

Nov. 29, 1966

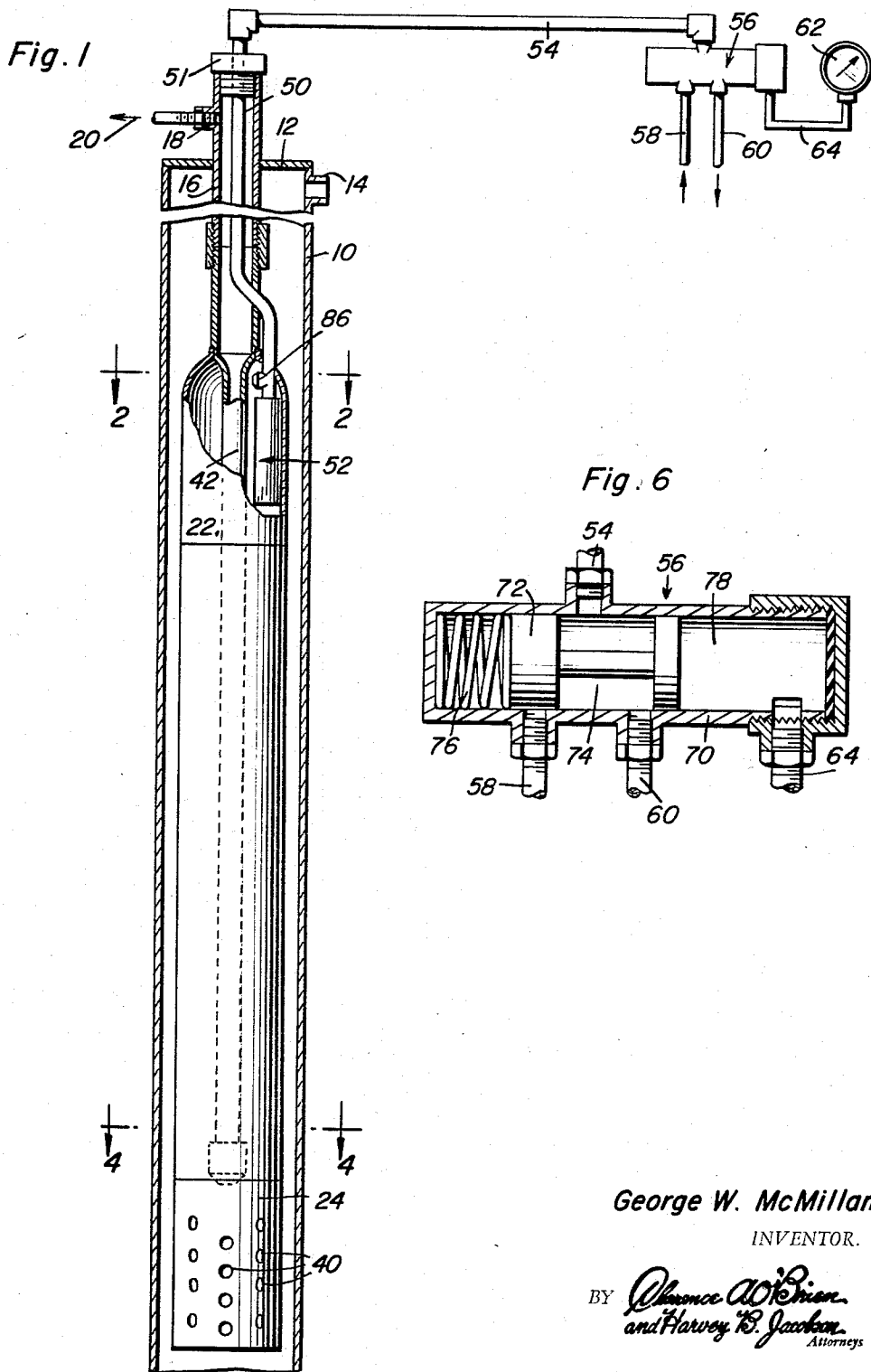
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3,288,081

