May 9, 1939. J. P. JACKSON 2,157,704

DEEP WELL PUMP

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Fig. 1.

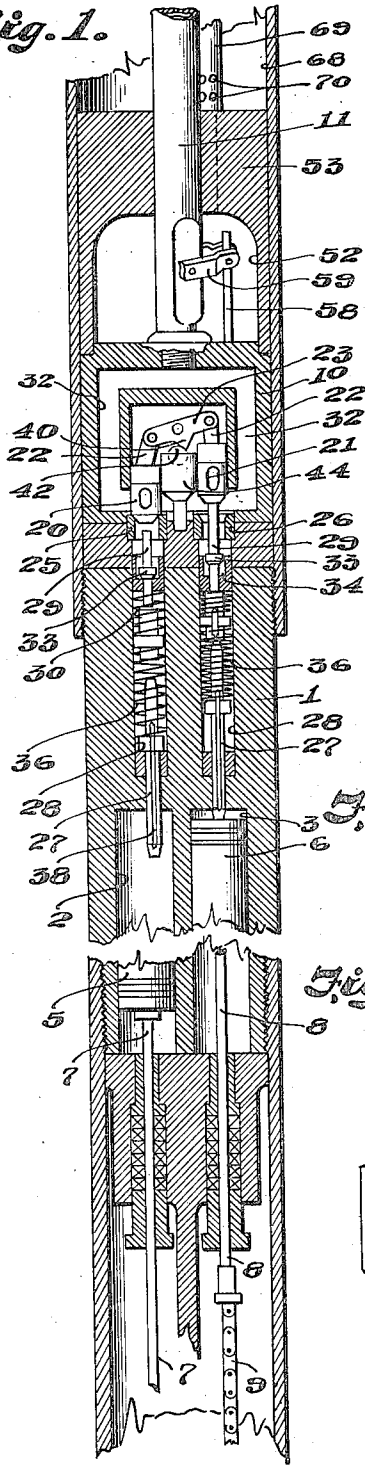


Fig. 2.

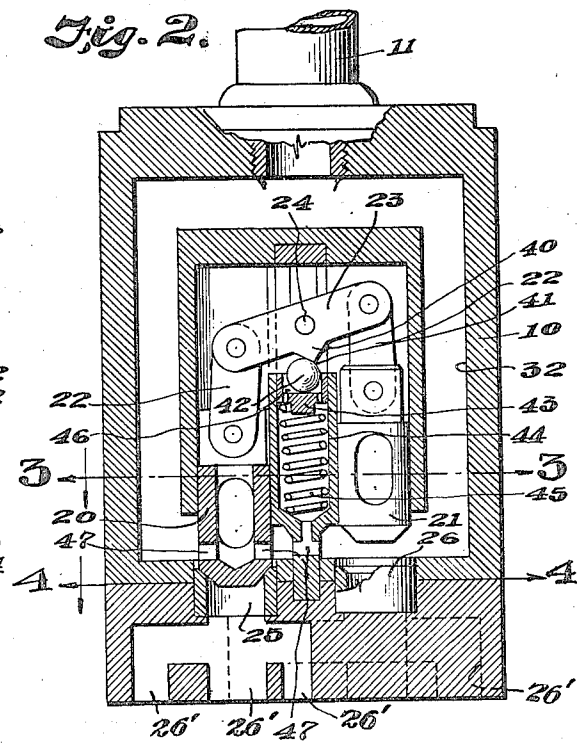


Fig. 6.



Fig. 3.

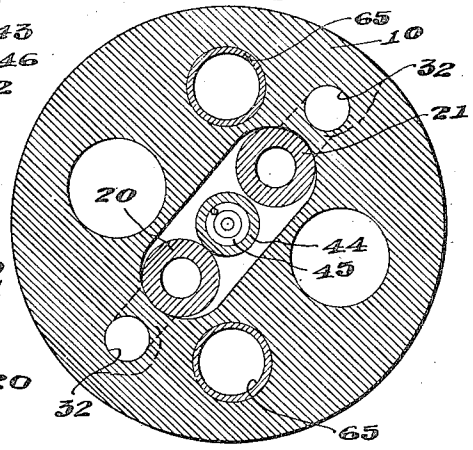
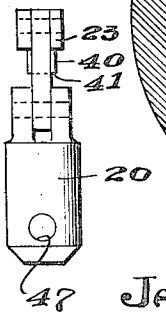


Fig. 5.



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Fig. 17.

