May 22, 1956 W. F. TEBBETTS 2,746,431

RODLESS FLUID PRESSURE-OPERATED PUMP

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Fig. 1.

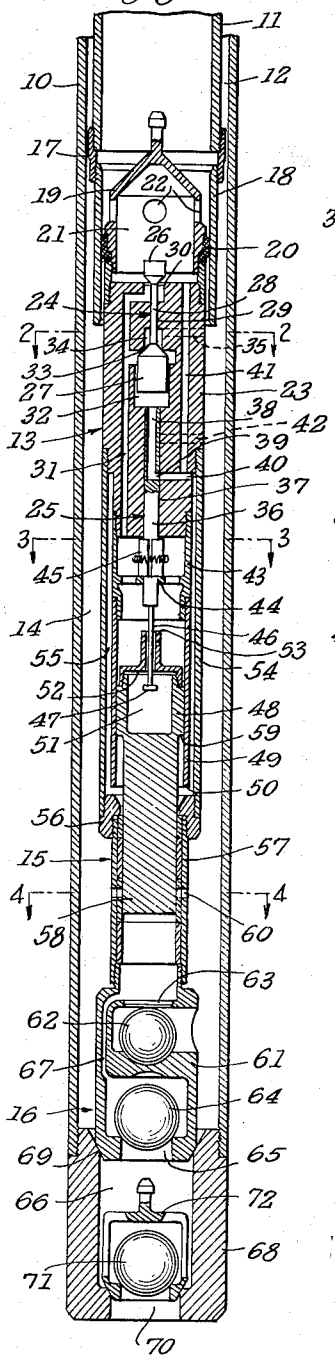



Fig. 2.

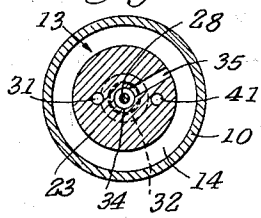



Fig. 3.

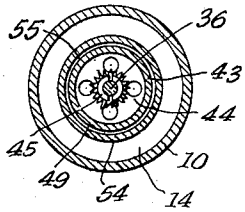



Fig. 4.

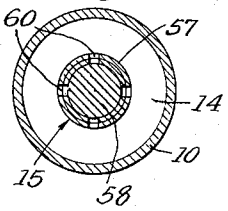
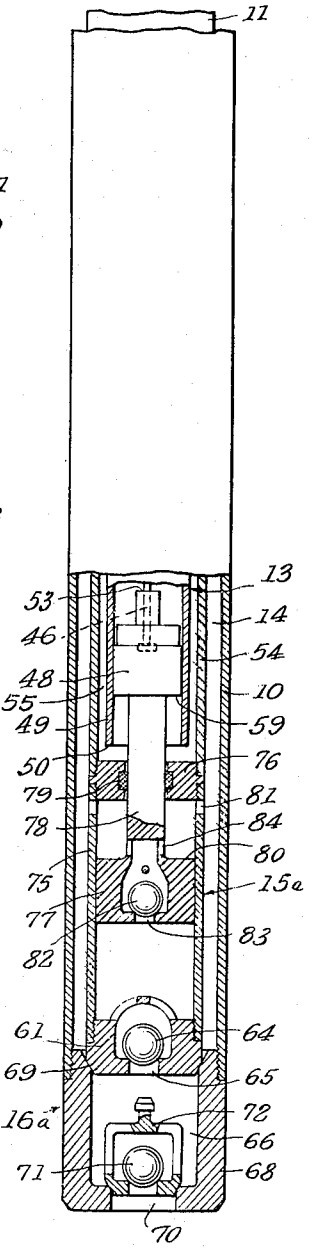



Fig. 5.




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Fig. 6.

