

Nov. 21, 1939.

C. REICHERT

2,180,366

PUMPING APPARATUS

Filed Feb. 14, 1938

2 Sheets-Sheet 1

FIG. 1.

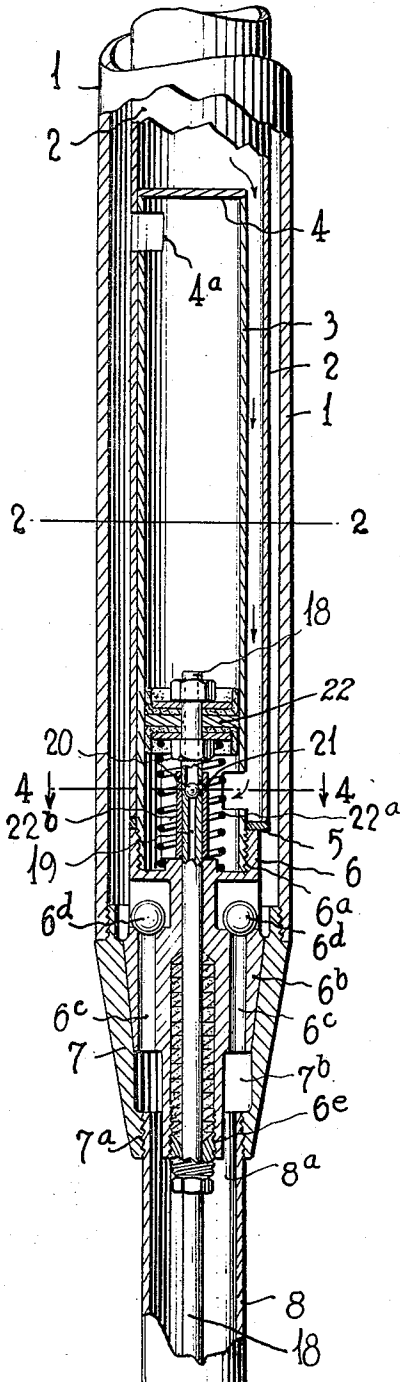


FIG. 1A

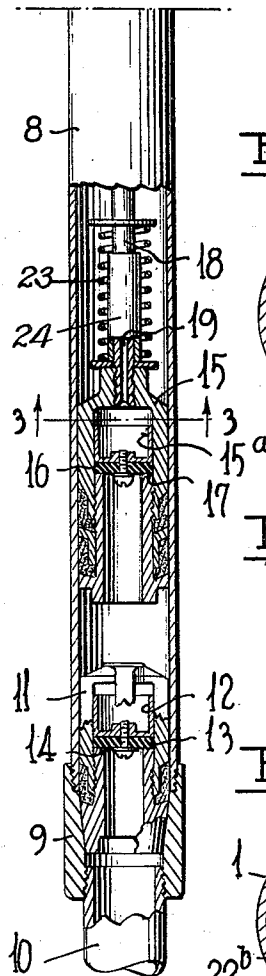


FIG. 2.

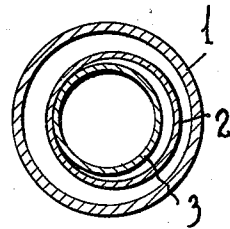


FIG. 3.

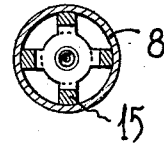
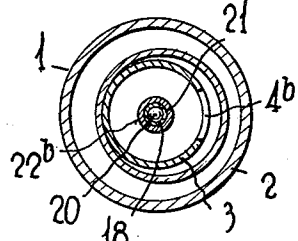


FIG. 4.



