

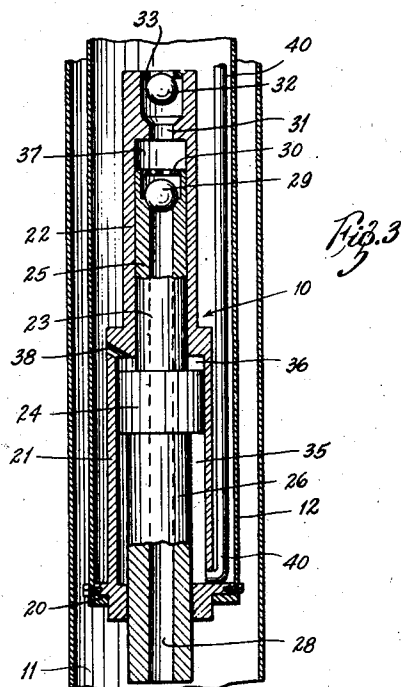
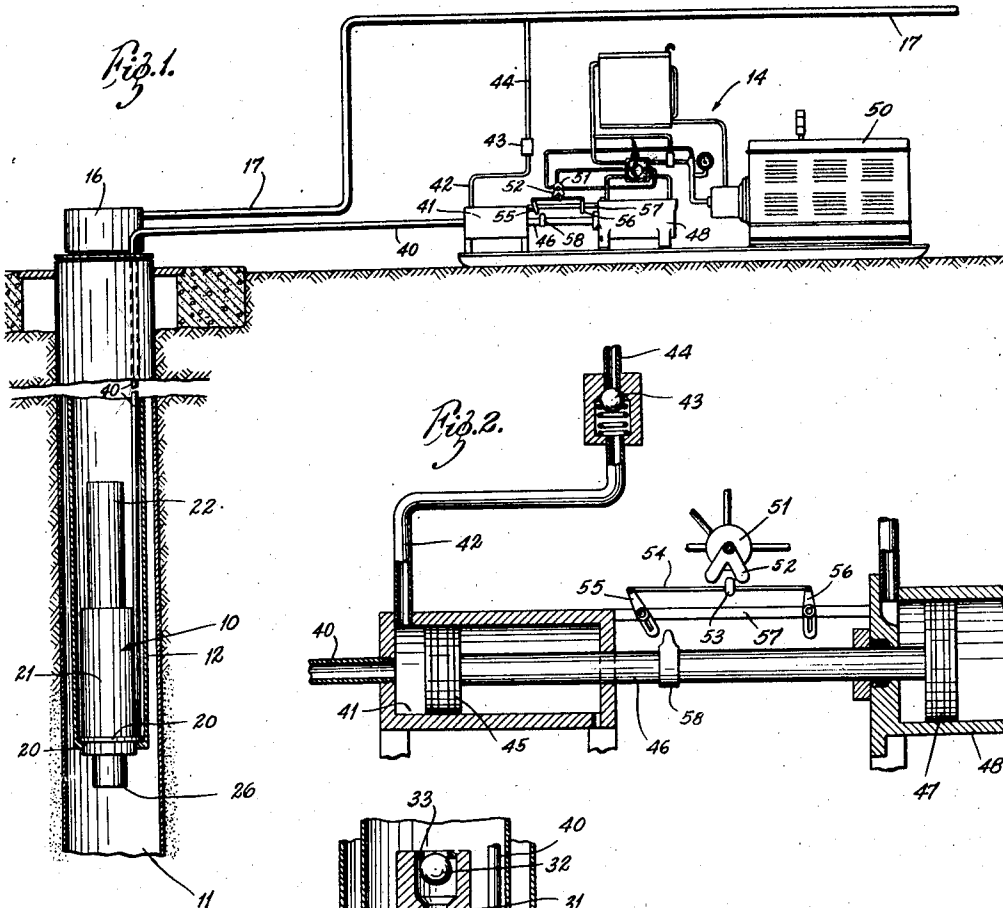
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DEEP WELL PUMPER

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DEEP WELL PUMPER

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The present invention relates to a deep well pumper, and more particularly to a pump construction especially applicable to a deep well, although obviously applicable to other pumping uses.

It is an object of the invention to provide an improved pump operated without moving mechanical connections extending from the surface to the bottom of the well. A particular object is to provide such a pump in which the column of liquid above a pumping unit at the bottom of the well actuates the pump on one stroke, and a column of the oil, to which pressure is applied, actuates the pump on the other stroke.

A further object of the invention is to provide a pump of the foregoing type in which a mechanical pump is used to apply force to a column of liquid running from the surface to the pumping element, but with the force generating parts of the pumping mechanism separated from the column to which pressure is applied.

