This invention relates to improvements in deep well pumps.

This application is a division of application Serial No. 316,128, filed January 29, 1940, and entitled “Hydraulic well pump,” now Patent No. 2,312,337, dated March 2, 1943.

One object of the invention is to provide a hydraulic pump having a plurality of completely separated hydraulic circuits.

Another object of the invention is to provide in a deep well pump a double stroke pumping cylinder, an operating circuit and automatic means for restoring liquid to said circuit at such times as may be necessary.

A further object of the invention is to provide in a pump a hydraulic operating system embracing a power system and an operating system.

Another object of the invention is to provide a hydraulically operated pump including an operating fluid under pressure, and means for controlling such pressure and automatically compensating for loss of any said fluid.

A still further object of the invention is to make it possible to position the operating head at a distance from the well.

A principal object of the invention is to provide in a hydraulically operated pump having a fluid actuated operating piston, in which the load on one side of the said piston is normally greater than on the opposite side thereof, means for carefully balancing at all times the said fluid pressure with the load and to by-pass the fluid at the end of the stroke.

With the above and such other objects in view, as may appear more fully hereinafter, the invention is illustrated in the accompanying drawings in which like reference numerals indicate like parts and in which:

Fig. 1 is a diagrammatic elevation illustrative of the invention.

Fig. 2 is a vertical section of a pump head.

Fig. 3 is a section of a pressure control pump.

Fig. 4 is a section thereof taken on line 4—4 of Fig. 3.

Fig. 5 is a bottom plan view of the pressure control pump.

Fig. 6 is an enlarged section taken on line 6—6 of Fig. 2.

Fig. 7 is a diagrammatic view of a pressure control system.

Fig. 8 is a longitudinal section of a pumping mechanism.

Fig. 9 is a diagrammatic view, showing the connection between the cylinder, shown in Fig. 8, and the oil pump shown in Fig. 2.

Figs. 10 to 14, inclusive, each are enlarged sections taken, respectively, on lines 10—10, 11—11, 12—12, 13—13 and 14—14 of Fig. 8.

Fig. 15 is a section taken on line 15—15 of Fig. 13.

Fig. 16 is an enlarged diagrammatic sectional detail of a motor cylinder.

Fig. 17 is a vertical section taken on line 17—17 of Fig. 3.

Fig. 18 is a vertical section taken on line 18—18 of Fig. 19, while Fig. 19 is a horizontal section taken on line 19—19 of Fig. 8.

In the several figures, 4 indicates a hydraulic deep well pump embodying the invention and including a pump head 2 upon which is mounted, or otherwise connected, a motor 3 for operating the crank 6 through gear 5, see Figs. 1, 2 and 9, or other suitable connection. Mounted on the housing 8 of the pump head is a pressure control and fluid replacement pump 1, see Figs. 2, 3, 7 and 17 having cylinders 8 and 9, see Figs. 3 and 17, connected at their lower ends by reduced bores 10 and 11 to bores 12 and 13.

Normally closing the lower ends of ports or bores 10 and 11 are ball valves 14 and 15, pressed by springs 16 and 17. Threaded into the lower ends of ports or bores 12 and 13 are tubes 18 and 19. The lower end of tube 18 is threaded into the three-way connection 20, see lower end of Fig. 2, and the lower end of tube 19 is threaded into the three-way connection 21 thereabove.

There is another bore 22 in the cylinder block 23, see Figs. 3, 4 and 17, to which is threaded the tube 24, the other end 25 of which is connected to the port 26 of bore 27 passing down through block 28, see Fig. 2, extending from the intermediate portion of the housing 8. The passage 27 extends vertically down to and enters the transverse passage 29 in said block 28, said latter passage connecting at its outer end with bore 30 in said block 28, and being connected through the port 31, controlled by the ball valve 32, to the relatively large bore 33 to which the three-way connection 21 is threaded at one inlet.

The ball 32 is pressed by spring 34, the tension of which is controlled by screw plug 35. The inner end of passage 29 opens into the oil sump 36 provided in the upper chamber 37 of housing 6, while the inner end of passage 33 enters the upper end 38 of a cylinder 39 in the pedestal 39 of said pump head 2, see Fig. 2, said cylinder being separated from chamber 37 by the wall 40.

