Sept. 26, 1939. A. WILL 2,174,114

DEEP WELL PUMP

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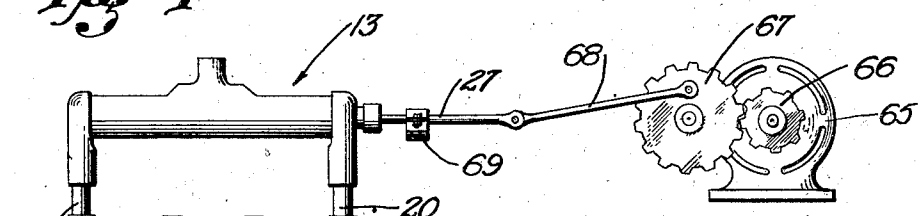
Fig. 1



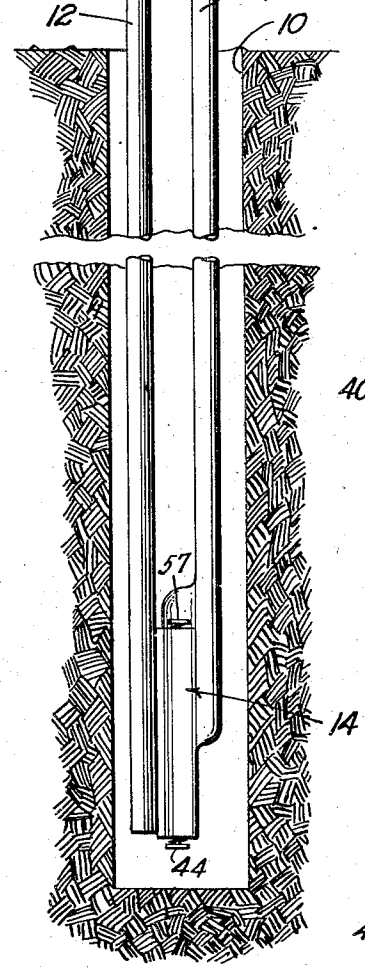


Fig. 2

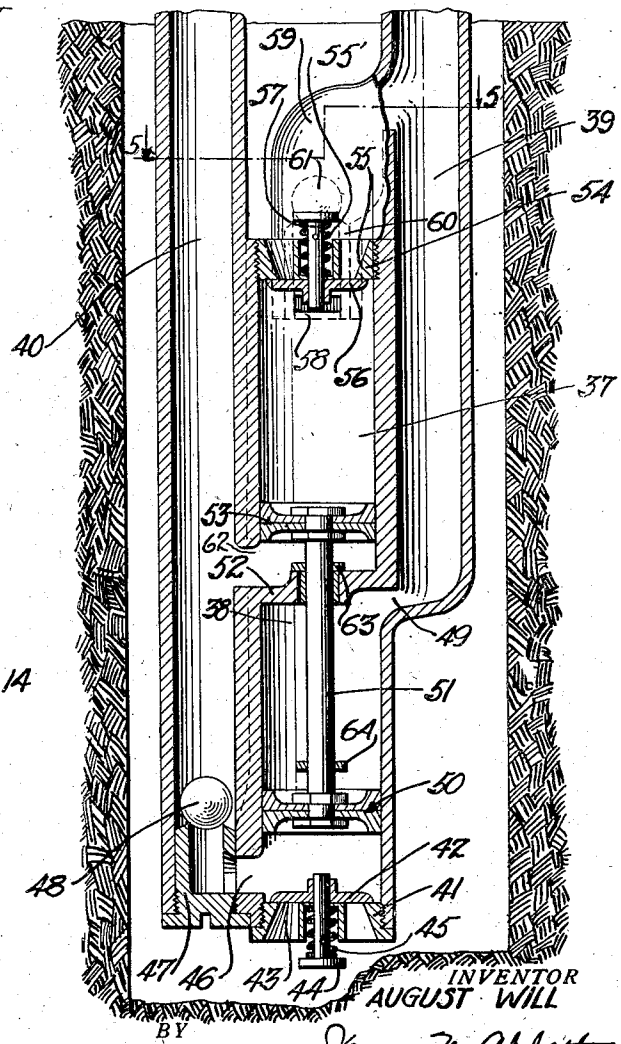


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Fig. 3

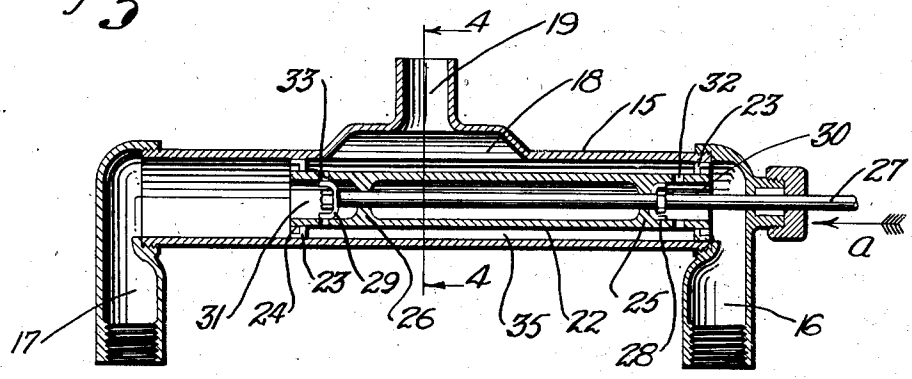
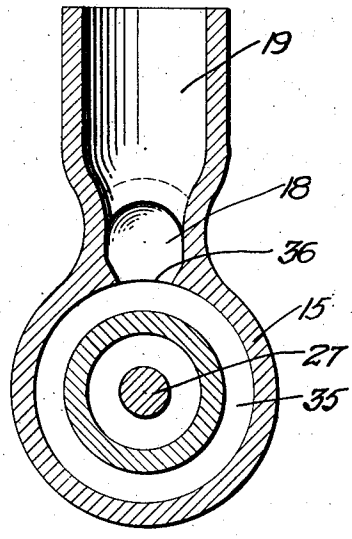


Fig. 4



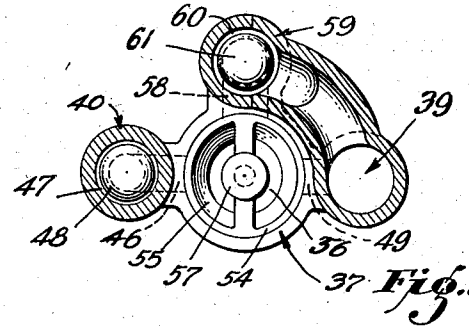


Fig. 5.

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DEEP WELL PUMP

August Will, Pasadena, Calif.

Application August 12, 1935, Serial No. 35,753

4 Claims. (Cl. 103—44)

This invention relates to a pump and particularly pertains to a deep well pump.

In pumping liquid from wells it is common practice to employ pumping equipment which requires the use of tubing lowered into the well to the level from which fluid is to be elevated, and the additional use of pump rods which reciprocate within the tubing and actuate pumping mechanism at desired levels within the well. This type of equipment also makes it necessary to use complicated and expensive pump mechanism, which is necessary due to the fact that an unbalanced load condition exists in a reciprocating deep well pump mechanism since a heavy column of liquid must be lifted on the up stroke of the mechanism and on the down stroke there are no load requirements. Elaborate counterbalanced structures are thus required. In addition to the disadvantages in using a reciprocating pump mechanism in a deep well as above enumerated, there is the disadvantage which results from crooked holes within which the tubing may be bent and through which the pump rods may reciprocate with difficulty due to the binding action and the wear that might occur between the pump rods and the tubing.

It is the principle object of the present invention, therefore, to provide a pump structure within which all of the pumping actuating apparatus is above ground and an additional valve and pump unit is within the well and which apparatus acts within the well by fluid pressure to elevate the liquid of the well, the structure acting to provide a balanced load on both strokes of the pump, thereby eliminating the use of sucker rods, the necessity for an elaborate counterbalancing mechanism, and making it possible to pump the liquid by mechanical action taking place entirely outside of the well bore.

The present invention contemplates the provision of a reciprocating power pump mechanism disposed above ground and which mechanism is attached to a pair of strings of tubing extending into the level of a desired depth of submergence within the well liquid, said tubing carrying a valve and pump mechanism by which fluid will be alternately introduced into the two strings of pump tubing as the power pump mechanism reciprocates and will be controlled automatically by the power pump mechanism alone.