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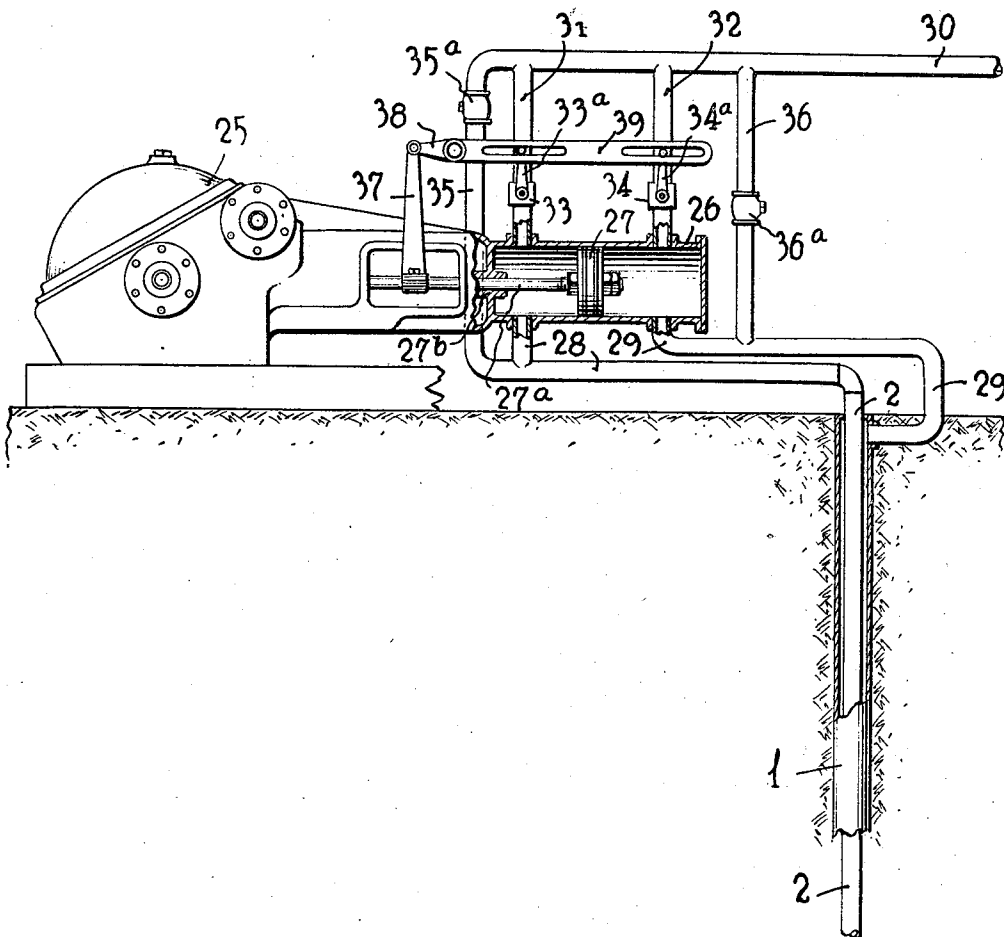
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2 Sheets-Sheet 2

FIG. 5



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UNITED STATES PATENT OFFICE

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PUMPING APPARATUS

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Application February 14, 1938, Serial No. 190,490

16 Claims. (Cl. 103—46)

This invention relates to deep well pumps of the type in which a piston located deep down in the well is operated by fluid pressure, thus dispensing with the usual pump rods extending from surface equipment.

It is known that deep well pumps have been designed to be operated by a pressure from surface equipment so as to eliminate pump rods. However, apparatus of that type has been expensive and difficult to install and maintain, because of complexity in the arrangement of parts. The present invention provides a simple arrangement of parts as will be hereinafter pointed out.

One of the features of the invention, in addition to that of simplicity, is the small number of parts required.

A further feature of the invention is the self-contained installation characterized by the presence of only two tubes at the upper end of a well hole or casing.

Another feature of the invention resides in the use and mounting of a pressure-operated power piston for operating a lifting piston, both parts being located deep down in the well.

Another feature of the invention relates to details of the rod connecting the power piston and lifting piston, whereby shock, due to application of pressure in the fluid columns is avoided.

Still another feature of the invention relates to the combination of the above-identified pump features or surface apparatus for withdrawing pumped liquid and supplying pressure to the respective tubes in required amounts only, depending on the pressure and capacity at the power piston deep down in the well.

The above and additional details and features of the invention are described and claimed in the following specification and claims, and illustrated in the accompanying drawings, in which—

Fig. 1 represents a vertical section taken centrally through that portion of the tubing containing the power cylinder and piston;

Fig. 1^a shows, partly broken away, in vertical section centrally through the lower portion of the apparatus, the lifting piston or sucker and lower check valve;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1, showing the relative position of the two tubes and innermost working chamber;

Fig. 3 is a section taken on the line 3—3 of Fig. 1^a looking in the direction of the arrows and illustrating the structure of the upper end of the lifting piston;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 1 looking in the direction of the arrows, and illustrating the position of the outlet at the upper end of the hollow piston rod opposite the lowermost port in the wall of the working chamber; and

Fig. 5 is a view of a suitable gear driven pump

for location above the earth's surface for supplying pressure to the working chamber shown in Fig. 1 and for withdrawing pumped liquid.