The bore 22 enters a cross-bore 41, see Figs. 3 and 4, one end being connected with cylinder 8 aforesaid and the other end with the cylinder 9.
of said pump 7. Both ends of said bore 41 are controlled by spring pressed valve balls 42 and 43, see Fig. 4. A bore 44, see Fig. 2, connects member 20 with a passage 45, see Fig. 7, in block 23 with the sump 36, said passage being controlled by a spring pressed valve ball 46, see Fig. 7, the tension of which is adjusted through screw plug 47.

The end 48 of crank 4 extends beyond its bearing 49, see Fig. 2, to operate the pistons 50 and 51, see Figs. 2, 3 and 17, through its cams 50' and 51, which pistons are provided with heads 52 and 53, between which and the head of block 23 are provided springs 54 and 55 for raising of the pistons.

Operating in the crank 4 is the connecting rod 56, see Fig. 2, connected to a piston rod 61 by a crosshead 58. The rod 57 operates through a packing box 59 in the wall 40, and carries the piston 55 in cylinder 33, said piston separating the cylinder into two chambers 61 and 62 above and below the piston, respectively. As above indicated, the passage 33 enters at the top of the chamber 61 and the passage 62, at the bottom of the chamber 62, has one port of the three-way connection threaded thereto. As shown in Figs. 2 to 7, inclusive, the piston 55 in cylinder 33 draws liquid from reservoir 35 through 29, 27, 25, 24, etc., and discharges same under pressure by line 19 to end 62 of cylinder 33, excess flowing through bore 44 and escaping through adjustable pressure relief valve 46 to chamber 45 in free communication with reservoir 36 by line 29, see Fig. 7. This is a closed cycle for make-up liquid supply.

In like manner, piston 61 in cylinder 9 draws liquid from reservoir 36 through 29, 27, 25, 24, etc., and discharges same under pressure by line 19 to end 61 of cylinder 35, excess flowing through bore 31 and escaping through adjustable pressure relief valve 32 to chamber 34 in free communication with reservoir 36 as at 29, see Figs. 6 and 7. This is a second closed cycle for make-up liquid supply and these two liquid circuits normally are independent of each other, except for the common reservoir 35, the common suction line 29 and the common discharge line 28, see Fig. 6, for in this disengaged view the line 23 extends oppositely from the lower end of chamber 36 positioned between chambers 34 and 45 and at the outer ends is connected thereto, so the three chambers, 34, 45 and 36, see Fig. 7, are in free communication. The only communication between these systems is that shown at the make-up supply end and in Figs. 9 and 16 shown at the power piston cylinder and in Fig. 16, and otherwise referred to herein.

Threaded to one port of said three-way connection, member 20 is a pipe line 64 and threaded to one port of the connection 21 is a pipe line 66, both of which lines, see Figs. 9 and 16, extend down into a well and terminate in ports 66 and 67 in a cylinder 68. It is through the action of the fluid in the cylinder 68 that the water pumping piston 69 in cylinder 10, see Figs. 8 and 9, is actuated.

The tubing or water pipe line 71 is of a diameter sufficient to accommodate the cylinder 68, see Figs. 1 and 8, the pump cylinder 70, the surrounding operating fluid pipe lines and water passages to which reference will be had hereinafter. These elements when desired may be independent (external) with piping 71, if found desirable or necessary.

Operating in the cylinder 68 is the upper end 72 of a piston rod 73, said upper end carrying a piston 74, which separates said cylinder 68 into chambers 75 and 76 above and below, respectively, said piston. The lower end 77 of the pipe line 64 enters chamber 55 through the port 66, see Figs. 15, 16 and 18, and the lower end 78 of pipe line 65 enters the bottom of chamber 76 through port 67.

A by-pass 79 leads from the upper end of chamber 75 to pipe line 64 and is controlled by a spring pressed valve 80. Said by-pass is so located that it will come just below the bottom wall of piston 74, when in its uppermost position, and other by-pass 81 is provided in the lower part of said chamber 76 just above the upper wall of said piston 74 when in its lowestmost position. This by-pass leads to the pipe 65 and is controlled by a spring pressed ball valve 82.

