

166
187

April 2, 1963

B. A. PETERS ETAL

3,083,774

SUBSURFACE PACKER INFLATING PUMP

Filed Dec. 24, 1959

2 Sheets-Sheet 1

FIG. 1.

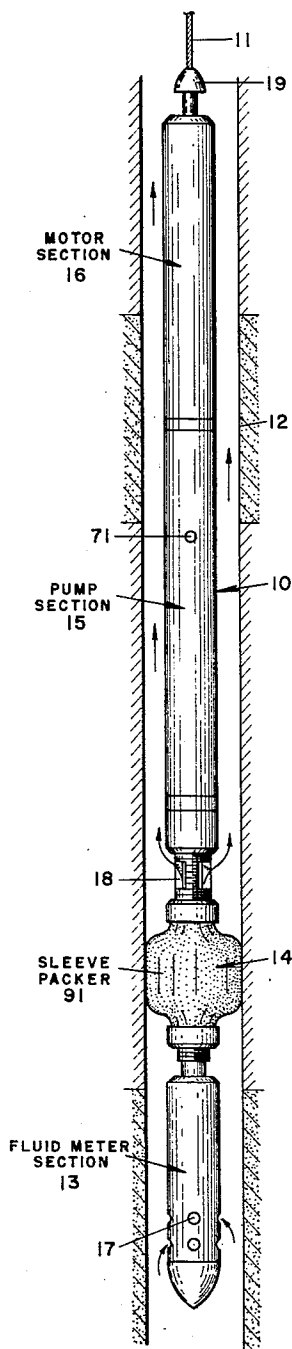


FIG. 10.

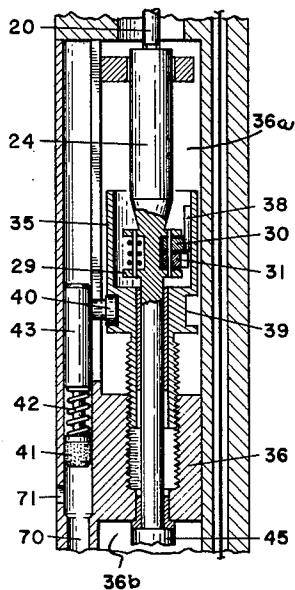


FIG. 5.

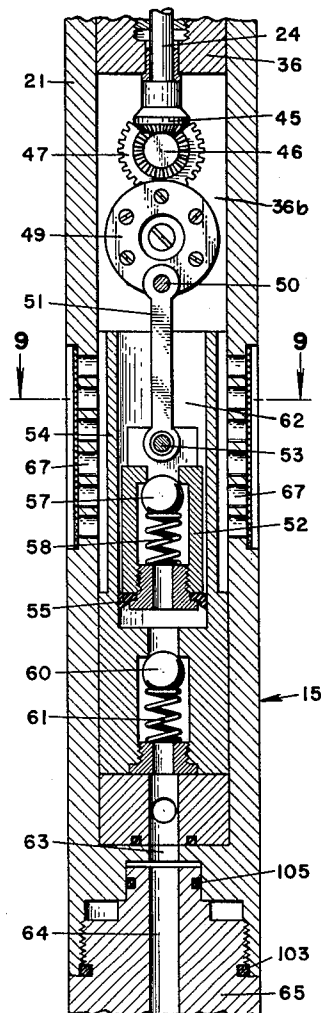
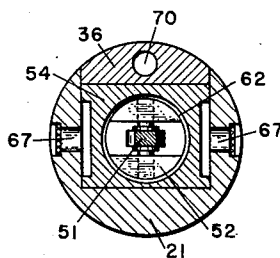


FIG. 9.



X104C

INVENTORS.

BELDON A. PETERS,
LOUIS A. CARLTON,
ELVIS RICH,
HENRY M. BUCK,

BY

John S. Schneider
ATTORNEY.