This invention presumes the use of the customary well casing or other lining for the wall of a drilled well. As one example, the apparatus illustrated in the accompanying drawings is intended for insertion into and use within such a casing, although theoretically the structure described and illustrated in connection with this invention is capable of functioning without such casing.

The apparatus herein described includes the provision of a working chamber and piston therein intended to be located deep down in the well and which has a sucker or a lowermost lifting piston connected to the power piston by a suitable piston rod. These essential features of the invention are operated by fluid pressure from the earth's surface transmitted through two passageways, comprising two tubes. The outermost of these tubes is closed at its lower end and is adapted to receive oil being forced upwardly and serves to conduct such oil to the surface. Within the outer tube and spaced from it is a second or inner tube which serves to supply pressure to the under face of the power piston within the working chamber to lift the power piston upwardly and thus to bring oil upwardly into the outlet passage formed by the inner wall of the outer tube and the outer wall of the inner tube. One feature of the operation of these essential parts is that there is a periodic downward pressure applied on the column of upwardly moving oil so that such pressure is exerted on the upper face of the power piston to lower the same in order that a further charge of oil may be admitted to the space above the lifting piston or sucker element. These and further features will now be more particularly described.

Referring in detail to the several figures of the drawings, 1 is the outer tubing, 2 is the inner tubing, and 3 represents the wall of the working chamber which is shown to be cylindrical. It will be observed that the working chamber 3 is concentric with the wall 1 of the outer tubing and that the inner tubing 2 is eccentrically positioned with respect to both 1 and 3 so that the walls 2 and 3 contact each other along one side. These two walls may be welded or otherwise secured together along the line of contact if desired. The upper end of the working cylinder 3 is closed by a suitable plate or cap 4 secured in any suitable manner to serve as a cylinder head. The lower end of the inner tube 2 rests on a plate 5 which encircles the outer wall of the wall 3 of the working chamber. Plate 5 thus serves to close the lower end of the space within the tube 2 about the wall of the working chamber 3.

Ports for the application of working fluid to

the power piston are shown at 4^a near the upper portion of the working chamber 3 where the port extends through the contacting walls 2 and 3, and at the lowermost portion of the working chamber at 4^b on the opposite side of the working chamber.

A combination junction element serving for the mounting of several essential parts also providing ports leading from the lowermost part of the apparatus is provided just below the plate 5 by the element 6 which serves not only as a spacer for the above mentioned tubing, but also as a stuffing box as will be described. The element 6 is of peculiar shape having an upstanding rim 6^a threaded on its inner face to provide thread-engagement with the lower end of the working chamber. From that rim 6^a this piece extends inwardly to provide a bearing support for the piston rod and stuffing box immediately therebelow and adapted to contain suitable packing, as illustrated. The lower portion of the element 6, where it is provided with a central space for packing, is shaped as an annular sleeve 6^b within which there are a series of upwardly extending ducts 6^c through which oil may be moved upwardly past ball valves 6^d, resting on the upper end openings of the ducts 6^c, thus serving to permit upward movement of the oil but prevent downward movement. The space immediately above the ducts 6^c and ball valves 6^d lead directly into the space between the inner wall of the outer tubing 1 and the outer wall of the inner tubing 2 for discharge. Extending below the portion 6^b, the stuffing box wall is extended downwardly and at its extreme end is threaded on its central face at 6^e for the reception of a suitable packing gland element to hold the packing material in place.

A union element 7 serves to connect the wall 1 of the outer tubing with the wall 8 of the lower working barrel or cylinder. The union element 7 is shown as being tapered smaller towards its lower end where it provides an opening threaded at 7^a for engagement with the upper threaded end of the working barrel 8. The inner surface of the union element 7 is likewise tapered with its smaller end downward, and the surface thereof serves as a seat for the support of the outer surface of the outer wall of the part 6^b of the combination element 6. Within the enclosure of the union element 7 is a space 7^b extending annularly around the lower end of the combination member 6. The ducts 6^c extend upwardly from the space 7^b.