The invention is illustrated by way of example in the accompanying drawings in which:

Figure 1 is a view in section and elevation indicating the application of the present invention.

Fig. 2 is an enlarged fragmentary view in central vertical section showing the automatic valve and pump unit at the bottom of the pump tubing.

Fig. 3 is an enlarged view in central longitudinal section showing the power pump mechanism.

Fig. 4 is a view in transverse section through the power pump mechanism as seen on the line 4—4 of Fig. 3.

Fig. 5 is a view in transverse section through the valve and pump mechanism as seen on the line 5—5 of Fig. 2.

Referring more particularly to the drawings, 10 indicates a well bore within which a pair of strings of well tubing 11 and 12 are placed. The upper end of these strings of tubing are connected with a power pump mechanism 13, while the lower ends of these strings of tubing connect with a valve and pump unit 14. The power pump mechanism, as shown more particularly in Fig. 3 of the drawings, comprises a main cylinder 15 preferably disposed horizontally and being formed with fluid connections 16 and 17 at its opposite ends. At a point intermediate the ends of the cylinder and in the upper wall thereof is an outlet passageway 18 provided with a discharge connection 19. The discharge member 19 may be attached to any suitable conduit by which the liquid from the pump may be conducted to storage or other apparatus. The fluid connections 16 and 17 are in communication with pump tubing 11 and 12, respectively, by pipes 20 and 21. Mounted within the cylinder 15 is a piston 22. This piston is of a length substantially less than the length of the cylinder in order to accommodate the stroke of the piston. Mounted upon opposite ends of the piston are packing cups 23 which form a tight fit with the wall of the bore of the cylinder 15 so that fluid will be displaced as the piston moves. Suitable lock means 24 hold the packing cups in position. The piston is substantially tubular and it is formed adjacent its opposite ends with webs providing bearings 25 and 26. These bearings have aligned openings through them to receive a piston rod 27. Mounted upon the piston rod beyond the webs 25 and 26 of the piston are packing cups 28 and 29 which are secured in place in any suitable manner and form a tight sliding fit with the cylindrical cavities 30 and 31 occurring at the ends of the piston beyond the webs and in direct communication with the interior of the cylinder 15. Formed through the wall portion of the piston 22 within which the cavities occur there are ports. Those leading from the cavity 30 are indicated at 32, and those leading from the cavity 31 are indicated at 33. These ports communicate with the cylin-

der within an annular space 35 which occurs between the wall of the cylinder bore and the outer face of the piston wall. The space is closed at its opposite ends by the packing cups 23 of the pistons 22, but is always in communication with the outlet passageway 18 through an elongated longitudinally extending port 36. Attention is directed to the fact that the spacing of the packing cups 28 and 29 upon the piston rod 27 is such as to insure that there will be a sufficient amount of lost motion between the piston rod and the piston as will cause the ports 32 and 33 to be alternately closed on alternate strokes of the piston rod 27, after which further movement of the piston rod in a given direction will make it possible for the piston 22 to be reciprocated within the cylinder 15.