FLUID PRESSURE OPERATED BOTTOM HOLE PUMP

Filed Dec. 7, 1964

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Fig. 2

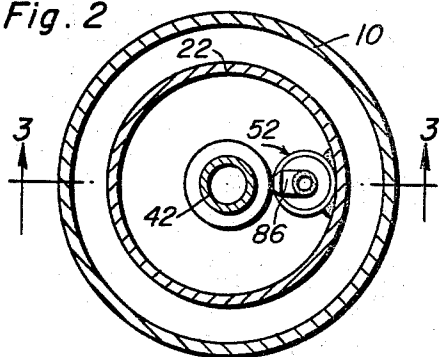


Fig. 4

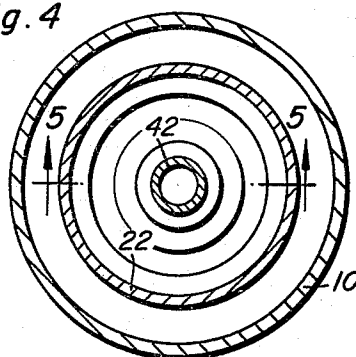


Fig. 3

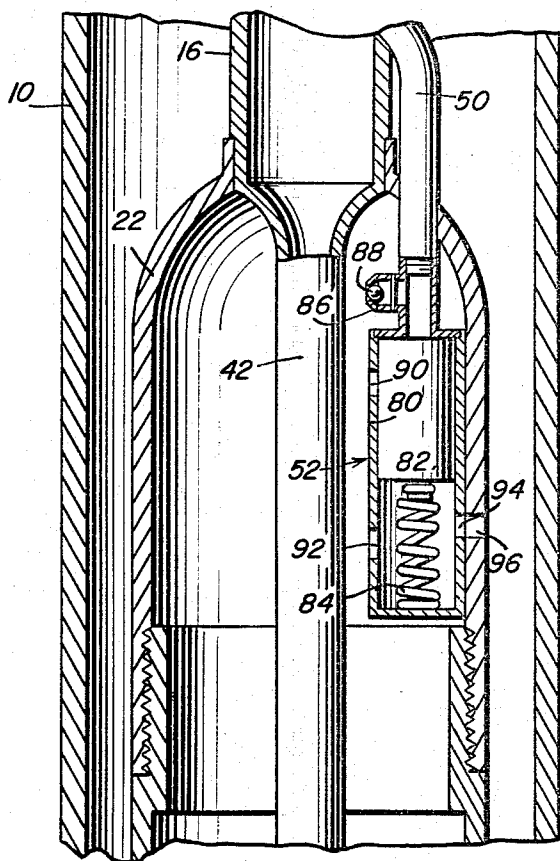
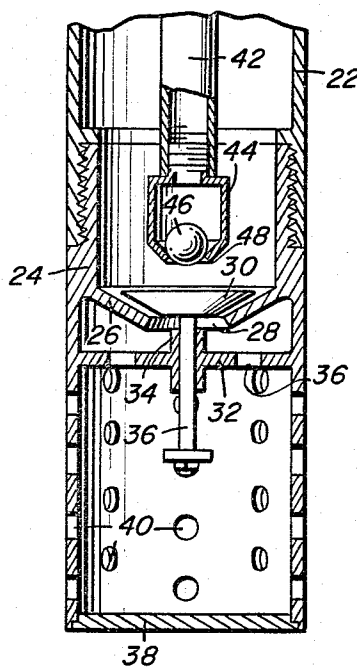


Fig. 5



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FLUID PRESSURE OPERATED BOTTOM HOLE PUMP

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This invention comprises a novel and useful fluid pressure operated bottom hole pump and more particularly pertains to a fluid pressure pumping installation particularly adapted for use in deep wells and especially as a bottom hole pump in oil wells.

Conventional deep well bottom hole pumps now operated in the petroleum industry are characterized by a pump barrel and a pump piston located at the bottom of the well bore with a tubing connected to the pump barrel and supporting the latter and discharging the fluid pumped by the device upwardly to the surface, while a string of sucker or pump rods extending through the tubing is connected to the pump piston at the bottom of the well and is vertically reciprocated to effect operation of the piston by a means or power source at the surface. The pumping installation of this type is conventional in the industry and has attained widespread use. However, it possesses a number of inherent disadvantages. Thus, owing to the increasing depths of well bores in the oil industry, mechanical problems arise from the long length of the tubing and the sucker rod string, often thousands of feet. In view of the weight alone of the sucker rod string, powerful operating mechanism is required to effect the vertical reciprocatory motion thereof to effect the pumping operation. Further, the large amount of material required in such a construction is expensive. The provision of the necessary stuffing boxes which establish a seal between the vertical reciprocating sucker rod and the stationary tubing is in itself a further source of wear and expense. Further, when it is desired for economical reasons to power a plurality of such pumping installations from a single power plant, the mechanical connections to different well bores each having its respective sucker rod string becomes complicated, expensive and a fruitful source of mechanical breakdowns.