April 2, 1963

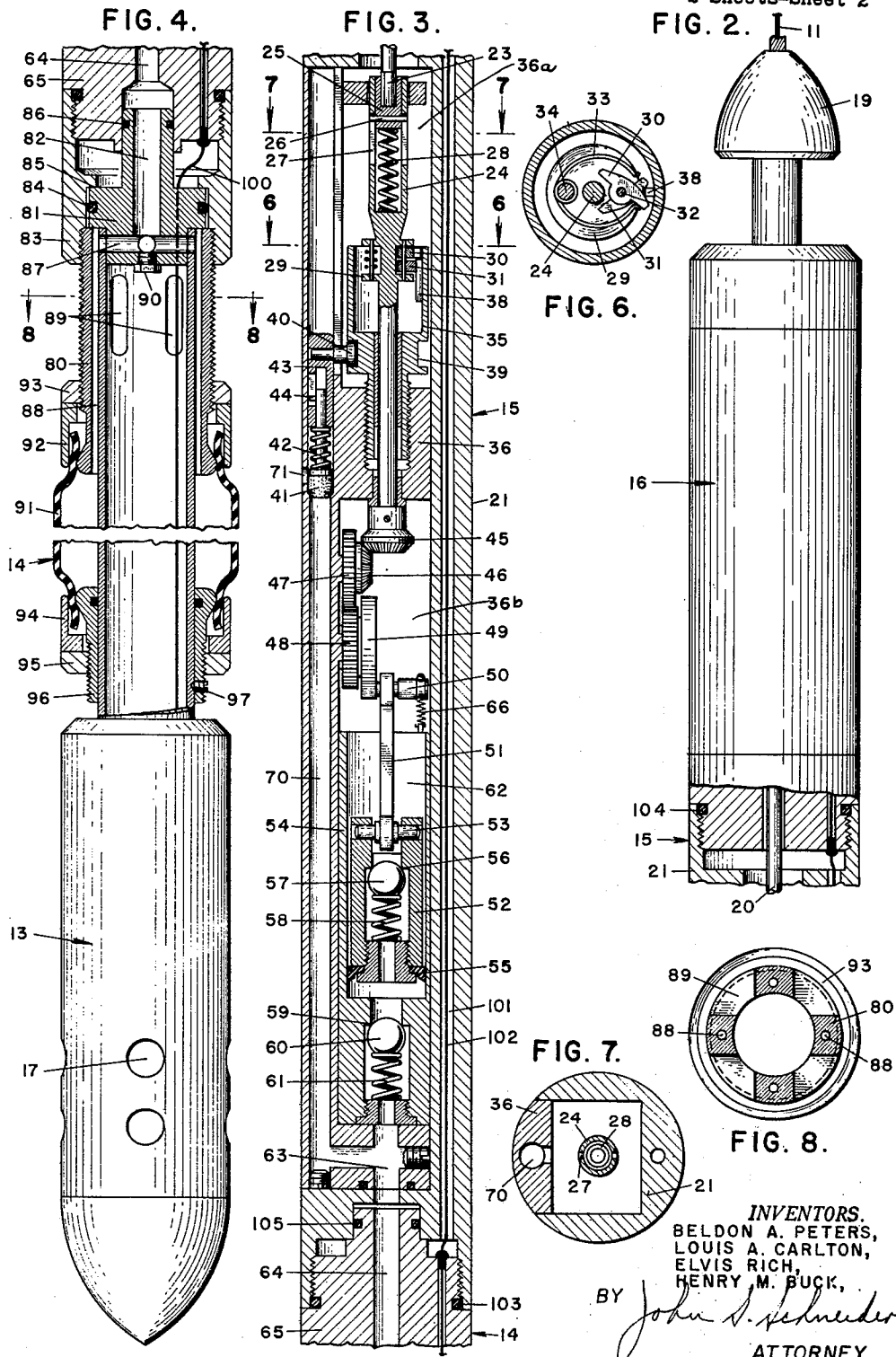
B. A. PETERS ETAL

3,083,774

SUBSURFACE PACKER INFLATING PUMP

Filed Dec. 24, 1959

2 Sheets-Sheet 2



1

3,083,774

SUBSURFACE PACKER INFLATING PUMP

Beldon A. Peters, Louis A. Carlton, Elvis Rich, and Henry M. Buck, all of Houston, Tex., assignors, by mesne assignments, to Jersey Production Research Company, Tulsa, Okla., a corporation of Delaware
Filed Dec. 24, 1959, Ser. No. 861,995
6 Claims. (Cl. 166—187)

The present invention concerns a surface operable subsurface pump for use in well bores and the like. The pump is used in conjunction with an electrically operated motor and an inflatable packer and a fluid meter. The latter is used to give surface indications of rate and direction of fluid flow in well bores.

The overall apparatus is designed to overcome inadequacies of packers employed with subsurface flow meters. The invention is an improvement in the pump portion of the arrangement of apparatus disclosed and claimed in U.S. Patent No. 2,856,006, entitled, "Subsurface Packer," issued to H. M. Buck et al., October 14, 1958.

