 29, has been unseated as previously stated, and pressure is exerted against the top ball 28, which is seated. The fluid in the chamber 32, is then forced upwardly through the ports 23, thence upwardly into the by-pass duct 38, past the ball 39, thence into the duct 36, and into the tubing 2, to the surface. The lower pumping chamber 33, is filled by fluid from the formation which passes the ball 46, thence through the ports 47, into the annular chamber 24, and then through the ports 35, into the chamber 33.

It will be evident from the foregoing description that the pump will operate on both the up and down stroke, and at the end of each stroke of the piston 25, the actuating pressure is relieved by unseating a ball in the piston, thus limiting the stroke of the piston, and preventing injury to the parts by the possible accumulation of pressure within the pump.

Having described my invention, I claim:

1. A hydraulically operated well pump including a casing, tubing in the casing a pump assembly on the lower end of the tubing, packing means between the pump assembly and the casing, a reciprocating piston in said pump assembly, a valve at the upper and a second valve at the lower end of the piston, said pump assembly having a fluid conduit extending from the tubing to the upper end of the piston, and a second conduit from the casing to the lower end of the piston, and means to unseat one of said valves at the completion of a stroke of the piston, each of said conduits acting to exhaust motive fluid when the other conduit conducts pressure fluid to the piston, and said pump assembly having a pump fluid inlet extending from the bottom thereof to the top of the piston and a pump fluid outlet from the bottom of the piston to said casing.

2. A hydraulically operated well pump including a casing, tubing in the casing, a pump assembly on the lower end of the tubing, packing means between the pump assembly and the casing, a reciprocating piston in said pump assembly, a valve at the upper and a second valve at the lower end of the piston, said pump assembly having a fluid conduit extend from the tubing to the upper end of the piston, and a pumping pin engageable by each of said valves to unseat one of the valves at the completion of the piston stroke, each of said conduits acting to exhaust motive fluid when the other conduit conducts pressure fluid to the piston, and said pump assembly having a pump fluid inlet extending from the bottom thereof to the top of the piston and a pump fluid outlet from the bottom of the piston to said casing.

3. A hydraulically operated well pump including a casing, tubing in the casing, a pump assembly on the lower end of the tubing, said pump assembly including an upper cage and a lower cage, a sub on the casing, said lower cage seating in the sub, a reciprocating piston in said pump assembly, a valve at the upper and a second valve at the lower end of the piston, said pump assembly having a fluid conduit extending from the tubing to the upper end of the piston, and a second conduit from the casing to the lower end of the piston, and means to unseat one of said valves at the completion of a stroke of the piston, each of said conduits acting to exhaust motive fluid when the other conduit conducts pressure fluid to the piston, and said pump assembly having a pump fluid inlet extending from the bottom thereof to the top of the piston and a pump fluid outlet from the bottom of the piston to said casing.

4. A hydraulically operated well pump including a casing, tubing in the casing, a pump as-

sembly on the lower end of the tubing, said pump assembly including an upper cage and a lower cage, a sub on the casing, said lower cage seating in the sub, a reciprocating piston in said pump assembly, a valve at the upper and a second valve at the lower end of the piston, said pump assembly having a fluid conduit extending from the tubing to the upper end of the piston, and a second conduit from the casing to the lower end of the piston, and a bumper pin engageable by each of said valves to unseat one of the valves at the completion of a piston stroke, each of said conduits acting to exhaust motive fluid when the other conduit conducts pressure fluid to the piston, and said pump assembly having a pump fluid inlet extending from the bottom thereof to the top of the piston and a pump fluid outlet from the bottom of the piston to said casing.

5. A hydraulically operated well pump including a casing, tubing in the casing, a pump assembly on the lower end of the tubing, said pump assembly including an upper cage and a lower cage, a sub on the casing, said lower cage seating in the sub, a reciprocating piston in said pump assembly, a valve at the upper and a second valve at the lower end of the piston, said pump assembly having a fluid conduit extending from the tubing to the upper end of the piston, and a second conduit from the casing to the lower end of the piston each of said conduits acting to exhaust motive fluid when the other conduit conducts pressure fluid to the piston, and said pump assembly having a pump fluid inlet extending from the bottom thereof to the top of the piston and a pump fluid outlet from the bottom of the piston to said casing, and means to unseat one of said valves at the completion of a stroke of the piston, said pump assembly having a pumping chamber above the piston, and a second pumping chamber below the piston, a foot valve in the sub, said pump assembly having an intake fluid passage extending through the lower cage, and thence to the upper pumping chamber, a valve in said intake fluid passage, a second intake fluid passage extending through the lower cage, and thence to the lower pumping chamber, and a valve in said second intake fluid passage, each of said first and second intake fluid passages serving as a fluid outlet when the other is acting as a fluid intake.