The lower ends of the pump tubing 11 and 12 are in constant communication with the automatic valve and pump unit 14. This valve and pump unit comprises a pair of longitudinally aligned central cylinders 37 and 38 which are disposed vertically and are positioned between manifolds 39 and 40 disposed in longitudinal alignment with the tubing strings 11 and 12, respectively, and in constant communication therewith. The cylinder 38 is lowermost and is fitted at its lower opened end with a valve seat 41 carrying a check valve 42. This valve is here shown as being disk shaped to close the fluid passageways 43 through the valve seat and is provided with a central stem, or pin, 44 around which an expansion spring 45 is disposed, said spring acting to hold the valve on its seat and acting in opposition to the pressure of the fluid within the well exteriorly of the cylinder. A port 46 extends laterally through the wall of cylinder 38 adjacent the lower end thereof and communicates with the manifold 40 through a removable valve seat 47. A ball foot valve 48 normally rests on this seat acting by gravity in the internal pressure of fluid within the manifold 40. The upper end of the cylinder 38 is provided with a lateral port 49 which leads outwardly from the cylinder and is in constant communication with the manifold 39. Mounted within the cylinder 38 is a reciprocating piston, or plunger, 50, which reciprocates within the cylinder 38 for a distance between the opposite end ports 46 and 49. This piston is carried upon a piston rod 51 which extends through a partition wall 52 by which cylinders 37 and 38 are separated. The upper end of the piston rod carries a piston 53. The opposite and upper end of the cylinder 37 from the partition wall 52 is provided with a valve seat 54 having fluid passageways 55 therethrough which are closed by a valve disk 56 disposed within the cylinder and tending to prevent the flow of fluid therefrom. A valve pin 57 is attached to the disk and extends upwardly through the valve seat 54 and receives a spring 55' which acts to hold the disk 56 in a closed position against pressure exerted exteriorly of the cylinder. It will, therefore, be seen that the valve disk 42 and the valve disk 56 when moved from their seats permit the inflow of fluid from the well bore, but prevent the outflow of fluid from the cylinders into the well. Directly beneath the valve 56 and through the wall of cylinder 37 is a port 58 which communicates with the passageway 59 leading to the manifold 39. A valve seat 60 is mounted within the lower end of this passageway and receives a valve ball 61 which normally rests upon the seat by gravity and pressure from within the manifold 39, thus duplicating the foot valve structure of valve ball 48 previously described. As illustrated in Fig. 2, at the lower end of the cylinder 37 a port 62 occurs which establishes communication between the cylinder 37 and the manifold 40 and below the piston 53 at the lower end of its stroke. Collars 63 and 64 are mounted upon the piston rod 51 to limit the movement of the piston rod 51 and its pistons 50 and 53 so that these pistons will not move to positions where they would close the cylinder ports at the opposite ends of either cylinders.

In operation of the present invention the power pump unit is asembled as generally indicated in Fig. 3, and the valve and pump unit is assembled as indicated in Fig. 2. These units are connected by suitable lengths of pump tubing 11 and 12 so as to suspend the valve and pump unit at a desired depth of submergence of the fluid to be elevated from the well. The entire structure is then primed with liquid. The power pump may be connected to any driving mechanism, such, for example, as a motor 65 provided with a pinion 66 in mesh with the gear 67 to which a pitman rod 68 is extended and which rod pivotally connects with the outer end of the piston rod 27. The piston rod is guided through suitable bearings 69 to maintain the piston in a linear path of movement. It will then be assumed that the piston is in the position shown in Fig. 3 of the drawings ready to be moved in the direction of the arrow A. At this time it will be noted that the packing cup 28 has moved to a position to uncover the ports 32 of the piston and that the packing cup 29 has moved to cover the ports 33 of the piston. The end of the piston adjacent the connection 17 will thus be completely closed so that as the piston moves forwardly the pressure of the fluid within the tubing string 12 will force its way downwardly, acting upon the foot valve 48 to maintain it closed so that the fluid will act against the lowerside of plunger 53 to lift this plunger within the cylinder 37 and to eject the fluid from the cylinder 37 through the port 58, lifting the foot valve 61 and forcing the liquid from cylinder 37 into the manifold 39 so that as it is forced upwardly along the tubing string 11 it will pass into the cavity 30 at the end of the piston adjacent the connection 16, and then outwardly through ports 32 into the cylinder 15, thereafter passing through the outlet port 36 into the members 18 and 19 to be discharged. At the time this is taking place the valve disk 56 will be seated to prevent fluid from within the cylinder 37 from being expelled into the well. At the same time that the piston 53 is forced upwardly by the pressure of fluid entering through port 62, the piston rod 51 will be lifted to elevate the piston 50 within the cylinder 38. This will cause any fluid which is within the cylinder 38 and above piston 50 to be forced outwardly into the manifold 39 to comingle with the fluid forced outwardly into the manifold 39 from the connection 59, thus insuring that while sufficient fluid is forced into the cylinder 37 to lift the piston 53, that twice that amount of fluid will be displaced in cylinders 37 and 38 and forced into the manifold 39 and the tubing string 11. While the piston 50 is moving upwardly, fluid pressure will be relieved from the valve disk 42 within the cylinder 38 and a suction action will take place, which, in combination with the force produced by the hydrostatic head of fluid within the well, lifts the valve disk 42, allowing the cylinder 38 to fill with liquid. It is to be understood that the piston displacement within cylinder 15 equals