Accordingly, an object of the invention is to provide an improved subsurface, surface operable pump for use with a subsurface packer and flow meter, the latter being surface indicating.

The instrumentation is designed to be run through tubing and used so that the packer may be selectively and controllably inflated and deflated and the measurement of the fluid flow rate and direction may be made at any selected point in the borehole.

A further object of the invention is to provide a reversible packer pump apparatus adapted to inflate the packer when operated in one direction and to permit deflation of the packer when operated in a reverse direction.

For rates of flow up to as much as 500 barrels of fluid per day, the device or apparatus seals off the borehole and diverts all fluid flow through the metering section thereof. For higher rates of flow, a measurable portion of the flow can be diverted through the device so that the total flow can be derived from this measured portion.

Briefly, the invention comprises driving means including a rotatable shaft; gear means; a pump chamber having fluid flow inlet and outlet means; piston means slidably arranged in said chamber; means interconnecting said gear means and said piston means adapted to reciprocate said piston means longitudinally upon rotation of said shaft, said gear means translating rotational motion of said shaft into longitudinal motion of said piston means; an intake valve mounted on said piston means adapted to admit fluid to said chamber; a discharge valve arranged on said chamber adapted to discharge fluid from said chamber; a fluid inflatable packer; means interconnecting said packer and said chamber adapted to direct fluid discharged from said chamber to said packer to inflate said packer; means fluidly communicating with said packer adapted to permit release of fluid from said packer; and means connected to said shaft adapted to permit and prevent release of fluid from said packer in response to the direction of rotation of said shaft.

The above objects and other objects of the invention will be apparent from a more detailed description of the invention taken in conjunction with the drawings wherein:

FIG. 1 is an elevational view of the apparatus including the pump portion thereof positioned in a well bore;

FIGS. 2 through 4 are elevational views, partly in section, showing the apparatus from top to bottom;

FIG. 5 is an elevational view, partly in section, showing another view of the pump portion of the apparatus;

FIG. 6 is a view taken on lines 6—6 of FIG. 3;

FIG. 7 is a view taken on lines 7—7 of FIG. 3;

FIG. 8 is a view taken on lines 8—8 of FIG. 4;

FIG. 9 is a view taken on lines 9—9 of FIG. 5; and

2

FIG. 10 is an elevational view, partly in section, of a portion of the apparatus shown in FIG. 3 in another position.

For a clearer understanding of the elements and the operation of the device, reference to the figures in greater detail will now be made.

In FIG. 1 is shown the composite flow meter-packer tool 10 suspended on a wire line 11 in a borehole 12. Tool 10 includes from bottom to top a fluid meter section 13, a packer section 14, a pump section 15, and a motor section 16. When it is desired to measure the rate and direction of fluid flow in borehole 12, the tool is lowered to the desired depth on wire line 11 and the motor of motor section 16 is energized to operate the pump of pump section 15 to inflate the inflatable sleeve-type packer of packer section 14 to seal off borehole 12 and force liquid flowing in the borehole through the meter of flow meter section 13. The fluid enters the meter through ports or openings 17 and exits the tool through openings 18 above packer section 14 or vice versa.

The tool of FIG. 1 is shown in greater detail in FIGS. 2 to 4 (top to bottom). Referring to these figures, in FIG. 2 electrically conductive cable 11 connects to a fishing neck 19. Motor section 16 contains a reversible motor such as a permanent magnet motor, the drive shaft 20 of which is shown extending into pump section 15. This section includes a cylindrical housing 21 screw-threadedly connected to motor section 16 at its upper end and to packer section 14 at its lower end. A wall or partition member 36 is fixed in housing 21 and forms therein an upper chamber 36a, a lower pump chamber 36b, and a packer drain passage 70. As seen in FIG. 3, the lower end of shaft 20 (in upper chamber 36a) is provided with a milled polygonal cross-section 23 for engaging and driving a pump drive shaft 24. The upper end of shaft 24 contains an engaging member 25 formed with a hole having a polygonal cross-section at its upper end adapted to engage the lower end of shaft 20. Engaging member 25 is held in place by a pin 26 which is free to move longitudinally in slots 27 formed in the wall of a recess formed in the upper end of drive shaft 24 and is biased upwardly by a coil spring 28 supported in the recess formed in the upper end of shaft 24.