In the drawing:

Fig. 1 is an elevation partly broken away and partly in section of the entire mechanism at the surface and in the well;

Fig. 2 is a fragmentary section of the surface pumping units; and

Fig. 3 is a vertical medial section of the pumping element at the bottom of the well.

While the present invention is obviously of broader aspect, it will be described in connection with pumping of oil.

Broadly speaking, the mechanism comprises a pumping unit 10 disposed near the bottom of a well 11 into which the usual well string 12 has been placed. The mechanism also includes a pressure generating means 14 on the surface.

The well string 12 is brought up in suitable sections, if desired, to the surface, and is there capped at 16. A discharge line 17 leads from the cap 16 to conduct the pump fluid, such as oil, to suitable reservoirs or other desired receiving means.

The pump element 10, shown in detail in Fig. 3, fits within the sleeve 12, and adjacent its lower part has a flange 20 making a seal with the inner surface of the string to separate the liquid in the well from that pumped into the string 12. The pumping unit 10 is desirably cylindrical with a lower cylinder 21 and an upper cylinder 22. A plunger, generally indicated at 23, is reciprocable within the pump member 10. It has a piston portion 24 engageable within the lower cylinder 21. On the upper side of the piston portion 24 a plunger portion 25 is integrally formed, and it

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slides within the upper cylinder 22. Below the piston portion 24 is a lower plunger portion 26 which reciprocates within the lower cylindrical portion 21, but is smaller than the inside diameter of this portion 21. The lower plunger portion 26 operates through an opening in the bottom of the member 10.

The plunger 23 has a passage 28 extending from the bottom to the top thereof. This passage opens at its bottom into the well to receive oil therein. At its upper part, a check valve 29 is provided to prevent back flow of oil downwardly through the passage 28. The ball 29 is suitably retained within an enlarged space at the top of the plunger portion 25 so that it will permit upward flow of oil through the passage 28, but prevent the downward flow therethrough. There is here shown a retaining member 30 provided with an irregular opening that limits upward movement of the ball 29 but does not prevent flow of oil therearound.

The upper cylindrical portion 22 has a passage 31 leading through the top thereof. The passage 31 has an enlarged space receiving a ball check valve 32. This ball check valve seats at the bottom of the enlargement to prevent downward flow of oil therethrough, and engages with a retaining means 33 having an irregular opening therethrough, when forced upwardly in such wise as to permit flow of oil therearound.

It will be seen from the foregoing that the pump mechanism may be considered to include a bottom cylinder 35 beneath the piston 24, a middle cylinder 36 above the piston 24, and an upper cylinder 37 above the top of the smaller upper plunger portion 25. It will be seen also that the cross sectional area of the cylinder 36 is larger than that of the cylinder 35, because the lower plunger portion 26 is larger than the upper plunger portion 25. The middle cylinder 36 is in communication with the column of liquid in the string, through a port 38.

A pipe 40 connects into the bottom of the lower cylinder 35 and leads to the surface, and thence into a pressure cylinder or container 41 of the surface pumping mechanism 14. From the cylinder 41 there extends a connection 42 leading through a ball check valve 43 into a line 44 that connects with the outlet 17.

A piston 45 reciprocates within the cylinder 41 and is driven by a piston rod 46. This piston rod 46 at its other end is connected to a piston 47 reciprocating within a cylinder 48 in which it is driven in opposite directions by a conventional mechanism here shown as an air compressor 50,

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or a low pressure hydraulic pump. This mechanism alternately delivers pressures to opposite ends of the cylinder 48 and exhausts the end that is not receiving pressure. This is accomplished by a suitable four-way valve 51 of conventional type. This valve 51 is provided with an oscillating fork 52, the arms of which are adapted to be engaged by a projection 53 on a rod 54 attached at opposite ends to links 55 and 56 that are pivoted on a bar 57 and project downwardly therefrom to be engaged by a lug 58 on the connecting rod 46. It may be seen that as the piston 47 approaches the end of its stroke in either direction it will cause the lug 58 to engage one or the other of the members 55 and 56 to act upon the fork 52 and reverse the four-way valve.

Operation

The pumping unit 10 is lowered to approximately the bottom of the well by being passed down through the string 12. In this disposition, the flange 20 forms a partition that separates the oil bearing sand, or the like, from the portion of the string above the partition. The only connection to the top of the well is the relatively small pipe 40. The line 17 is connected into the cap 16 and thereby connects with the string above the partition 20. Previously pumped oil fills this line 17 and the string down to the partition 20, including the cylinder 36, and oil also fills the pipe 40 and associated parts. In the original starting it will be necessary to partially fill the line 17 and pipe 40 with water or oil.