A buffer spring 83 is fixed to the upper wall 84 of cylinder 68 and a similar spring 85 is attached to the bottom wall 86 of said cylinder in order to obviate any possibility of hammering of the piston in this cylinder. On the lower end 77 of the piston rod 73 is carried piston 69, see Fig. 9, and 10, of said water pumping cylinder 70 which has a reduced portion 86 on side of wall 88 of which is sealed a valve 89 normally covering passage 90 and on the opposite wall 91 of which is a screw plug 32 through which said valve may be seated.

In the lower end of the pipe line 71, just below the cylinder 70 is a valve case 93 carrying the removable core 94 which separates the case into the water inlet port 95 and chambers 96 and 97, and passage 98 by means of its suitably arranged center wall 99 and the valves 100 and 102. The said formation of wall 99 permits the use of much larger valves than otherwise could be used within the comparative diameter of casing 93. This particular subject matter is claimed in the copending application, now Patent No. 2,312,397, dated March 2, 1943.

Operation

Crank 4, see Fig. 5, operates piston 30 to drive oil down through pipe 64 to port 65 in cylinder 68 (chamber 75 being this time filled with oil). Piston 74, in said cylinder, being driven down, moves piston 69 in cylinder 70 which action drives water in chamber 71 through valve 102 into passage 98 in turn driving the water therein up through the water pipe line 71, to tank 1. The reverse action of oil piston 69 drives the oil from chamber 61 of cylinder 36 through pipe 65 into lower chamber 76 of cylinder 68, driving piston 74 up forcing the oil in chamber 75 back up through pipe 64 into cylinder 33. This action, of course, raises piston 69 in cylinder 10 drawing water in through port 95 and through valve 101 into chamber 97 and cylinder 70. The down movement of piston 69 drives water in chamber 97 through valve 102 into chamber 98 forcing the water therein through its passage continuation and out through connections 103 into pipe line 71. Chamber 96 connects with the upper end 104 of cylinder 70 through port 105 and exhausts into passage 99 through check valve 90 controlled port 90' as the piston 69 rises in cylinder 70. Chamber 95 is filled from water intake passage 95 through the check valve 100 controlled port when the piston 69 is moved downwardly in cylinder 70.

The water piston 69 is double acting for supplying water into the pressure water pipe line 71 for each direction of movement of piston 69. This piston is power operable by piston 74 to
which it is directly connected by rod 73. Piston 74 is operable in each direction by oil pressure applied thereto and derived from cylinder 33—61 when piston 60 is mechanically reciprocated therein.

Pumps of this general character heretofore tried out have failed to properly function due to the fact that no practical automatic means has heretofore been provided for maintaining the exact necessary fluid pressure in the oil system for operation piston 74 which operates piston 59, therefore as leakage or evaporation or other exhaustion is bound to occur in the system, the failure of the proper action of the pump results. The inventor has overcome this difficulty in his pump, through the automatic means for resupplying oil, or other operating fluid, as needed, and in maintaining the same at proper pressure through the following means: An extra supply of the operating fluid is provided in the oil sump 36, immediately above cylinder 33, see Fig. 2, through the port 29 of which the fluid may pass, either through ports 31, entering outlet 33, the bored passage 44 into passage 29, or the passage 27 into pipe 24, oil pump inlet 22, thence to the passage 41 from whence it may be drawn through valves 42 and 43 into cylinders 3 and 9, on the up stroke of pistons 59 and 51 operated by cams. On the down stroke of said pistons the oil in cylinders 3 and 9 is forced down through the valve controlled ports 19 and 11.

Through pipe lines 18 and 19, connections 20 and 21, pipe lines 84 and 85 and into the upper and lower chambers 75 and 76 of cylinder 66 through the ports 66 and 67, consecutively, thus aiding in driving piston 74, first up and then down, which, in turn operates water piston 69, through their common piston rod 73. The bypasses 78 and 81 controlled by valves 80 and 82, are provided to prevent the piston 74 from creeping at either end of the cylinder 66, and causing a hammer in the pumping operation. Springs 93 and 95 are used to further obviate striking of the pistons against the cylinder ends. It is obvious from what has been stated above, that through the above explained system the exact necessary fluid pressure for perfect operation is at all times maintained, and that the necessary quantity of fluid in the system is also automatically maintained at all times, no matter what the cause of loss therefrom, other than failure to keep a sufficient supply of oil in the sump 36.