Also in upper chamber 36a two identical but oppositely directed pawls 30 and 31 are mounted on a common pin 32 which is connected to a pawl holder 29 arranged on shaft 24, as seen more clearly in FIG. 6. A pawl biasing spring 33 is mounted on a pin 34. The lower end of a longitudinally movable pawl follower 35 screw-threadedly connects to wall member 36. Pawl follower 35 is provided with a key 38 which projects internally from the pawl follower wall. A cylindrical or annular groove 39 is formed in pawl follower 35. A follower 40 mounted in this groove. Plug holder 43 is positioned in drain passage 70 adjacent a drain port 71. A pin 44 attached to a plug 41 longitudinally movable relative to plug holder 43 rides in a slot in plug holder 43. A spring 42 arranged on pin 44 between plug 41 and the lower end of plug holder 43 biases plug 41 downwardly. In the lower positions of pawl follower 35 and plug holder 43 and pin 44, plug 41 covers and plugs drain port 71.

In lower chamber 36b a miter gear 45 is positioned on the lower end of shaft 24. (See also FIG. 5.) Miter gear 45 meshes with a vertically arranged miter gear 46 to which is connected a spur gear 47 which meshes with a second spur gear 48. A crank disc 49 is mounted on spur gear 48 for rotation therewith. A crank pin 50 is screwed into crank disc 49 providing a rotating arm to operate a connecting rod 51, which, in turn, is connected to a piston 52 by means of a wrist pin 53. Piston 52 reciprocates in a cylinder 54 also arranged in lower cham-

ber 36b and piston ring 55 provides a seal of the piston with the cylinder. Two check valves consisting of seat 56, ball 57, and spring 58, and seat 59, ball 60, and spring 61 are arranged in and adjacent to, respectively, cylinder 54.

Well fluids are sucked into expansible chamber 62 formed by piston 52 and cylinder 54 through screened holes 67, shown in FIGS. 5 and 9, in the sides of housing 21 and are pumped into the packer section through an opening 63 and a passage 64, the latter being formed in a wall member 65 interconnecting the pump and packer sections.

Two tension springs 66, each having one end hooked to cylinder 54 and the other end hooked to crank pin 50 store energy on crank pin 50 when piston 52 is on a suction stroke and release this energy when the piston is on a pumping stroke thereby reducing the peak power required by the motor driving the pump. Drain passage 70 fluidly communicates drain port 71 and port or opening 63 and passage 64 leading to the packer. When plug 41 is lifted by the pawl and key arrangement, fluid within the packer drains through drain passage 70 and out drain port 71. Also, plug 41 may be moved upwardly to open port 71 if the pressure increases enough to overcome the bias of spring 42.

Packer section 14 consists of a tubular mandrel 80 which is preferably silver-soldered to an intermediate passage member 81 having a passage 82 therethrough fluidly communicating with passage 64. Member 81 is pressure sealed from a packer adapter 83 by means of an O-ring 84. Member 81 shoulders against a ledge 85 formed in packer adapter 83 and the upper end thereof extends to passageway 64 in wall member 65 where a fluid seal is maintained by means of an O-ring 86. Passageway 82 also communicates with transverse ports 87 formed in tubular mandrel 80 which is thick-walled at its upper end and threadedly connected into the lower end of adapter 83. A plurality of longitudinally extending passageways 88 are provided throughout the length of the thick-walled portion of mandrel 80 and these passageways fluidly communicate with ports 87. As seen in FIGS. 4 and 8, a series of fluid inlet and outlet ports 89 extend through the upper end of mandrel 80 between the passageways 88. A plug 90 screws into the bottom of member 81 in line with passageway 82.

An inflatable sleeve type packer 91 is mounted on mandrel 80 with its upper end clamped by a clamping ring 92 and threaded nut 93 while its lower end is clamped by a clamping ring 94 and threaded nut 95. The latter is threadedly mounted on a sleeve 96 which is, in turn, slidable on mandrel 80. Sleeve 96 may be locked on mandrel 80 in any desired position by set screw 97. Passageways 88 fluidly communicate with the interior of packer 91. The lower end of packer-mandrel 80 threadedly connects to the fluid metering section 13. Packer 91 may consist of a preformed oil resistant rubber element having a maximum diameter approximating the diameter of the borehole wherein the flow measurement is to be made. The oil resistant rubber element may be reinforced with fabric so that it may be inflated to a definite size to form a selected sized baffle which would provide a controlled fluid by-pass in the borehole when measuring large rates of flow. From a measure of the amount of well fluid being diverted through the device, the total fluid flowing in the well bore may be readily derived. With this type of packer, a small pressure release valve may be screwed into member 81 in the hole plugged off by plug 90. The release valve will assure that the packer is always inflated to the proper pressure.