It is therefore the primary object of this invention to provide a pumping system which will largely overcome the foregoing disadvantages.

A further object of the invention is to provide a pumping installation particularly adapted for economically and efficiently pumping deep wells and which will completely eliminate the necessity for a mechanical connection such as sucker rod strings for connecting a bottom hole pump to an operating source at the surface.

A further object of the invention is to provide a device which will eliminate the necessity for vertically reciprocating pump actuating members in a well bore and will replace them by a stationary conduit for supplying a controlled adjustably varied fluid pressure to a pump located at the bottom of the well bore.

Yet another object of the invention is to provide a fluid pressure operated deep well pump which may have any desired liquid volume of delivery without the limitations customarily incurred through requiring a reciprocating piston therein.

A still further object of the invention is to provide a fluid pressure operated bottom hole pump which will be singularly free from the detrimental effects of sand from the formation entering the pump barrel.

A still further object of the invention is to provide a fluid pressure operating deep well pumping installation which lends itself readily to adjustable times and cycles of operation.

These together with other objects and advantages which

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will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a somewhat diagrammatic view showing a pumping installation in accordance with this invention and with an encased well bore having the pumping installation of this invention therein disclosed partly in vertical section and partly in elevation with parts being broken away;

FIGURE 2 is a horizontal transverse sectional view taken upon an enlarged scale substantially upon the plane indicated by the section line 2-2 of FIGURE 1 and showing the upper end of the pump barrel and pressure fluid inlet means of the installation;

FIGURE 3 is a detail view taken upon an enlarged scale at the upper portion of FIGURE 1 and of the pump barrel and pressure fluid control means therefor, being taken substantially upon a plane indicated by the section line 3-3 of FIGURE 2;

FIGURE 4 is a further detail view in horizontal section taken upon an enlarged scale substantially upon the plane indicated by the section line 4-4 of FIGURE 1 and of the lower portion of the pump barrel;

FIGURE 5 is a detail view taken in vertical and transverse section of the lower portion of the pump barrel, being taken substantially upon the plane indicated by the section line 5-5 of FIGURE 4; and

FIGURE 6 is a view taken upon an enlarged scale in vertical longitudinal section through the automatic control valve of the device.

Referring first to FIGURE 1 it will be seen that the numeral 10 designates a portion of the casing of a well bore which extends from the surface down into a productive formation from which oil or other liquid is to be recovered. At the casing head 12 the casing is provided with a connection 14 by means of which the interior of the casing may be vented to the atmosphere. Extending through the casing head and secured thereto in any suitable manner is the upper end of a tubing string 16 by means of which liquid is produced from the well bore and is discharged through a suitable fitting 18 as indicated by the arrow 20 to any suitable place for collection of liquid as, for example, to oil storage tanks and the like. The tubing string extends downwardly through the casing 10 and at any suitable place adjacent its lower end is provided with diametrically enlarged cylindrical body 22 comprising the barrel of the pump unit of the installation. At its lower end, as shown in FIGURE 5, the pump barrel is closed by a threadedly connected closure body 24 having a partition 26 therein with an opening 28 comprising an inlet port for the lower end of the barrel. A foot valve 30 cooperates with the adjacent surface of the partition or wall 26 about the opening 28 to serve as an upwardly opening non-return inlet valve by means of which fluid is admitted into the lower end of the pump barrel 22 through the port 28 from the well bore, and is prevented from return thereto.

It will be further noted that the lower end of the closure body 24 is provided with a horizontal partition 32 thereacross provided with a bushing guide sleeve 34 through which the stem 36 of the valve is slidably received and by which the valve is retained. The partition 32 is of a spider-like character, or if desired may be a plate having a plurality of perforations 36 therethrough to permit the passage of fluid upwardly therethrough. The lower end of the body 24 is closed as by a bottom wall 38 which may be threadedly engaged therewith, while a plurality of apertures 40 through the side wall constitutes a cylindrical screening element for the device by which fluid

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from the lower portion of the well casing may enter into the lower end of the pump barrel through the foot valve 30.

Disposed centrally of the pump barrel 22 and extending downwardly from the flow tubing string 16 is a pipe 42 whose lower end has threadedly secured thereto a valve cage 44 as shown in FIGURE 5, and which is disposed closely adjacent the bottom wall 26 of the pump barrel and above the foot valve 30 therein. The valve cage has a non-return downwardly closing check valve such as the ball valve 46 which cooperates with a port or valve seat 48 in the valve cage 44. The valve permits fluid to enter the lower end of the pipe 42 and pass upwardly therethrough to the tubing string to the surface from which it is discharged to the fitting 18, but prevents return flow.