Reference is had to Fig. 2 and attention directed to cams 50' and 51' (see also Figs. 3 and 17 for larger illustrations) and the chambers 38—52 in which is mounted piston 69 on rod 61. The position of these cams relative to the piston is such that retarding pressure fluid is forced into the lines during the respective power strokes of piston 69 and when the pressures upon the respective sides thereof are at or near their maximum.

It is also to be noted that while oil is mentioned as the pressure fluid, this is not restrictive, for any suitable relatively incompressible fluid may be used instead of oil.

While the invention has been illustrated and described in great detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character.

The several modifications described herein, as well as others which will readily suggest themselves to persons skilled in this art, all are considered to be within the broad scope of the invention, reference being had to the appended claims.

I claim:

1. In a hydraulically operable system having a working unit including a pressure operable piston and a cylinder therefor, said pressure operable piston being of floating type and a power supplying pressure unit including a cylinder and a piston therein, both pistons being double acting, a power operable rod for actuating the last mentioned piston, a power transmitting rod connected to the first piston, means for maintaining the synchronous movement of said pistons, a conduit connecting the rod end of the second cylinder to the rod end of the first cylinder, and another conduit independent of the first conduit and connecting the opposite rodless end of the second cylinder to the opposite rodless end of the first cylinder, each rod being slidably supported by the first mentioned rod ends of the cylinders, and for balanced operation of the system, the combination of a pressure liquid make-up supply conduit for each of the conduits near one end thereof, said make-up conduits having no direct communication with each other, a single make-up reservoir, dual pump means connected to the reservoir and to each of the make-up conduits, an interdependent adjustable pressure relief valve to maintain the pressure relationship of pressure to load on the rod end of both cylinders, and an interdependent adjustable pressure relief valve to maintain the proper relationship of pressure to load on the rodless end of said cylinders, said dual pump means combined with both relief valves and including their mutual interdependence comprising the means for maintaining the floating piston in synchronous movement with the piston of the power supplying unit.

2. In a hydraulically operable system having a working unit including a pressure operable piston and a cylinder therefor, said pressure operable piston being of floating type, and a power supplying pressure unit including a cylinder and a piston therein, both pistons being double acting, a power operable rod for actuating the last mentioned piston, a power transmitting rod connected to the first piston, means for maintaining the synchronous movement of said pistons, a conduit connecting the rod end of the second cylinder to the rod end of the first cylinder, and another conduit independent of the first conduit and connecting the opposite rodless end of the second cylinder to the opposite rodless end of the first cylinder, each rod being slidably supported by the first mentioned rod ends of the cylinders, and for balanced operation of the system, the combination of a pressure liquid make-up supply conduit for each of the conduits near one end thereof, said make-up conduits having no direct communication with each other, a single make-up reservoir, dual pump means connected to the reservoir and to each of the make-up conduits, interdependent adjustable pressure relief valves controlling the discharges from the pump means to said reservoir for establishing the interrelated pressure to load equilibrium required for maintaining the synchronous movement of the first mentioned pistons.

3. In a hydraulically operable system having a working unit including a pressure operable piston and a cylinder therefor, said pressure opera-
ble piston being of floating type, and a power supplying pressure unit including a cylinder and a piston therein, both pistons being double acting, a power operable rod for actuating the last mentioned piston, a power transmitting rod connected to the first piston, means for maintaining the synchronous movement of said pistons, a conduit connecting the rod end of the second cylinder to the rod end of the first cylinder, and another conduit independent of the first conduit and connecting the opposite rodless end of the second cylinder to the opposite rodless end of the first cylinder, each rod being slidable supported by the first mentioned rod ends of the cylinders, and for balanced operation of the system, the combination of a pressure liquid make-up supply conduit for each of the conduits near one end thereof, said make-up conduits having no direct communication with each other, a single make-up reservoir, dual pump means connected to the reservoir and to each of the make-up conduits, said power transmitting rod and connected piston having timed relation operation with said pump means for synchronizing pressure applied to the liquid in the two first mentioned conduits, said dual pump means and power transmitting rod and piston simultaneously applying pressure to one of the two first mentioned conduits at a time, interdependent adjustable pressure relief valves controlling discharges from the make-up conduits to said reservoir, said means for the synchronized application of pressure by the pressure supply piston and the dual pump means combining with both adjustable pressure relief valves and their mutual interdependence comprising the means for maintaining the synchronous movement of said first mentioned pistons.