The structure at the lower end of the apparatus is illustrated in Fig. 1^a and includes the lower working barrel 8. At the lower extreme end of the barrel 8 is a collar 9 which may be screw threaded to the lower end of the working barrel 8 and receive at its lower end a suitable pipe connection 10 as may be desired. Within the working barrel 8, and adjacent the collar 9, is a fixed valve cage 11 within which is a valve element 12 having a renewable face 13 adapted to seat on the upper edge of a valve seat 14 so that oil flowing upwardly or sucked upwardly into the casing may move through the valve cage 11, lifting the movable parts 12 and 13 from the seat. Tendency for the oil to pass downward is prevented by the seating of the parts 12 and 13 on the edge 14.

The suction or lifting part of the equipment includes a cylindrical plunger 15 having a movable valve element 15^a therein, having a renewable surface 16 which is adapted to rest on the upper edge of a valve seat 17, the latter having

threaded engagement with the part 15 and serving to confine suitable packing material between the cylindrical plunger and the inner wall of the working chamber 8.

The valve rod or piston rod transmits power from the working chamber to the cylindrical plunger 15 as indicated at 18, the cylindrical plunger 15 being connected to the rod 18 with a screw threaded engagement, as illustrated. The rod 18 is peculiar in that it has a central duct 19 extending upwardly therethrough. This duct 19 serves to provide ported communication below the space in the cylindrical lifting plunger 15 and the space within the working chamber, subject to the control of the valve parts 15^a and 16 at its lower end and a small ball valve 20 at its upper end, opposite an outlet opening 21 located in the wall of the rod 18, as will be described.

A power piston 22 located within the working cylinder 3 is shown conventionally in Fig. 1 as having a central plate, and at either side thereof, oppositely facing leather cups, these parts being positioned at the upper end of the rod 18 and held thereon by suitable nuts clamping the parts together.

Means to limit the extreme lower movement of the piston 22 is provided as follows. A coil spring 22^a surrounds the rod 18 and serves to cushion the extreme lower movement of the piston. A definite limit stop for such downward movement of the piston is provided by a sleeve 22^b which surrounds the rod 18 and is positioned between the spring 22^a and the rod 18, and is of such a length as to prevent the piston 22 in its downward movement from closing the port 4^b. As shown in Fig. 1 the sleeve 22^b also closes the outlet opening 21 leading from the ball valve 20 at the upper end of the duct 19. Upward movement of the piston 22 and rod 18 will raise the opening 21 above the upper edge of the sleeve 22^b. If the weight of the sleeve 22^b is not sufficient to hold it down in the position shown in Fig. 1, it may be secured at its outer lower margin to the adjacent surface of the part 6, as by welding.

Means for limiting the upward movement of the piston 22 so as to cushion the same is provided by a spring 23 encircling and carried by the rod 18 and located within the upper end of the lower working cylinder 8. A sleeve 24 positioned between the spring and the rod 18 serves to limit the movement of the piston 22 upwardly by limiting the upward movement of the cylindrical plunger 15 in its upward travel and in this way the piston 22 is prevented from closing the upper port 4^a in the working chamber. The sleeve 24, as shown, is not immovably mounted and it will function as illustrated, thus slidably mounted on the rod 18. If desired, however, it may be secured at the lowermost end of the rod 18, as for example to the upper side of the piston body 15. Next adjacent the spring 23, for engaging the upper and lower ends thereof, are washers or rings, as shown, and which receive the end thrust of the spring 23 when the latter is compressed therebetween, as for example in the extreme upper movement of the rod 18. Such washers or rings are preferably slidable on the rod 18 and serve to prevent the spring 23 from sliding over or being caught upon the fastening or adjusting screws or nuts of the rod 18.

Apparatus for operating the above mentioned working parts within the well is provided by the following equipment, suitably located at the

earth's surface as shown in Fig. 5. 25 indicates a gear-driven unit for operating a standard pressure pump such as the following. 26 indicates the wall housing a reciprocating piston 27 having a piston rod 27^a mounted in suitable stuffing box 27^b. The space at one side of the piston is connected by a pipe 28 with the inner tubing 2 of the well equipment. The space at the opposite side of the piston 27 is connected by a pipe 29 with the outer space within the tubing 1 and exteriorly of the inner tubing 2. A discharge pipe for storage is indicated at 30 and is connected to the space at opposite sides of the piston by pipes 31 and 32, respectively, as considered in connection with the space supplied by the pipes 28 and 29. Throttle valves for the pipes 31 and 32 are indicated respectively at 33 and 34 and these two valves are in turn respectively controlled by mechanism as will be described.