Regardless of the variety of packer employed, protection of the packer may be desirable when being run into the well bore. The protection may be afforded by a thin enveloping rubber sheath which has a small longitudinal slit therein. This sheath will fail and fall away when the packer enclosed by the sheath is inflated. In-

stead of a sheath, protection for the packer may be afforded by rubber bands positioned at random along the packer length. In this instance, inflation of the packer in the well will cause these bands to slip toward the packer end.

Fluid metering section 13 is the same as that described in U.S. patent application Serial No. 526,916, now Patent No. 2,934,947, filed in the name of H. M. Buck, August 8, 1955, entitled "Flowmeter." Any type of flowmeter which is adapted to transmit information as to rate or direction of fluid flow, or both, to the earth's surface may be used in combination with the motor pump and packer described.

The signal from the flowmeter section 13, indicating characteristics of the flow in the well bore, is carried from the meter section to and through the packer section on a conductor 100. The signals are carried through the pump section 15 by means of a conductor 102 in a bore 101. All of the electrical contacts and leads are sealed from well pressure and well fluids by O-rings 103, 104, and 105 at each end of the pump section.

In operation, the tool is lowered in the well bore 12 with packer 91 in a deflated condition and with the motor for driving shaft 20 inactivated. At a depth at which it is desired to take a flow reading, vertical travel of the tool is arrested. Then, the motor is actuated to cause shaft 20 to rotate in one direction which causes rotation of shaft 24 and pawl holder 29. Rotation of shaft 24 rotates miter gear 45, which, in turn, rotates miter gear 46 and spur gear 47 connected thereto which rotates spur gear 48 meshed with spur gear 47 and crank disc 49. Rotation of crank disc 49 rotates crank pin 50 and causes reciprocation of connecting rod 51 which, in turn, reciprocates piston 52 in cylinder 54 and pumps well fluid into passageway 64. Also pawl 30 engages key 38 causing pawl follower 35 to move downwardly in wall member 36 carrying with its downward movement follower 40, which rides in recess 39, and plug holder 43 and plug 41 connected thereto. The pawl follower moves downwardly until pawl 30 moves over the top of key 38. This lower position of pawl follower 35 positions plug 41 adjacent port 71 to seal off drain passage 70. This prevents the fluid pumped through port 63 from passing outwardly through passageway 70 and drain port 71. Fluid is, therefore, directed through passageway 64, passageway 82, ports or passageways 87 and passageways 88 into the interior of packer 91 to inflate the packer. If fluid pressure inflating the packer exceeds a predetermined amount, plug 41 will move upwardly against the bias of spring 42 which opens port 71 and releases the excess fluid pressure.

Once a seal is effected by packer 91 in the well bore 12, a reading of the flow rate may be made at the surface. After the reading has been made and it is desired to retrieve the device or obtain another reading at a different depth, packer 91 is deflated preparatory to moving the device by reversing the motor to reverse the direction of rotation of shaft 20. Upon reversal of rotation of shaft 20, the rotation of shaft 24 is also reversed which causes pawl 31 to engage key 38 to rotate follower 35 and cause it to move upwardly as it unscrews in wall member 36. Upward movement of pawl follower 35 continues until pawl 31 underrides key 38. Plug 41 is moved upwardly by upward movement of plug holder 43 and in this position, plug 41 is above port 71, as seen in FIG. 10. The packer then drains even though the motor continues pumping by fluid draining through passageways 88, 87, 82, 64, port 63, passage 70 and out port 71. This permits the packer to drain and leaves it in a condition to continue draining while raising and lowering the device or tool. It is equally important that the packer be open to permit draining while being raised in the borehole since the decreased pressure at lesser depth in the well causes the gas in the vestige of oil remaining in the packer after deflation to break out of solution. If the packer is not

5

in draining condition when the device is raised, this liberated gas would cause expansion of the packer and thus cause damage to the packer or prevent its removal from the well. When the packer is sealed against the well bore, any fluid flow in the well will be diverted through the metering section 13 via ports 17 and 18. It is to be noted that once inflated, the packer remains inflated even though the pump motor ceases to run. Similarly, port 71 is uncovered after the motor has run for approximately 5 secs. in the counterclockwise direction after which pawl 31 has slipped under the lower end of key 38. Thus, protracted running of the motor in a reverse direction is not necessary to drain the packer.