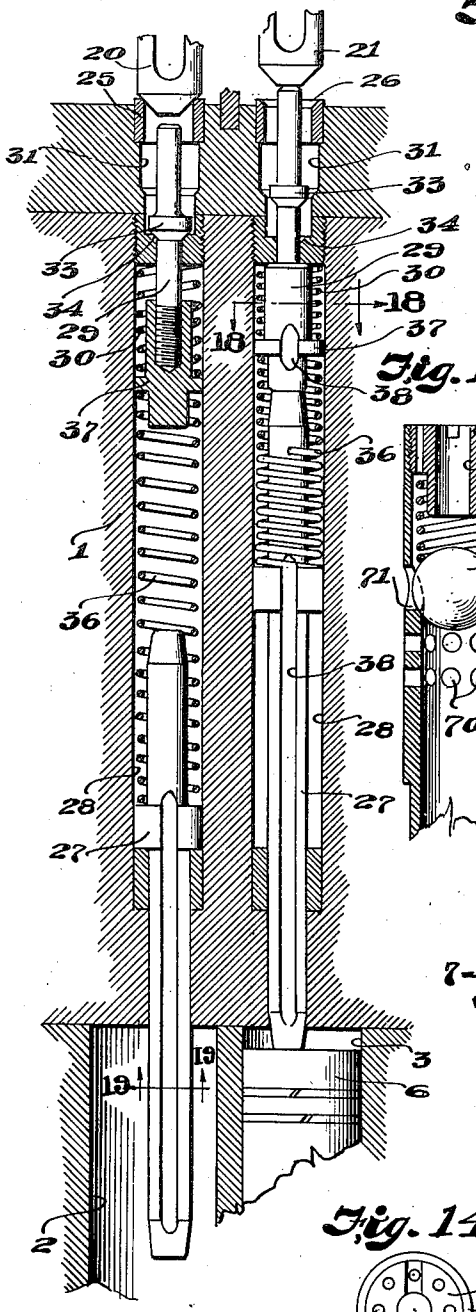


Fig. 4.

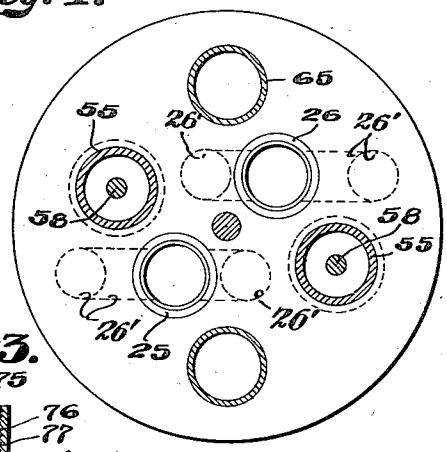


Fig. 13.

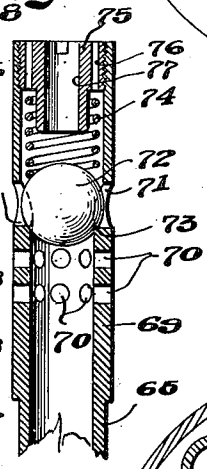


Fig. 18.

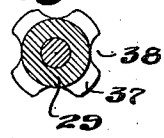


Fig. 19.

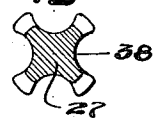


Fig. 8.

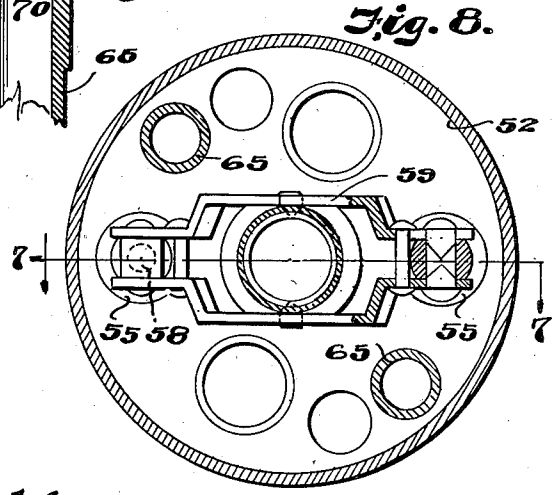
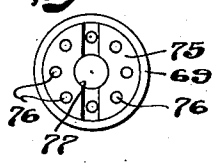


Fig. 14.