A pipe 35 leading from the pipe 28 to the outward pipe 30 and provided with a pressure relief valve 35^a serves to insure the safe discharge of oil from the pipe 28 and inner tubing 2 if the pressure on the working fluid therein becomes excessive. A similar by-pass pipe is indicated at 36, extending from the pipe 29 to the pipe 30 and has a pressure relief valve indicated at 36^a.

Means for operating the valves 33 and 34 includes a moving arm 37 clamped at its lower end to the piston rod 27^a and coupled at its upper end to a horizontally extending bar 39 by means of a link 38. The bar 39 has slots therein for the reception of offset projections from the upper end of the connecting levers 33^a and 34^a attached to and adapted to respectively operate the valves 33 and 34 to control the passage through the pipes 31 and 32.

The general operative function of the apparatus illustrated in Fig. 5 will now be described. The piston 27 is shown in Fig. 5 as in a neutral or intermediate position. During the forward stroke of the piston 27, that is to the right, as shown in Fig. 5, it compresses fluid and forces it through the pipe 29 into the outside tube 1. Near the end of the forward stroke of the piston 27 the throttle valve 34 is opened and at the same time the throttle valve 33 is closed by the forward motion of the arm 37, the link 38, and the horizontally extending bar 39.

When the movement of the piston 27 is in the opposite direction, that is to the left as shown in Fig. 5, the throttle valve 33 being closed, the pressure is directed through the pipe 28 to the inner tubing 2 within the well thus applying a pressure to the under face of the power piston and serving to raise oil upwardly in the space between the pipe 1 and the pipe 2 and thence outwardly through the pipe 29. During this time the throttle valve 34 is open and the pumped oil may be discharged through the pipe 30 to storage.

The pressure relief valves 35^a and 36^a constitute means to overcome any difference in the pressure of fluid in the pump 26 and the working cylinder 3 within the well, extremes of pressure permitting relief through valves 35^a or 36^a into the discharge pipe 30. The pressure relief valves 35^a and 36^a should normally be set for a slightly greater pressure than needed to operate the power piston in the working chamber 3 within the well.

It is important that the discharge line 30 be positioned at a level above the cylinder 26 in

order to insure that there is fluid in the cylinder 26 at all times.

The operation of the pumping parts within the well will now be described. When pressure is applied by the surface apparatus through the pipe 28 and inner tube 2, fluid is forced through the lower port 4^b and pressure thus applied to the under face of the piston 22 forcing it upward. During the upward stroke the valve parts 15^a and 16 in the plunger 15 will be in the closed position, and will be lifted up by the action of the piston 22. At this stage, while the fluid within the lower working barrel or tube 8 is moving upward, the suction will also cause the lowermost valve 11 having the operating parts 12 and 13 to open and allow the lower end of the working barrel 8 to fill with fresh material to be pumped. During the upward stroke of the piston 22, the fluid being lifted by the plunger 15 will pass through the chamber 7^b, thence upwardly through the ducts 6^c and past the ball check valves 6^d and thence into the space within the outer tubing 1 and between it and the outer wall of the inner tubing 2, and onward to the surface. During that time also any fluid present within the working chamber above the piston 22 will be moved outwardly through the upper port 4^a and become merged with the oil being passed upwardly and outwardly from the well.

At the end of the upstroke of the piston 22 the pressure is reversed by the surface equipment so that pressure is applied through the pipe 29 into the tube 1. The action is such as to interrupt the upward flowing movement of oil and to send an impulse through the oil downward. Some of the oil enters the opening 4^a and exerts pressure on the upper surface of the piston 22, movement of the latter forcing the piston rod 18 and the plunger 15 downwardly, thus opening the valve parts 15 and 16 and forcing oil from the lower part of the tube 8 into the space above the plunger 15.