Obviously successive readings of flow rates in the well bore may be made by spotting the flowmeter at the desired depth and then inflating the packer making the flow measurement and deflating the packer, as described. It is possible to employ attachments with this device to determine if the packer is being inflated or whether or not it is holding the fluid pressure. For example, it may be desirable to screw in the hole blocked by plug 90 in member 81 a small bellows. The bellows when containing a certain minimum pressure would actuate a switch which would remove a partial short circuit in the spinner breaker circuit. When properly adjusted, this switch would be a means for determining if the packer is being inflated and whether or not it is holding fluid pressure.

Having described the apparatus, operation, and objects of our invention, we claim:

1. A surface-operable subsurface packer inflating pump apparatus comprising

a longitudinally extending housing connected at the lower end thereof to a packer and suspended in a well bore from the upper end thereof on a wire line; drive means including a rotatable shaft arranged in said housing;

a rotatable pawl holder mounted on said shaft; oppositely directed pawls arranged on said pawl holder; a stationary wall member secured to said housing;

a rotatable pawl follower provided with a key positioned adjacent said pawls and threadedly connected to said wall member such that rotation of said pawl follower in one circumferential direction moves said pawl follower upwardly and rotation of said pawl follower in a reverse circumferential direction moves said pawl follower downwardly, one of said pawl followers engaging said key when said shaft and pawl holder are rotated in said one circumferential direction to rotate said pawl follower until it moves a selected longitudinal distance upwardly where said one pawl disengages from said key and said pawl holder rotates freely, said other pawl engaging said key when said shaft and pawl holder are rotated in said reverse circumferential direction to rotate said pawl follower until it moves a selected longitudinal distance downwardly, where said other pawl disengages from said key and said pawl holder rotates freely;

a pump cylinder arranged in said housing;

a reciprocating piston arranged in said cylinder to form an expansible chamber therein;

a reciprocating piston rod connected to said piston;

means interconnecting said shaft and said piston rod adapted to translate the rotational motion of said shaft to the reciprocating motion of said piston rod;

a traveling valve arranged on said piston adapted to admit and discharge fluid to and from, respectively, said chamber upon reciprocation of said piston;

a standing valve arranged in said cylinder adapted to permit discharge of fluid from said chamber upon movement of said piston in one direction and to prevent discharge of fluid from said chamber on movement of said piston in an opposite direction;

said housing being provided with an opening fluidly

6

communicating the interior and exterior thereof adapted to supply well fluid to said chamber via said traveling valve;

a first passage in said housing fluidly communicating said standing valve and said packer;

said housing being provided with a packer drain port; a second passage in said housing fluidly communicating with said first passage and said drain port;

said pawl follower having an annular groove;

a cam follower arranged in said groove and movable with the longitudinal movement of said pawl follower; and

a longitudinally movable drain port plug holder connected to said cam follower and longitudinally movable therewith from a first to a second position and vice versa;

a drain port plug attached to said plug holder and movable therewith, said plug itself also being longitudinally movable from a first to a second position and vice versa;

biasing means arranged adjacent said plug for urging said plug to its first position whereby when said plug holder and said plug are in their first positions said drain port is closed to fluid communication there-through and when said plug holder is in its first position and said plug is in its second position and also when said plug holder is in its second position and said plug is in either its first or second positions fluid communication through said drain port is permitted, said plug being moved from its first to its second position when said plug holder is in its first position by an increase in fluid pressure in said second passageway above a selected pressure.

2. Apparatus as recited in claim 1 wherein said means for translating the rotational motion of said shaft to reciprocating motion of said piston rod includes a crank pin connected to said piston and biasing means interconnecting said cylinder and said crank pin adapted to store energy on said crank pin when said piston is moving in said opposite direction.