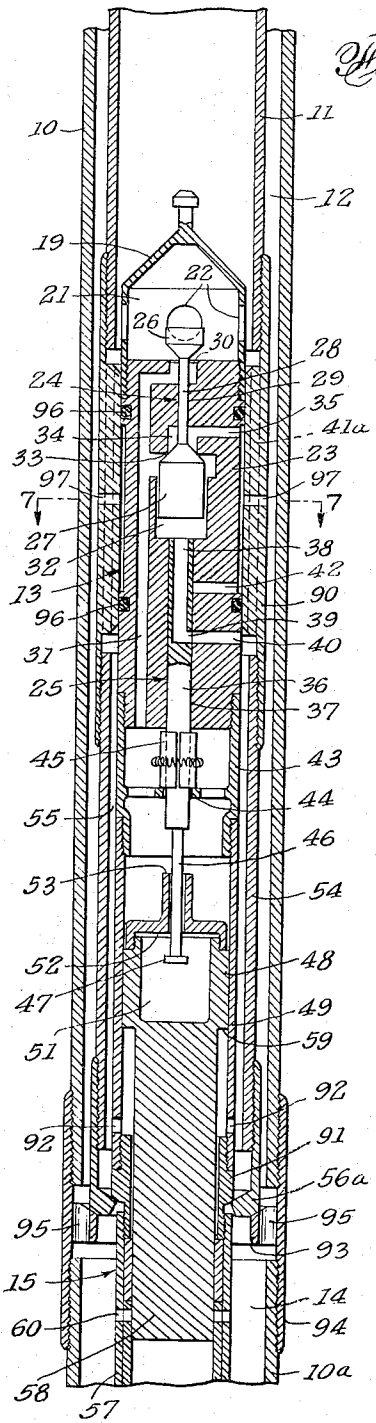
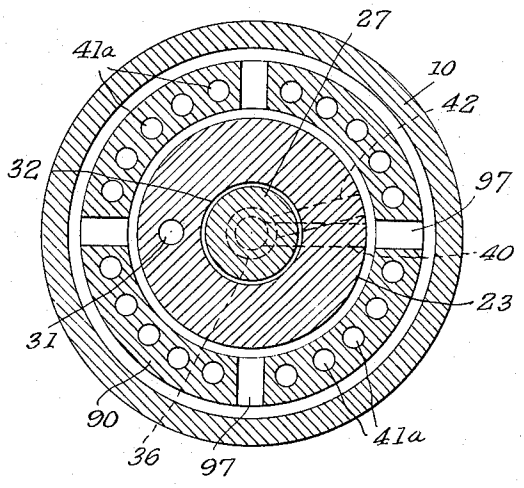



Fig. 7.




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# RODLESS FLUID PRESSURE-OPERATED PUMP

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6 Claims. (Cl. 121—157)

This invention relates to a well pump and, more particularly, to a rodless pump that performs its cycle of operation through the medium of a constant flow of pressure fluid from above.

The present invention is characterized by its simplicity of construction, fewness of operating elements in relation to prior hydraulic or fluid-operated pumps, and long life enabling continuous and economical use, it being an important object of the invention to provide a well pump as characterized above.

Another object of the invention is to provide a fluid-operated well pump that has general use and is more particularly suited for handling sandy and viscous oil deposits.

A further object of the invention is to provide a fluid-operated well pump in which the operating parts are under constant lubrication by clean high-pressure oil to minimize wear due to the abrasive action of sand in the production flow from a well in which said pump is installed.

A still further object of the invention is to provide a pump as characterized above that is adapted to handle production of a well in which gases may be present.

The ability of the present pump to handle a sandy production flow results from a construction that maintains continuous motion or agitation of the flow both on the filling and discharge strokes of the pump due to the provision of oversize filling and discharge valves in relation to a relatively small pumping piston. The advantages of the above are well-known to those skilled in this art.

By providing the present pump with a pumping piston of small size and relatively long stroke, and providing the cylinder for said piston with a port or ports that are opened, near the upper end of the piston movement, to communicate said cylinder with the production flow, gas in the fluid beneath said piston readily vents to production. At the same time, these gases pressurize the pumping cylinder to obviate a gas lock and said port or ports also fulfill the important function of preventing a too rapid descent of the pumping piston by insuring the presence of liquid rather than a gas directly beneath the piston. Another result of the gas relief afforded by said port or ports is a material increase in the volumetric displacement efficiency of the pump.

The invention also has for its objects to provide such means that are positive in operation, convenient in use, easily installed in a working position and easily disconnected therefrom, economical of manufacture, relatively simple, and of general superiority and serviceability.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. However, the drawing merely shows and the following description merely describes, preferred embodiments of the present invention, which are given by way of illustration or example only.



In the drawing, like reference characters designate similar parts in the several views.

Fig. 1 is a longitudinal sectional view of a rodless fluid pressure-operated pump according to the present invention.

Figs. 2, 3 and 4 are cross-sectional views as taken on the respective lines 2—2, 3—3 and 4—4 of Fig. 1.

Fig. 5 is a partial elevational and partial longitudinal sectional view of a modification.

Fig. 6 is a longitudinal sectional view of an alternative construction, drawn to a somewhat enlarged scale.