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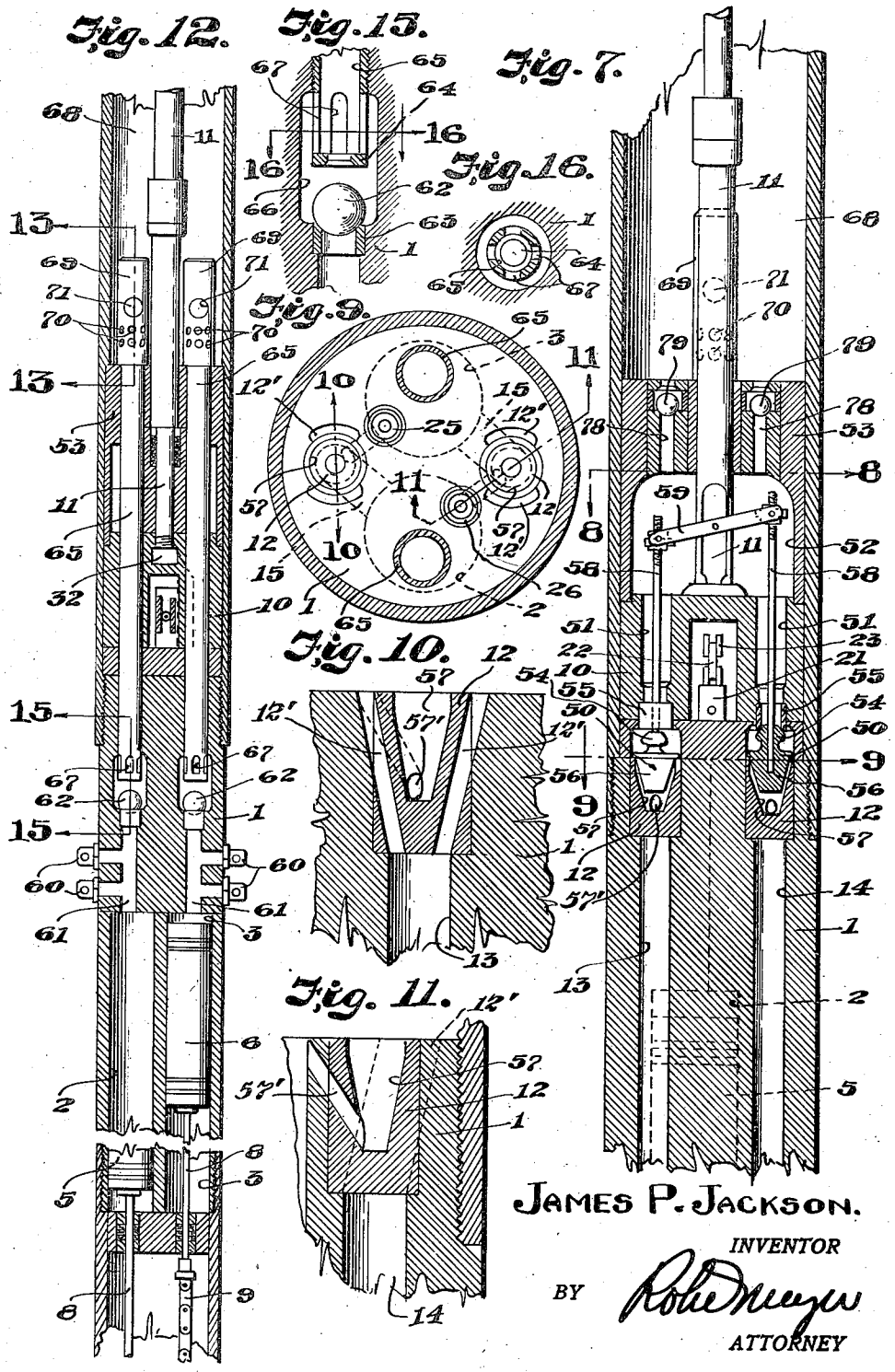
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DEEP WELL PUMP

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UNITED STATES PATENT OFFICE

2,157,704

DEEP WELL PUMP

James Phillip Jackson, Oklahoma City, Okla.

Application October 9, 1935, Serial No. 44,192

12 Claims. (Cl. 121—134)

This invention relates to deep well pumps, and more particularly to improvements in deep well pumps actuated by fluid under pressure from a remote point, wherein such fluid serves as an actuating medium for the pump pistons and also mingles with the out-flowing liquid for the purpose of adding impetus to its flow.

The present invention is an improvement over the deep well pump shown in my companion United States Letters Patent Number 2,049,957 of August 14, 1936.

An object of the present invention is to provide a deep well pump of the type referred to, a novel valve structure and its operating mechanism for controlling the flow of the high-pressure motivating fluid, which valve structure is so constructed as to make it impossible for the valve or valves to stop in a neutral position and also insures positive seating of the valve or valves at all times when seating movement has been started.