that required to move the piston rod 51 within the valve assembly within the length of its stroke. When the driving mechanism reverses the stroke of the piston rod 27, the piston will stand still initially due to this inrush, and the piston rod 27 will shift in a counter-direction of the arrow A, causing the packing cup 29 to uncover the ports 33 and the packing cup 28 to cover the ports 32. The reverse operation is then accomplished at which time fluid under presure will pass downwardly through the tubing string 11 to the manifold 39 and will then pass against the upper face of the piston 50 to force the piston 50 and its piston rod 51 downwardly. The valve disk 42 will move to a closed position and the foot valve 48 will open so that the fluid within the cylinder 38 and beneath piston 50 will be forced into the manifold 40 and upwardly through the string of tubing 12. At this same time the piston 53 will move down in unison with the piston 50, displacing the fluid occurring beneath it through the manifold and into the port 62. The valve disk 56 will be drawn from its seat to permit an additional charge of fluid to enter the cylinder 37, and due to the pressure existing within the manifold 39 the foot valve 61 will remain on its seat. Thus the cycle of operation will be completed.

It will thus be seen that the device here disclosed provides simple means having a few moving parts and whereby fluid may be elevated from a well at any depth and in constant load without the use of expensive pump and counterbalanced mechanism.

While I have shown the preferred form of my invention as now known to me, it will be understood that various changes may be made in combination, construction, and arrangement of parts by those skilled in the art without departing from the spirit of my invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a pumping device of the character described, a pump cylinder having fluid connections at the opened ends thereof, a pump discharge connection communicating with the cylinder through the wall thereof at a point intermediate the ends of the cylinder, a piston within said cylinder forming a fluid tight fit with the cylinder adjacent its opposite ends and forming an intermediate fluid passageway between the intermediate portion of the piston and the cylinder, said passageway being at all times in communication with said discharge connection, said piston being formed with passageways through its opposite ends to establish communication between said ends of the cylinder and the passageway there between, and valve means alternately operating as the piston reciprocates to alternately establish communication between the end of the cylinder from which the piston is moving to the discharge opening and simultaneously closing the opposite opening in the piston.

2. In a pumping device of the character described, a pumping cylinder having fluid connections at its opposite ends, a pump discharge means communicating with said cylinder, a piston adapted to reciprocate within said cylinder, valve means on said piston permitting discharge of the fluid from the alternate ends of the cylinder upon alternate strokes of said piston, and means automatically establishing communication between one of the fluid connections and the discharge means as said piston moves within the cylinder and in a direction away from the fluid connection with which said discharge means communicates.

3. In a pumping device of the character described, a pump cylinder having fluid connections at the opposite ends thereof, a pump discharge connection communicating with said cylinder at a point intermediate the ends thereof, a piston within said cylinder forming fluid tight fit therewith adjacent its opposite ends and forming an intermediate fluid passageway between the intermediate portion of the piston and the cylinder, said passageway being at all times in communication with said discharge connection, said piston being formed with passageway through it opposite ends so as to establish communication between the ends of the cylinder and the passageway therebetween, and valve means carried by said piston and alternately operating as piston reciprocates so as to alternately establish communication between the end of the cylinder from which the piston is moving to the discharge opening and simultaneously closing the opposite opening in the piston.

4. In an operating mechanism for a well pump, which pump has a pair of vertically aligned cylinders, fluid conduits leading from said cylinders to the top of the well, pistons disposed in each cylinder moving in unison, a pair of alternately operating valves for each cylinder, one acting to permit fluid to pass into the cylinder from the exterior thereof only, and the other permitting fluid to pass from the cylinder to one of said connections, the operating mechanism comprising a power pumping cylinder having fluid connections at its opposite ends adapted to communicate with the well cylinders through said fluid conduits, a piston adapted to reciprocate in said cylinder, means permitting discharge of the fluid from said cylinder upon alternate strokes of said piston, and means automatically establishing communication between one of the fluid connections and discharge means as said pistons move within the cylinder and in a direction away from the fluid connection with which said discharge means communicates.

AUGUST WILL.