Fig. 7 is a further enlarged cross-sectional view as taken on line 7—7 of Fig. 6.

The pump that is illustrated in Figs. 1 to 4 comprises, generally, an outer tubing or casing 10, an inner tubing 11 defining an annular production passage 12 between itself and tubing 10, a fluid-operated motor 13 suspended from inner tubing 11 and operated by pressure fluid introduced from above into tubing 11, an annular production passage 14 being defined between motor 13 and outer tubing 10 and said latter passage being a lower extension of and in communication with passage 12, a pump 15 extending downwardly from motor 13, and fill and discharge valving means 16 at the lower end of tubing 10 and through which production fluid from a well is drawn by pump 15 and discharged into production passage 14.

The motor 13 is carried by inner tubing 11 by means of an internally threaded collar 17 connected to the lower end of said tubing, a tube 18 connected at its upper end to said collar, a cage 19 within tube 18, and a pressure seal 20 carried by the cage and tightly engaged with the inner face of tube 18. The motor 13 is carried by the lower end of said cage which is interiorly hollow at 21 and is provided with ports 22 that freely admit pressure fluid from tubing 11 into the hollow 21 of said cage.

The motor 13 comprises an elongated body 23 that mounts a master valve 24 in its upper end and a pilot valve 25 in its lower end, both valves being preferably on the longitudinal axial center of said body.

Master valve 24 comprises an upper poppet 26, a lower larger poppet 27, and a stem 28 integrally connecting said poppets and slidingly engaged in a bore 29 in the valve body 23. Poppet 26 is disposed above the valve body and is preferably provided with a conical portion adapted to engage the seat of a port 30 that is in communication with the interior 21 of cage 19 and, thereby, controls pressure fluid flow to said port. A longitudinal passage 31 extends from said port 30 to the lower end of body 23. A chamber 32 somewhat larger than lower poppet 27 houses the latter and is in lateral communication with passage 31. Chamber 32 is defined at the top by an annular shoulder 33 that is adapted to engage an upper conical portion of poppet 27 to limit the upward movement of master valve 24. A reduced chamber 34 is provided in the motor body 23 above shoulder 33 and an exhaust port 35 extends from chamber 34 to the outside of said body and, therefore, communicates with production chamber 14.

Pilot valve 25 comprises a plunger 36 that has a push fit in a bore 37 in motor body 23, said bore extending from chamber 32 to the bottom of said body. The plunger 36 is provided with a longitudinal passage 38 open at its top to chamber 32 and terminating at its bottom in a lateral port 39. Body 23 is provided with a transverse passage 40 in communication with port 39 when said pilot valve is in its uppermost position, and with a longitudinal passage 41 that extends between passage 40 and the interior 21 of cage 19. A transverse passage 42 is provided for venting chamber 32 to production chamber 14 when

the pilot valve has been moved downwardly as later described.

A fitting 43 is attached to and forms a lower extension of body 23, the same being provided with an intermediate transverse spider 44 that is spaced below the lower end of said body. The lower end of plunger 36 is guided by said spider. Since said plunger has upper and lower positions, to insure retention of the same in said positions until moved as hereinafter described, a friction drag 45 is applied to the plunger in the space between body 23 and spider 44. A stem 46 extends downwardly from plunger 36 and the lower end of said stem is provided with a head 47.

The motor 13 further includes a motor piston 48 that operates in a cylinder 49 that forms a lower extension of fitting 43, said cylinder being open at its bottom 50. Said piston 48 is provided with an interior cavity 51 that is defined by an upper abutment 52. The head 47 of pilot valve 25 operates in said cavity and is engaged by abutment 52 to effect downward movement of said pilot valve. The upper end 53 of piston 48 comprises an abutment that engages the lower end of plunger 36 to effect upward movement of the pilot valve.

The pump 15 is carried by a tube 54 that surrounds cylinder 49 and extends downwardly from body 23. Said tube and cylinder are spaced to define an annular passage 55 that communicates passages 40 and 41 with the lower open end 50 of said cylinder 49. A bottom fitting 56 is carried by the lower end of tube 54.

The pump 15 comprises a cylinder 57 extending downwardly from fitting 56 and a pump piston 58 operating in said cylinder and comprising a smaller lower extension of motor piston 48, a downwardly facing annular shoulder 59 being defined between pistons 48 and 58. Intermediate its ends, cylinder 57 is provided with pressurizing ports 60 that are uncovered by piston 58 at the top of its stroke.