When the motor 50 starts, the fluid pumped thereby drives the piston 47, which, through the connecting rod 46, moves the operating piston 45 to the left in Fig. 2. This movement of the piston 45 to the left applies pressure to the oil within the line 40, which is prevented from escape into the discharge line 17 by the check valve 43. This pressure, therefore, is transmitted through the line 40 to the pumping unit 10, where it acts in the cylinder 35 beneath the piston 24. The cylinder 36, in the meanwhile, will be filled with oil at a pressure determined by the head of oil thereabove in the string and in the line 17. Consequently, the pressure applied through the line 40 is made greater than the foregoing head of oil acting within the cylinder 36. The pressure developed in the cylinder 35 must also take into account the action of the column of oil acting within the chamber 37, as will appear. The force exerted by the oil in the cylinder 35 will lift the plunger 23 against the resisting forces thereon.

As the plunger 23 rises, the piston 24 will expel oil from the cylinders 36 and 37 into the string.

When the power piston 47 reaches the left hand end of its stroke, the lug 58 will strike the link 55 and shift the four-way valve 51 to reverse the pressure conditions within the cylinder 48 to cause the piston 47 to move to the right, drawing with it the piston 45. This relieves the pressure within the line 40 to below a point where the upward force on the plunger 23 is less than that exerted downwardly on the plunger 23. Consequently the force of the head of oil acting upon the piston 24 drives it down. The fact that the cross sectional area of the upper surface of the piston 24 is greater than that of the lower surface of the piston insures that the head of oil in the string will force the piston down regardless of the fact that the head of oil in the pipe 40 is the same as that within the string.

As the plunger 23 descends, the valve 32 is closed, resulting in a relatively low pressure with-

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in the chamber 37 above the small portion 25 of the plunger 23. This causes new oil to be drawn from the well below the partition 20, through the passage 28, and past the valve 29 into the chamber 37.

When the piston 47 reaches the right end of its stroke, the lug 58 strikes the link 56 to shift the four-way valve 51 and reverse the pressure condition within the cylinder 48 so that the two pistons 47 and 45 again move to the left. This elevates the plunger 23 again by the fact that the net force acting beneath the piston exceeds the net force above it. The oil entrapped within the chamber 37 by the check valve 29 is expelled past the check valve 32, where it adds to the quantity of oil within the string. Since it receives the pressure of the head of oil within the string, it will be seen that this head acts downwardly in the chamber 37 during this stroke, so that the pressure exerted through the pipe 40 must be great enough to produce a force that overcomes not only the force exerted within the cylinder 36, but also the force exerted within the chamber 37.

Upon the subsequent relief of the pressure within the pipe 40 by shifting of the pressure applying piston stroke, the plunger 23 descends but the check valve 32 prevents oil from the string from entering the chamber 37. Consequently the force acting beneath the piston 24 must be relieved to such a point that the pressure acting within the chamber 36 will produce a force that will cause the piston to descend.

The pipe 40 is always kept charged with oil by its connection with the line 17. The charging is by gravity, plus the fact that the plunger 46, when moving to the right, produces a low pressure condition that, when it goes below the resistance of the valve 43, will cause that valve to open to recharge this line.

It will be seen that this pumping mechanism provides a device that requires only a single connection with the bottom of the well; that that connection is not a moving part; and that the connection may be relatively simple. Further, the pump unit itself has a minimum number of moving parts, and requires a minimum of space. The power mechanism is simplified, and is arranged so that the dirty oil from the well is kept away from the parts where wear is most critical.

What is claimed is:

1. In a pumping mechanism for pumping liquid from a supply to a system under pressure, means separating the liquid supply from the liquid system, a pumping unit including an oppositely movable piston means, means to draw liquid from the supply and to discharge it into the system upon movement of the piston means, one side of the piston means being at all times open to the liquid in the system to receive a force to displace the piston means in one direction, and means alternately to apply and to withdraw a different fluid pressure force to the opposite side of the piston means, said force applying means being adapted to produce a force greater than the opposite force produced by the liquid in the system, and then to withdraw to a force less than that produced by the liquid in the system, said force applying means comprising a liquid conduit opening into the space on the said opposite side of the piston means, the effective area of said other side being less than the corresponding area of said one side, pressure producing means adapted to apply increased pressure to the liquid in

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the conduit and then to reduce the same, said pressure producing means comprising a container into which the conduit is connected, a plunger operable oppositely in the container to increase and decrease the effective size thereof, and means to drive the plunger back and forth.