4. In a hydraulically operable system having a working unit including a pressure operable piston and a cylinder therefor, said pressure operable piston being of floating type, and a power supplying pressure unit including a cylinder and a piston therein, both pistons being double acting, a power operable rod for actuating the last mentioned piston, a power transmitting rod connected to the first piston, a conduit connecting the rod end of the second cylinder to the rod end of the first cylinder, and another conduit independent of the first conduit and connecting the opposite rodless end of the second cylinder to the opposite rodless end of the first cylinder, each rod being slidable supported by the first mentioned rod ends of the cylinders, and for balanced operation of the system, the combination of a pressure liquid make-up supply conduit for each of the conduits near one end thereof, said make-up conduits having no direct communication with each other, a single make-up reservoir, dual pump means connected to the reservoir, each half of the pump means connecting independently to a make-up conduit, and interdependent adjustable pressure relief valves, each controlling a discharge to said reservoir for venting excess make-up liquid therefrom, and means actuating said dual pump means in timed relation with said second piston for make-up supply to and in communication with associated independent conduit connecting the cylinders only when subject to said piston pressure.

5. In a pumping system having a pressure liquid supplying unit including a cylinder and a piston therein, a working unit including a cylinder and a piston therein, said pressure operable piston being of floating type, a power transmitting rod connected to the last mentioned piston, means for normally maintaining the synchronous movement of said pistons, and normally independent conduit means connecting corresponding ends of said cylinders, and means for restoring the synchronism of the aforesaid pistons, the combination of a bypass means for each independent conduit means, said conduit means having intercommunication only when either of said bypass means is operating, a liquid reservoir positioned above the first cylinder, a piston rod extending from the first cylinder and through the reservoir, power means above the reservoir for reciprocating the piston rod therein, said reservoir included piston rod alternately applying pressure to the working liquid in the independent conduit means, dual make-up pump means operable synchronously with the power means and arranged to withdraw liquid from the reservoir and independently and in timed relationship with the reservoir included piston rod to discharge the reservoir withdrawn make-up liquid to said independent conduit means, the reservoir included piston rod and the corresponding part of the dual pump means applying pressure simultaneously to the liquid in one of the independent conduit means at a time, and interdependent adjustable pressure relief valves controlling the venting of surplus make-up liquid from the independent conduit means, said means, for the synchronized application of pressure by the first mentioned piston and the dual pump means being combined with both adjustable pressure relief valves and including their mutual interdependence operating in conjunction with said by-pass means, comprising the means for maintaining the synchronous movement of said first mentioned pistons and for restoring their synchronism when necessary.

6. In a pumping system having a pressure liquid supplying unit including a cylinder and a piston therein, a rod for the pressure supply piston, power means for operating said piston and pivotally connected to the remote end of that rod, a working unit including a cylinder and a piston therein, said pressure operable piston being of floating type, a power transmitting rod connected to the last mentioned piston, means for normally maintaining the synchronous movement of the said pistons, and normally independent conduits connecting corresponding rod ends and rodless ends of said cylinders, the combination of a bypass system for restoring the synchronization of said pistons, said conduits having intercommunication only when said bypass system is operating, said pressure supplying system alternately applying pressure to the liquid in the conduits, a reservoir for make-up liquid, dual make-up pump means connected to the reservoir and operable synchronously with the power means for reservoir liquid withdrawal and independently and in timed relationship with the power operable piston to discharge the withdrawn liquid to the independent conduits, the power operable piston and the corresponding part of the dual pump means applying pressure simultaneously to the liquid in one of the conduits at the same time, and interdependent piston pressure relief valves to control the independent venting of surplus make-up liquid from the independent conduits, said bypass system combined with means for the synchronized application of pressure by the power transmitting piston and the dual pump means
operating in conjunction with both adjustable pressure relief valves and including their mutual interdependence comprising the means for maintaining the synchronous movement of the first mentioned pistons and for restoring their synchronism when necessary.

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