An operating fluid under pressure such as air, gas or the like is supplied by the fluid pressure inlet line 50 extending through a suitable fitting 51 at an upper end of the tubing string 16, and passes downwardly through the tubing string entering an automatic selector valve 52 which is disposed in the upper end of the pump barrel and to one side thereof. As will be noted from FIGURE 1, the gas supply conduit 50 is connected by a suitable pipe 54 to an automatic control valve indicated generally by the numeral 56. Fluid under pressure such as air or gas is supplied from any suitable source, not shown, by means of a conduit 58 to the selector valve 56 and from thence to the lines 54 and 50, while the interior of the pumping installation is vented to the atmosphere periodically through the selector valve 56 and a venting line 60. Any conventional form of automatic timer 62 is provided which through an operating or connecting means indicated by the conduit 64 effects operation of the selector valve 56 at predetermined time intervals for a predetermined period of time. As a result of this arrangement, the pumping operation of the installation is automatic and may be preset for a period of time intervals and for pumping operations of variable duration. Inasmuch as conventional forms of automatic timers for pumping wells are well known and the construction and connection of the timing device to the selector valve forms no part of the present invention, a further description thereof is deemed to be unnecessary.

Referring now to FIGURE 6 it will be observed that the selector valve includes a cylindrical valve casing 70 to one end of which the operating line 64 is connected. Reciprocable within the barrel 70 is a valve piston 72 having a diametrically reduced central portion 74 providing a valving passage. The valve piston is spring-urged by the spring 76 toward the right as viewed in FIGURE 6. The pressure delivery conduit 54 communicates with the interior of the valve 70 and the vent conduit 60 and the pressure supply conduit 58 are disposed on opposite sides of the delivery conduit 54. The dimensions and proportions of the plunger and the arrangement of the ports are such that the conduit 54 may be connected with either of the conduits 60 or 58 in alternation but not with both conduits at one time. At the right side of the valve, there is provided an operating chamber 78. As previously mentioned, the spring 76 drives the valve toward the right, and the fluid pressure supplied to the operating chamber 78 from the operating means 64 of the automatic controller 62 serves to move the plunger toward the left against the spring.

The arrangement is such that when no pressure is supplied to the chamber 78, the spring 76 will urge the plunger toward the right at which time the delivery conduit 54 will be in connection with the venting conduit 60 so that the interior of the device will be vented to the atmosphere. At this time the standing level of liquid in the well casing 10 will move upwardly through the foot valve 30, and will fill the pump barrel to the same level therein. However, when the automatic timer 62 delivers a fluid pressure impulse to the chamber 78, the plunger 72 will

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be forced to the left against the spring 76 and the venting conduit 60 will be moved out of registration with the delivery conduit 54, while the pressure supply conduit 58 will be placed in communication with the delivery conduit 54. At this time, the source of fluid under pressure will be placed in communication through the conduit 54 and 50 and the valve assembly 52 with the interior of the pump barrel, the pressure thus supplied to the top surface of the liquid standing therein, forces this liquid downwardly in the pump barrel and upwardly through the valve 46 and discharging it through the flow tubing 16 and 18. As will be noted, the increase of pressure will close the foot valve 30 so as to prevent the escape of the operating pressure into the casing.

Referring next to FIGURE 3 it will be observed that the valve 52 likewise provides a cylindrical casing 80 in which is vertically reciprocally disposed a plunger 82. The latter is spring-urged as by the spring 84 into an upward position at the upper end of its casing.

Within the pump barrel 22 and above the valve assembly 52 the operating fluid pressure inlet conduit 50 is provided with a laterally extending valve cage 86 having therein a non-return valve 88. The arrangement is such that pressure within the conduit 50 will close this valve, while when the conduit pressure 50 drops below that within the pump barrel 22, the pressure of the latter will enter through the valve 86, will pass upwardly through the conduits 50 and 54 and be discharged through the selector valve 56 through the vent passage 60 thereof. Thus, the pressure within the interior of the pumping barrel 22 is relieved periodically and automatically by operation of the selector valve 56.

It will be further noted that the valve housing 80 has upper and lower vents 90 and 92 which communicate with the interior of the pump barrel. A further lower vent 94 registering with a port 96 in the cylinder barrel establishes communication between the lower end of the valve housing 80 and the interior of the well casing 10 exteriorly of the pump barrel.