2. In a pumping mechanism for pumping liquid from a supply to a system under pressure, means separating the liquid supply from the liquid system, a pumping unit including an oppositely movable piston means, means to draw liquid from the supply and to discharge it into the system upon movement of the piston means, one side of the piston means being exposed to the liquid in the system to receive a force to displace the piston means in one direction, and means alternately to apply and to withdraw a different fluid pressure force to the opposite side of the piston means, said force applying means being adapted to produce a force greater than the opposite force produced by the liquid in the system, and then to withdraw to a force less than that produced by the liquid in the system, said force applying means comprising a liquid conduit opening into the space on the said opposite side of the piston means, pressure producing means adapted to apply increased pressure to the liquid in the conduit and then to reduce the same, said pressure producing means comprising a container into which the conduit is connected, a plunger operable oppositely in the container to increase and decrease the effective size thereof, means to drive the plunger back and forth, said container also being connected into the system, and check means to permit flow of liquid from the system into the container but not from the container into the system.

3. In a pumping mechanism for pumping liquid from a supply to a system under pressure, means separating the liquid supply from the liquid system, a pumping unit including an oppositely movable piston means, means to draw liquid from the supply and to discharge it into the system upon movement of the piston means, one side of the piston means being exposed to the liquid in the system to receive a force to displace the piston means in one direction, and means alternately to apply and to withdraw a different fluid pressure force to the opposite side of the piston means, said force applying means being adapted to produce a force greater than the opposite force produced by the liquid in the system, and then to withdraw to a force less than that produced by the liquid in the system, said force applying means comprising a liquid conduit opening into the space on the said opposite side of the piston means, pressure producing means adapted to apply increased pressure to the liquid in the conduit and then to reduce the same, said pressure producing means comprising a container into which the conduit is connected, a plunger operable oppositely in the container to increase and decrease the effective size thereof, and means to drive the plunger back and forth, comprising a separate fluid driven motive means having its own separate fluid system, and a member driven thereby, and means to connect the driven member with the plunger.

4. In a pumping mechanism for pumping liquid from a supply into a column having a vertical component, means separating the liquid supply from the column, a pumping unit below the top of the column and having oppositely movable piston means subjected to the pressure of the column on one side, a liquid line connected to

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the other side of the piston means, said liquid line extending upwardly to produce a predetermined pressure head therein, the area of the piston means on the column side being related to the area on the liquid line side so that the force produced by the column on the piston means is greater than that produced by the line liquid, means intermittently to increase the pressure of the line liquid to produce a force on the piston means greater than that produced by the column, whereby the piston means may be oppositely operated, and pump means operated by the piston means to draw liquid from the supply and expel it into the column.

5. In a pumping mechanism for use in a well to pump liquid from the well into a line, a pumping means adapted to extend into the liquid within the well, partition means separating the liquid in the well from the liquid discharged by the pumping means, said pumping means including a piston receiving the liquid pressure from the column of liquid between the surface and the piston, a plunger connected with the piston, said pumping means including a cylinder within which said plunger operates, said cylinder being connected to the well beneath the partition, check means to permit liquid to enter the cylinder through said connection but to prevent expulsion of liquid therethrough, an additional connection from the cylinder to the well above the partition, check means to permit liquid to be expelled from the cylinder through said additional connection but to prevent back flow into the cylinder, a liquid pressure line connected from the surface to introduce fluid against the piston opposite to the pressure above the partition, and means alternately to supply pressure to the last-named liquid and to relieve the said pressure.

6. In a pumping mechanism for use in pumping liquid from a supply to a line under pressure, means separating the supply from the liquid under pressure, a pumping unit including reversible piston means to withdraw liquid from the supply and expel it into the line, said piston means being adapted to receive liquid under line pressure for moving the same in one direction, and being adapted to receive liquid under pressure to move the same in the other direction, the piston means having a greater pressure receiving area subjected to the line pressure than to the second pressure, means to alternately increase and decrease the second pressure so that its force acting upon the piston means will drive the piston means against the force produced by the line pressure, said pressure alternate means comprising a container connected to the piston means, a plunger operable into or out of the container, and separate means for driving the plunger, the container also being connected to the line, and a check valve to permit liquid to be withdrawn from the line but to prevent liquid from being expelled by the plunger into the line.

7. In a pumping mechanism for pumping liquid from a supply to a system under pressure, means separating the liquid supply from the liquid in the system, a pumping cylinder, a piston therein, the cylinder having opposite first and second pressure chambers separated by the piston, the piston having a first pressure side in the first chamber and a second pressure side in the second chamber, the first pressure chamber being open to the liquid in the system, means operated by reciprocation of the piston to transmit liquid from the supply to the system, a fluid pressure line, said line being constantly connect-

ed to the second pressure chamber, whereby when fluid pressure applied through the pressure line, acting on the area of the second side of the piston, produces a force greater than that of the system pressure acting on the first side of the piston, the piston will be moved, and when the said fluid pressure produces a force less than that produced by the system pressure, the piston may be actuated in the opposite direction by the system pressure, the area of the opposite sides of the pistons being different, so that when the unit fluid pressure and unit system pressure have less than a predetermined differential, the piston will be moved in one direction.

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