The fill and discharge valving means 16 comprises a cage 61 extending downwardly from pumping cylinder 57. The upper portion of said cage houses a ball valve 62 that controls a port 63 which communicates the interior of cylinder 57 with the production chamber 14. The lower portion of said cage 61 houses a ball valve 64 that controls a port 65 in the lower end of said cage and which communicates the interior of cylinder 57 with a chamber 66 by means of a passage 67. The chamber 66 is provided in a fitting 68 carried by the lower end of outer tubing 10. Cage 61 has a seated engagement at 69 with fitting 68 shutting off production chamber 14 from chamber 66 except through valved ports 65 and 63. Said fitting 68 has a bottom inlet port 70 that is controlled by a ball valve 71 that may be housed in a cage 72 disposed in chamber 66.

*Operation*

Assuming that the master valve 24 is in its low position with poppet 26 closing port 30, the pilot valve 25 in its low position with port 39 out of register with and below passage 40, and the combined motor and pumping pistons 48 and 58 in their lowermost position with head 47 of the pilot valve engaged by abutment 52, pressure fluid, oil, for instance, supplied in inner tubing 11, passes into the interior of cage 19 through ports 22 and enters longitudinal passage 41. Since ports 39 and 40 are out of register, this fluid can only pass into annular chamber 55 and, through the open bottom 50 of cylinder 49, is effective on piston shoulder 59 to move the combined pistons 48 and 58 upward. There is, at this time, only low production pressure on the top of piston 48 because the upper end of cylinder 49 is open to production chamber 14 through spider 44, longitudinal passage 31, chambers 32 and 34, and transverse passage 35. Since the unit pressure of the fluid acting on shoulder 59 is relatively high, the total pressure on said shoulder is considerably greater than the resistance of the head of material in the production chambers 12, 14 and on the top of piston 48. Consequently, the combined pistons move up.



This upward movement of piston 58 causes an upward displacement of material into the lower end of cylinder 57, the same moving past check valves 71 and 64 through port 70, chamber 66, port 65 and passage 67. Simultaneously, the low pressure head in chamber 14 forces check valve 62 to close port 63.

This inlet of material—both liquid and sand—continues during upward movement of piston 58. As the latter nears the top of its stroke, its lower end uncovers ports 60. Since any gases that may be present in the material in cylinder 57 will rise to the top, the same will readily pass into production chamber 14 leaving a substantially solid column of liquid and particles in cylinder 57.

Before the pistons reach the top of their stroke, abutment 53 encounters the lower end of plunger 36 of the pilot valve 25 and moves said valve upwardly against the friction of drag 45. When port 39 achieves register with transverse passage 40, pressure fluid from passage 41 enters longitudinal passage 38 in plunger 36 and, entering chamber 32, is effective on the bottom of poppet 27. Since poppet 27 is larger than poppet 26, the fluid pressure on the latter is overcome and port 30 is cracked open. As the pressure in chamber 32 builds up, the master valve moves to its uppermost position with the poppet 27 against shoulder 33 and port 30 fully open. Vent 35 permits full seating of the poppet on said shoulder.

Opening of port 30 admits full flow of pressure fluid in longitudinal passage 31 and the same becomes effective on the top of piston 48 to overcome the continuing fluid pressure on piston shoulder 59 because of the substantially greater area of said piston top than said shoulder. The pistons 48, 58, therefore, move down. The pilot valve is held in its raised position by drag 45 and because the same is in hydraulic balance. A slight downward movement of pilot valve 25 during initial downward movement of the pistons would be immaterial providing passage 42 is not uncovered by the top of plunger 36. If any such movement would occur to move port 39 out of register with passages 40 and 41, hydraulic pressure on the bottom of poppet 27 would still be present, being supplied through passage 31 to chamber 32 in which said poppet is but loosely fitted, as shown. Therefore, the master valve remains open as the pistons 48, 58 move down.

Since the bottom of piston 58 is pressing on a solid column of material in cylinder 57 because of the gas relief afforded by ports 60, at the instant that downward movement of said pistons start check valves 64 and 71 close ports 65 and 70 and valve 62 opens port 63, enabling the pumping piston 58 to effect a full discharge of material into production chamber 14.