Referring to the duct 19 extending through the piston rod 18, it may be explained that this duct provides for the following function. It will be observed that the lower end of the duct 19 is open and in ported communication with the space above the plunger 15 through the open upper end of the latter. Upon downward movement of the plunger 15, pressure due to the cross-sectional area of the piston rod 18 is relieved by the fact that fluid is permitted to escape upwardly through the duct 19 and out past the ball valve 20 in the upper end thereof. As shown in Fig. 1 it will be noted that the outlet port 21 is apparently closed by reason of the fact that it is slightly below the upper end of the encircling sleeve 22^b. However, this is only at the extreme end of the travel of the piston downwardly. At all other times and through the major portion of the travel of the piston 22, the opening 21 is not covered and during the downward movement of the piston 22 oil passing upwardly through the duct 19 may be discharged into the space beneath the piston 22. The duct permits relief of pressure which otherwise would exert a force against the lower end of the plunger 15 during its downward travel. In short, the duct serves to relieve the pressure which would otherwise be set up on account of the displacement by the piston rod 18.

It is important that the pump cylinder 26 have the same displacement as the power cylinder 3 within the well.

The equipment described above not only pro-

vides for the elimination of usual sucker rods, but also renders unnecessary such surface equipment as jacks and so-called central power units. The apparatus lends itself readily to use in connection with deep wells having crooked or peculiarly shaped holes by reason of the fact that the total length of the power piston and piston rod may be relatively short as compared to equipment having the usual sucker rod. It is noteworthy that the equipment provides the use of two fluid columns and thus requires a minimum of apparatus.

I claim:

1. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, and an inner tube within said outer tubing leading from the earth's surface and extending alongside of and exteriorly of said power chamber and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston.

2. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tube leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, and an inner tube within said outer tube leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, said inner tube being eccentrically positioned with respect to said power chamber and the walls of said inner tube and said power chamber being in contact in one region and having an opening extending through both said walls for said ported communication.

3. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, and an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, the upper end of said power chamber extending across a substantial area of the bore of said inner tube and being located above and in the near region of said point of ported communication.

4. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement of said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and

connected to said rod, an outer tube leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, and an inner tube within said outer tube leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, said inner tube being eccentrically positioned with respect to said power chamber and the walls of said inner tube and said power chamber being in contact in one region and having an opening extending through both said walls for said ported communication, the upper end of said power chamber extending across a substantial area of the bore of said inner tube and being located above and in the near region of said point of ported communication.

5. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, an inner tube within said outer tubing leading from the earth's surface and extending alongside of and exteriorly of said power chamber and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, and operating means for applying pressure alternately to the liquid within said outer tube and said inner tube whereby said piston is moved respectively downwardly and upwardly to correspondingly admit oil above said lifting plunger and to raise the latter.

6. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, and operating means for applying pressure alternately to the liquid within said outer tube and said inner tube whereby said piston is moved respectively downwardly and upwardly to correspondingly admit oil above said lifting plunger and to raise the latter, said inner tube being eccentrically positioned with respect to said power chamber and the walls of said inner tube and said power chamber being in contact in one region and having an opening extending through both said walls for said ported communication.

7. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with

said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, and operating means for applying pressure alternately to the liquid within said outer tube and said inner tube whereby said piston is moved respectively downwardly and upwardly to correspondingly admit oil above said lifting plunger and to raise the latter, the upper end of said power chamber extending across a substantial area of the bore of said inner tube and being located above and in the near region of said point of ported communication.

8. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, and operating means for applying pressure alternately to the liquid within said outer tube and said inner tube whereby said piston is moved respectively downwardly and upwardly to correspondingly admit oil above said lifting plunger and to raise the latter, said inner tube being eccentrically positioned with respect to said power chamber and the walls of said inner tube and said power chamber being in contact in one region and having an opening extending through both said walls for said ported communication, the upper end of said power chamber extending across a substantial area of the bore of said inner tube and being located above and in the near region of said point of ported communication.

9. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, and an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, said piston rod being tubular and providing a passageway lengthwise thereof in ported communication with the space above said lifting plunger and the space beneath said piston, and a valve adapted to permit upward movement of liquid through said passageway and prevent downward movement of liquid therethrough during the downward movement of said piston rod.

10. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in

line with said rod, a piston within said chamber and connected to said rod, an outer tube leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, and an inner tube within said outer tube leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, said inner tube being eccentrically positioned with respect to said power chamber and the walls of said inner tube and said power chamber being in contact in one region and having an opening extending through both said walls for said ported communication, said piston rod being tubular and providing a passageway lengthwise thereof in ported communication with the space above said lifting plunger and the space beneath said piston, and a valve adapted to permit upward movement of liquid through said passageway and prevent downward movement of liquid therethrough during the downward movement of said piston rod.

11. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, and an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, the upper end of said power chamber extending across a substantial area of the bore of said inner tube and being located above and in the near region of said point of ported communication, said piston rod being tubular and providing a passageway lengthwise thereof in ported communication with the space above said lifting plunger and the space beneath said piston, and a valve adapted to permit upward movement of liquid through said passageway and prevent downward movement of liquid therethrough during the downward movement of said piston rod.

12. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement of said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tube leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, and an inner tube within said outer tube leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, said inner tube being eccentrically positioned with respect to said power chamber and the walls of said inner tube and said power chamber being in contact in one region and having an opening extending through both said walls for said ported communication, the upper end of said power chamber extending across a substan-

tial area of the bore of said inner tube and being located above and in the near region of said point of ported communication, said piston rod being tubular and providing a passageway lengthwise thereof in ported communication with the space above said lifting plunger and the space beneath said piston, and a valve adapted to permit upward movement of liquid through said passageway and prevent downward movement of liquid therethrough during the downward movement of said piston rod.

13. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge of oil upwardly, an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, and operating means for applying pressure alternately to the liquid within said outer tube and said inner tube whereby said piston is moved respectively downwardly and upwardly to correspondingly admit oil above said lifting plunger and to raise the latter, said piston rod being tubular and providing a passageway lengthwise thereof in ported communication with the space above said lifting plunger and the space beneath said piston, and a valve adapted to permit upward movement of liquid through said passageway and prevent downward movement of liquid therethrough during the downward movement of said piston rod.

14. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, and operating means for applying pressure alternately to the liquid within said outer tube and said inner tube whereby said piston is moved respectively downwardly and upwardly to correspondingly admit oil above said lifting plunger and to raise the latter, said inner tube being eccentrically positioned with respect to said power chamber and the walls of said inner tube and said power chamber being in contact in one region and having an opening extending through both said walls for said ported communication, said piston rod being tubular and providing a passageway lengthwise thereof in ported communication with the space above said lifting plunger and the space beneath said piston, and a valve adapted to permit upward movement of liquid through said passageway and prevent downward movement of liquid therethrough during the downward movement of said piston rod.

15. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, and operating means for applying pressure alternately to the liquid within said outer tube and said inner tube whereby said piston is moved respectively downwardly and upwardly to correspondingly admit oil above said lifting plunger and to raise the latter, the upper end of said power chamber extending across a substantial area of the bore of said inner tube and being located above and in the near region of said point of ported communication, said piston rod being tubular and providing a passageway lengthwise thereof in ported communication with the space above said lifting plunger and the space beneath said piston, and a valve adapted to permit upward movement of liquid through said passageway and prevent downward movement of liquid therethrough during the downward movement of said piston rod.

16. In a deep well pump, a lower cylinder with a lifting plunger therein for raising liquid, a piston rod for transmitting movement to said lifting plunger, a cylindrical power chamber in line with said rod, a piston within said chamber and connected to said rod, an outer tubing leading to the earth's surface and having walls concentric with said power chamber and in valved communication with said lower cylinder for the discharge passage of oil upwardly, an inner tube within said outer tubing leading from the earth's surface and in ported communication with said power chamber at a point beneath said piston, said power cylinder and said outer tube being in ported communication at a point above said piston, and operating means for applying pressure alternately to the liquid within said outer tube and said inner tube whereby said piston is moved respectively downwardly and upwardly to correspondingly admit oil above said lifting plunger and to raise the latter, said inner tube being eccentrically positioned with respect to said power chamber and the walls of said inner tube and said power chamber being in contact in one region and having an opening extending through both said walls for said ported communication, the upper end of said power chamber extending across a substantial area of the bore of said inner tube and being located above and in the near region of said point of ported communication, said piston rod being tubular and providing a passageway lengthwise thereof in ported communication with the space above said lifting plunger and the space beneath said piston, and a valve adapted to permit upward movement of liquid through said passageway and prevent downward movement of liquid therethrough during the downward movement of said piston rod.

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