6. A hydraulically operated well pump including a casing, tubing in the casing, a pump assembly on the lower end of the tubing, said pump assembly including an upper cage and a lower cage, a sub on the casing, said lower cage seating in the sub, a reciprocating piston in said pump assembly, a valve at the upper and a second valve at the lower end of the piston, said pump assembly having a fluid conduit extending from the tubing to the upper end of the piston, and a second conduit from the casing to the lower end of the piston each of said conduits acting to exhaust motive fluid when the other conduit conducts pressure fluid to the piston, and said pump assembly having a pump fluid inlet extending from the bottom thereof to the top of the piston and a pump fluid outlet from the bottom of the piston to said casing, and a bumper pin engageable by each of said valves to unseat one of the valves at the completion of a piston stroke, said pump assembly having a pumping chamber above the piston and a second pumping chamber below the piston, a foot valve in the sub, said pump assembly having an intake fluid passage extending through the lower cage, and thence to the upper pumping chamber, a valve in said intake fluid passage, a second intake fluid passage extending through the lower cage, and thence to the lower pumping chamber, and a valve in said second intake fluid passage, each of said first and second intake fluid passages serving as a fluid outlet when the other is acting as a fluid intake.

7. A hydraulically operated well pump including a casing, tubing in the casing, a pump assembly on the lower end of the tubing, said pump assembly including an upper cage and a lower cage, a sub on the casing, said lower cage seating in the sub, a reciprocating piston in said pump assembly, a valve at the upper and a second valve at the lower end of the piston, said pump assembly having a fluid conduit extending from the tubing to the upper end of the piston, and a second conduit from the casing to the lower end of the piston each of said conduits acting to exhaust motive fluid when the other conduit conducts pressure fluid to the piston, and said pump assembly having a pump fluid inlet extending from the bottom thereof to the top of the piston and a pump fluid outlet from the bottom of the piston to said casing, and means to unseat one of said valves at the completion of a stroke of the piston, said pump assembly having a pumping chamber above the piston, and a second pumping chamber below the piston, a foot valve in the sub, said pump assembly having an intake fluid passage extending through the lower cage, and thence to the upper pumping chamber, a valve in said intake fluid passage, a second intake fluid passage extending through the lower cage, and thence to the lower pumping chamber, and a valve in said second intake fluid passage, and said pump assembly having an outlet fluid passage extending from the upper pumping chamber through the upper cage and thence into the tubing, a valve in said outlet fluid passage, a second outlet fluid passage extending from the lower pumping chamber through the upper cage, and thence into the casing, and a valve in the second outlet passage, each of said first and second intake fluid passages serving as a fluid outlet when the other is acting as a fluid intake.

8. A hydraulically operated well pump including a casing, tubing in the casing, a pump assembly on the lower end of the tubing, said pump assembly including an upper cage and a lower cage, a sub on the casing, said lower cage seating in the sub, a reciprocating piston in said pump assembly, a valve at the upper and a second valve at the lower end of the piston, said pump assembly having a fluid conduit extending from the tubing to the upper end of the piston, and a second conduit from the casing to the lower end of the piston each of said conduits acting to exhaust motive fluid when the other conduit conducts pressure fluid to the piston, and said pump assembly having a pump fluid inlet extending from the bottom thereof to the top of the piston and a pump fluid outlet from the bottom of the piston to said casing, said pump assembly having a pumping chamber above the piston, and a second pumping chamber below the piston, a foot valve in the sub, said pump assembly having an intake fluid passage extending through the lower cage, and thence to the upper pumping chamber, a valve in said intake fluid passage, a second intake fluid passage extending through the lower cage, and thence to the lower pumping

chamber, and a valve in said second intake fluid passage, and said pump assembly having an outlet fluid passage extending from the upper pumping chamber through the upper cage and thence into the tubing, a valve in said outlet fluid passage, a second outlet fluid passage extending from the lower pumping chamber through the upper cage, and thence into the casing, and a valve in the second outlet passage, and a bumper pin engageable by each of said valves in the piston to unseat one of said piston valves at the completion of a piston stroke, each of said first and second intake fluid passages serving as a fluid outlet when the other is acting as a fluid intake.

CLIFFORD M. HOWARD.

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