Before the motor piston 48 approaches the bottom of its stroke, abutment 52 thereof encounters head 47 of pilot valve 25. The first downward movement of said valve has no effect on the master valve 24, as above explained, but, as abutment 52 continues to pull on head 47, the upper end of plunger 36 moves below passage 42, thereby venting chamber 32 to the low pressure of production chamber 14. Since this vent acts to relieve the pressure on poppet 27 as supplied through passage 31, the constant pressure on poppet 26 is now the greater and moves the master valve 24 to its initial low position closing port 30. Residual high pressure in passage 31 and above piston 48 is vented by said passage 42. Since the two valves 24 and 25 and the pistons 48, 58 are in their lower most positions as at the start of the description of the operation, a full cycle has been completed and is ready to be repeated, as above described, as upward movement of the pistons is initiated by the constant high pressure on shoulder 59.

The modification shown in Fig. 5 provides a pump construction that has increased material-displacement capacity than in the above-described form. In this modification, the motor is the same or equal to the motor 13 of Fig. 1, while pump 15*a* and fill and discharge valving means 16*a* have been modified with respect to the respective means 15 and 16.

The pump 15*a* comprises a cylinder 75 that depends from a fitting 76 which constitutes a bottom closure for chamber 55. A pump piston 77 reciprocatively operates in cylinder 75 and is connected by a stem 78 to motor piston 48. The latter extends through fitting 76, packing 79 being provided to seal around said stem. Whereas the bottom face of piston 58 is the material-displacing face, the top face 80 of piston 77 serves this purpose in the modification. Thus, the constant pressure on piston shoulder 59 constitutes the force that discharges material from between piston 77 and fitting 76 into production chamber 14, the discharge being through ports 81 in cylinder 75. Accordingly, the diametral size of stem 78 is such as to provide for relatively large surface area of face 80.

Piston 77 carries a traveling check valve 82 that controls a bottom port 83 in said piston and flow between said port and ports 84 that open into cylinder 75. Whereas port 63 closed during up stroke of piston 58 and opened during down stroke, port 83 is closed during up stroke of piston 77 and open during down stroke to displace well production from beneath said piston to thereabove and outwardly through ports 81 into production chamber 14. In other respects, means 16*a* is similar to means 16 above described.

The form of the invention shown in Figs. 6 and 7 more nearly follows the form of Figs. 1 to 4 in that the motor 13, pump 15 and valving means 16 are similarly arranged, it being understood that said means 16, while omitted from Fig. 6, is the same or similar to the means shown in Fig. 1. The particular advantage of the alternative construction of Fig. 6 resides in the increased size or capacity of pump 15 or, conversely, in the reduced size of the outer tubing 10 with a pump 15 of the same capacity as the pump of Fig. 1.

In the alternative construction, inner tubing 11 carries a fitting 90 at its lower end and the same is provided with longitudinal passages 41*a* that replace the passage 41 of the earlier form. Tube 54 depends from fitting 90 to enclose annular passage 55, and a fitting 56*a* replaces fitting 56 of said earlier form. Instead of motor cylinder 49 being open at the bottom, the same carries a fitting 91 and holes 92 admit flow of pressure fluid from passage 55 to the annular shoulder 59 of motor piston 48. In this manner, constant fluid pressure is exerted on said shoulder 59.

Since the inner tubing 11 and tube 54 are approximately the same diametral size for the same size of outer tubing, the size of piston 48 in the alternative form may be larger than in the form of Fig. 1 where tube 54 is substantially smaller than inner tubing 11.

In order to limit the position of the inner tubing 11 and the parts depending therefrom in tubing 10, the fitting 56*a* has shoulder abutment on an internal flange 93 of a coupling 94 that connects outer tubing 10 to a lower extension 10*a* of similar size. Holes 95 in said flange 93 communicate passages 12 and 14 so that production displaced by pump piston 58 may enter production passage 12. Also, gas passing through holes 60 may find its way to the surface of the well.

Fittings 56*a* and 91 also have shoulder abutting engagement to limit the longitudinal position of the motor 13 and pump 15 relative to inner tubing 11 and the parts depending therefrom. Pump cylinder 57 extends downward from fitting 91, as before.

The internal diameter of fitting 90 slidingly receives motor body 23 and suitable seals in the form of O-rings 96 seal between said fitting and body. It will be noted that fitting 90 constitutes a separable part of body 23 and, together, the same serve as the motor body when assembled as shown. The vents 35 and 42 are connected to the production passage 12 by holes 97 in fitting 90. Since in other respects the construction is similar to the form of Fig. 1, the same reference numbers for similar parts have been applied to Figs. 6 and 7 as to Fig. 1.

The present alternative pump structure of Figs. 6 and 7 functions in the manner described above for Fig. 1, and the same need not be repeated.