3. A surface-operable subsurface packer inflating pump apparatus comprising

a housing connected at the lower end thereof to a packer and suspended in a well bore from the upper end thereof on a wire line;

a reciprocating pump means arranged in said housing and having a fluid suction end and a fluid discharge end;

said housing being provided with an opening fluidly communicating said suction end of said pump means and the exterior of said housing, said discharge end of said pump means fluidly communicating with said packer whereby said pump means pumps well fluid into said packer to inflate said packer;

drive means including a rotatable shaft arranged in said housing;

means interconnecting said shaft and said pump piston adapted to translate rotational motion of said shaft to reciprocating motion of said pump piston;

a rotatable pawl holder mounted on said shaft;

oppositely directed pawls arranged on said pawl holder; a stationary wall member secured to said housing;

a rotatable pawl follower provided with a key positioned adjacent said pawls and threadedly connected to said wall member such that rotation of said pawl follower in one circumferential direction moves said pawl follower upwardly and rotation of said pawl follower in a reverse direction moves said pawl follower downwardly, one of said pawls engaging said key when said shaft and pawl holder are rotated in said one circumferential direction to rotate said pawl follower until it moves a selected longitudinal distance upwardly where said one pawl disengages from said key to permit said pawl holder to rotate freely, said other pawl engaging said key when said shaft

7

and pawl holder are rotated in said reverse circumferential direction to rotate said pawl follower until it moves a selected longitudinal distance downwardly where said other pawl disengages from said key to permit said pawl holder to rotate freely;

5 said housing being provided with a packer drain port fluidly communicating with said pump fluid discharge end and said packer; and

10 a plug holder connected to said pawl follower for longitudinal movement therewith;

a packer drain port plug mounted in said plug holder for movement therewith and also longitudinally movable relative to said plug holder;

15 said plug holder and plug being adapted to move together from a first position in which said drain port is sealed against fluid communication therethrough to a second position in which fluid communication through said drain port is permitted and vice versa;

20 said plug being movable independent of said plug holder in response to increased fluid pressure above a selected fluid pressure when said plug holder and plug are in said first position from the position in which said plug closes off fluid communication through said drain port to a position in which it permits fluid communication through said drain port.

4. A surface-operable subsurface packer inflating pump apparatus comprising

25 a housing connected at the lower end thereof to a packer and suspended in a well bore from the upper end thereof on a wire line;

30 a reciprocating pump means arranged in said housing and having a fluid suction end and a fluid discharge end;

35 said housing being provided with an opening fluidly communicating said suction end of said pump means and the exterior of said housing for admitting well fluid to the suction end of said pump means, said discharge end of said pump means fluidly communicating with said packer;

40 drive means including a rotatable shaft arranged in said housing;

means interconnecting said shaft and said pump piston adapted to translate rotational motion of said shaft to the reciprocating motion of said pump piston, said pump means being adapted to pump well fluid into said packer to inflate said packer;

45 said housing being provided with a packer drain port fluidly communicating with said pump fluid discharge end and said packer;

50 plug means arranged in said housing movable from a first to a second position and vice versa adapted when in its first position to seal off said drain port to fluid communication therethrough and when in

8

its second position to permit fluid communication through said drain port; and

means interconnecting said plug means and said shaft adapted to move said plug means from said first to said second position upon rotation of said shaft in one circumferential direction and to move said plug means from said second to said first position upon rotation of said shaft in an opposite circumferential direction.

5. Apparatus as recited in claim 4 wherein said plug means includes

a plug holder and a plug mounted in said plug holder and independently movable relative to said plug holder;

15 said plug being adapted to move from a drain port sealing position to a position permitting fluid pressure above a selected fluid pressure applied thereto when said plug means is in its first position.

6. A surface-operable subsurface packer inflating pump apparatus comprising

20 a housing suspended in a well bore and connected at the lower end thereof to a packer;

a pump means arranged in said housing having a fluid suction end and a fluid discharge end;

25 said housing being provided with an opening fluidly communicating said suction end of said pump means and the exterior of said housing for admitting well fluid to the said suction end of said pump means, said discharge end of said pump means fluidly communicating with said packer;

30 drive means including a rotatable shaft arranged in said housing;

means interconnecting said drive means and said pump means adapted to actuate said pump means, said pump means being adapted to pump well fluid into said packer to inflate said packer;

35 said housing being provided with a packer drain port fluidly communicating with said pump means fluid discharge end and said packer;

40 plug means arranged in said housing movable from a first to a second position and vice versa adapted when in its first position to seal off said drain port to fluid communication therethrough and when in its second position to permit fluid communication through said drain port; and

45 means interconnecting said plug means and said drive means adapted to move said plug means from said first to said second position and vice versa.

References Cited in the file of this patent

UNITED STATES PATENTS

2,856,006 Buck et al. ----- Oct. 14, 1958