The arrangement is such that normally the spring 84 will urge the valve 82 into closed position closing off the port 90 and thus the interior of the pump barrel from the supply line 50. At the same time, the ports 92, 94 and 96 establish free communication with the interior of the pump barrel cylinder 22 and the well casing 10 thereby facilitating the filling of the pump barrel from the foot valve 30.

When actuating pressure is supplied by the conduit 58 through the selector valve 56 under the control of the automatic timer 62, it will first close the venting valve 88, will then move the plunger 82 downwardly uncovering the port 90 and permitting this pressure to again enter the interior of the pumping cylinder barrel. Thus, the delivery stroke of the pump is effected, the capacity of which will vary with the size of the pumping barrel. When the automatic timer 62 discontinues the operating impulse through the conduit 64 upon the selector valve 72, the latter moves toward the right as shown in FIGURE 6, and then cuts off the operating fluid pressure from the conduits 54 and 50, and the drop in pressure of the chamber 78 then allows the spring 76 to move the valve to the position shown in FIGURE 6 at which time the conduits 50 and 54 place the interior of the pump barrel in connection with the venting passage 60. Thus the pressure within the pumping chamber is released. This pressure, upon decrease of the pressure in the conduits 54 and 50, opens the venting valve 88 allowing air to escape from the pump barrel chamber and to the atmosphere in the manner above mentioned.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents

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may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A pump installation comprising a vertically elongated pump barrel adapted to be submerged in a liquid in a well, said barrel comprising a housing closed from the atmosphere and having a non-return pump inlet valve effecting the intake of liquid into said barrel but preventing reverse flow, a pump delivery conduit entering said pump barrel and having a delivery conduit inlet communicating with the lower portion of the pump barrel, a non-return pump delivery valve in said conduit inlet admitting liquid from said pump barrel into said delivery conduit while preventing reverse flow, fluid pressure pump operating means including an automatic selector valve periodically supplying an operating gas under pressure into said pump barrel and thereby discharging accumulated liquid therein into said delivery conduit inlet and subsequently periodically venting the pump barrel interior to the atmosphere, pressure responsive valved passage means mounted within the pump barrel communicating the interior of said pump barrel with the well bore whereby a rapid equalization of pump barrel-well bore pressure is facilitated, said fluid pressure pump operating means closing said passage means when operating gas under pressure is being supplied into said pump barrel and opening said passage means when said pump barrel is being vented to the atmosphere.

2. The combination of claim 1, wherein said fluid pressure pump operating means includes a source of fluid under pressure remote from said pump barrel, a gas pressure delivery conduit connecting said source with the interior of said pump barrel, a selector valve in said gas pressure conduit operable to selectively alternately connect the latter to said source and to the atmosphere.

3. The combination of claim 2 including a control valve in said gas pressure conduit, said control valve including a valve housing having a discharge port opening into said pump barrel, a plunger slidable in said housing for selectively covering and uncovering said discharge port, spring means yieldingly urging said plunger into discharge port closing position, the gas supplied under pressure against said plunger from said source moving said plunger into discharge port uncovering position.

4. The combination of claim 3 including a venting valve

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communicating said pump barrel interior with said gas pressure conduit upstream from said control valve, said venting valve comprising a pressure responsive valve allowing flow from said pump barrel into said gas pressure conduit but preventing return flow.

5. The combination of claim 4 wherein said passage means is opened by said plunger when the latter closes said discharge port and is closed by said plunger when the latter opens said discharge port.

6. The combination of claim 1, wherein said fluid pressure pump operating means includes a source of fluid under pressure remote from said pump barrel, a gas pressure delivery conduit connecting said source with the interior of said pump barrel, a selector valve in said gas pressure conduit operable to selectively alternately connect the latter to said source and to the atmosphere.

7. The combination of claim 6 including a control valve in said gas pressure conduit, said control valve including a valve housing having a discharge port opening into said pump barrel, a plunger slidable in said housing for selectively covering and uncovering said discharge port, spring means yieldingly urging said plunger into discharge port closing position, the gas supplied under pressure against said plunger from said source moving said plunger into discharge port uncovering position.

8. The combination of claim 7 including a venting valve communicating said pump barrel interior with said gas pressure conduit upstream from said control valve, said venting valve comprising a pressure responsive valve allowing flow from said pump barrel into said gas pressure conduit but preventing return flow.

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