While I have illustrated and described what I now contemplate to be the best modes of carrying out my invention, the constructions are, of course, subject to modification without departing from the spirit and scope of the invention. It is, therefore, not desired to restrict the invention to the particular forms of construction illustrated and described, but to cover all modifications that may fall within the scope of the appended claims.

Having thus described the invention, what I claim and desire to be secured by Letters Patent is:

1. In a pressure fluid-operated well pump comprising outer tubing and inner fluid-conducting tubing, a fluid-operated motor carried by the lower end of the inner tubing and comprising a body having passages to conduct fluid supplied by the inner tubing, an outer tube depending from the body, an inner tube depending from said body and constituting a motor cylinder, said tubes defining an annular chamber, one of said passages being in direct communication with said annular chamber, the inner tube being open at the bottom and in communication with said annular chamber, another of said passages communicating the inner fluid-conducting tubing and the upper end of said cylinder, a reciprocative master valve in the upper end of said body to control the latter passage, a pilot valve in the lower end of the body and provided with a downwardly directed extension provided with spaced abutments, a motor piston in said cylinder and having longitudinally spaced abutments alternately engaged with the abutments of said pilot valve to reciprocate the same, said piston having a downwardly-facing annular shoulder against which the fluid supplied through the first-mentioned passage constantly impinges to constitute a constant force urging said piston upwardly, the second-mentioned passage, when open, conducting pressure fluid to impinge the top of said piston to create a force larger than the force on the annular shoulder to urge said piston downwardly, passage means connected with the first-mentioned passage and controlled by the pilot valve to control flow of pressure fluid to the master valve to move the latter to a position opening the second-mentioned passage, and means to vent the pressure in the latter passage when the pilot valve is moved by the piston to close said passage means.

2. In a pressure fluid-operated well pump according to claim 1: said master valve comprising an upper poppet controlling said second-mentioned passage, a lower larger poppet subject to the pressure in the mentioned passage means, and a stem connecting the poppets and guided in said body, the larger poppet being disposed in a chamber receptive of pressure fluid from said passage means and in communication with the second passage to receive pressure fluid therefrom when open, the chamber being larger than the larger poppet therein.

3. In a pressure fluid-operated well pump according to claim 1: said master valve comprising an upper poppet controlling said second-mentioned passage, a lower larger poppet subject to the pressure in the mentioned passage means, and a stem connecting the poppets and guided in said body, the larger poppet being disposed in a chamber receptive of pressure fluid from said passage means and in communication with the second passage to receive pressure fluid therefrom when open, the chamber being larger than the larger poppet therein, a shoulder on the body above the larger poppet to engage the latter and limit the upward movement thereof, and a vent in the body to exhaust said chamber above said shoulder.

4. In a pressure fluid-operated well pump according to claim 1: said pilot valve comprising a plunger in a longitudinal bore in said body, and the mentioned passage means comprising a laterally-ported top-open pas-

sage in the upper end of said plunger and open to the master valve and a communicating passage extending from the first-mentioned passage.

5. In a pressure fluid-operated well pump according to claim 1: said pilot valve comprising a plunger in a longitudinal bore in said body, and the mentioned passage means comprising a laterally-ported top-open passage in the upper end of said plunger and open to the master valve and a communicating passage extending from the first-mentioned passage, said plunger being reciprocative by alternate moving engagement of the piston abutments with the head thereof, and friction means engaged with said plunger to hold the same in the positions to which moved by the piston.

6. A fluid motor comprising, in combination, a stationary cylindrical body member, an outer cylinder attached to said body, an inner cylinder attached to said body, said outer and inner cylinders being concentric to one another and said inner cylinder having an open end in respect to said outer cylinder, a piston movable within said inner cylinder, said piston having opposed pressure receiving areas, one of said areas being large in respect to the other area to provide a substantial pressure differential between said areas when fluid pressure is applied, a passage extending through said body member for conducting fluid to the annular area defined by said outer and inner concentric cylinders, a pilot valve in one end of said body member and interconnecting said body



member and said piston, a reciprocable poppet valve in the opposite end of said body member from said pilot valve, a second passage extending through said body member from said pilot valve to said poppet valve for conducting fluid therethrough, the flow of fluid through said passage being controlled by said pilot valve and causing said poppet valve to reciprocate, a third passage extending through said body member for conducting fluid therethrough to the larger of said opposed pressure receiving areas of said piston when said poppet valve is actuated, and a plurality of transverse passages in said body member to release the fluid pressure in the passages extending through said body member to permit subsequent cycles of operation of said fluid motor.

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