The present invention of a deep well pump embodies a pair or plurality of pistons which serve both as power and pumping pistons and are operated in their power stroke by high pressure fluid from a remote source, which fluid exhaust from the cylinders of the pump into the flow of liquid being discharged from the pump, where, mingling with the liquid, it serves to add impetus to the flow of the liquid and facilitate its discharge from the well in which the pump is used.

Another object of the invention is to provide a novel structure for operating the high pressure fluid control valves which includes means mechanically acted upon by the pistons and which means is so constructed that seizure thereof due to foreign matter, such as sand, interfering with the operation is eliminated, and should the normal mode of operation be suspended for any reason whatsoever, the said means will still operate to insure throwing of the pressure fluid control valves.

Still further objects of the present invention are; to provide means for preventing the leakage of high-pressure motivating fluid into the cylinders on the pumping sides of the pistons; to provide a novel and positive acting valve mechanism for controlling the exhaust of the high-pressure motivating fluid from the pump cylinders, and to provide a simple positive acting mechanism to prevent the reverse flow of pump fluid into the cylinders of the pump during the suction strokes thereof.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts which will be first described in connection with the accompanying drawings, showing a valve of the preferred form embodying the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 is a longitudinal section through the improved deep well pump having parts thereof broken away.

Figure 2 is an enlarged longitudinal section through the valve structure for controlling the motivating fluid.

Figure 3 is a cross section taken on the line 3—3 of Figure 2.

Figure 4 is a cross section taken on the line 4—4 of Figure 2.

Figure 5 is a detail side elevation of one of the valves which control the motivating fluid.

Figure 6 is a detail view in plan of a part of the high-pressure motivating fluid control valve.

Figure 7 is a fragmentary longitudinal section through the improved pump taken on the line 7—7 of Figure 8.

Figure 8 is a horizontal section through the improved pump taken on the line 8—8 of Figure 7.

Figure 9 is a cross section taken on the line 9—9 of Figure 7 and having the exhaust control valves removed.

Figure 10 is a detail section taken on the line 10—10 of Figure 9.

Figure 11 is a detail section taken on the line 11—11 of Figure 9.

Figure 12 is a longitudinal section through the pump taken at right angles to the longitudinal section shown in Figure 1.

Figure 13 is an enlarged longitudinal section through one of the discharge control outlets of the fluid pump, and taken on the line 13—13 of Figure 12.

Figure 14 is a top plan of the discharge control outlet.

Figure 15 is a detail section taken on the line 15—15 of Figure 12.

Figure 16 is a cross section taken on the line 16—16 of Figure 15.

Figure 17 is an enlarged section taken on the same plane as the section of Figure 1 and illustrating in detail the piston operated mechanism for operating the motivating fluid control valves.

Figure 18 is a detail section taken on the line 18—18 of Figure 17.

Figure 19 is a detail section taken on the line 19—19 of Figure 17.

Referring more particularly to the drawings, the deep well pump which embodies the present invention comprises a cylinder block 1 having cylinders 2 and 3 bored therein. Pistons 5 and 6 reciprocate in the cylinders 2 and 3 and serve the dual functions of power pistons and pumping pistons. The pistons 5 and 6 are connected at their lower ends through the medium of piston rods 7 and 8 and a flexible member 9 such as a chain or the like so that when one of the pistons moves upwardly in liquid pumping stroke under impetus of the motivating pressure fluid the other piston must move downwardly.

The pistons 5 and 6 are operated by any suitable fluid under pressure, such as gas, air or the like, which is compressed by any approved type of compressor (not shown) and delivered to the valve housing 10 through the high-pressure fluid supply pipe 11.

A novel type of valve mechanism is provided which controls the distribution of the motivating pressure fluid to the cylinders 2 and 3 and the motivating fluid after passing the valve structure passes through the distributing block 12 and to the passages 13 and 14, leaving these passages, at their lower ends and passing through the connecting passages or ducts 15 (see Figure 9) into the lower ends of the cylinders 2 and 3 where it acts upon the pistons 5 and 6 for operating these pistons.

In deep well pumps of this type where one of the pistons is moving in a pumping suction motion and a motivating fluid exhausing motion or direction while the other piston is moving in a liquid discharging movement under action of the motivating fluid, it is very necessary that the leakage of any pressure fluid into the cylinder in which the piston is moving in its suction motion is prevented.

The improved valve structure is particularly designed to prevent such leakage and to insure the proper distribution of the motivating fluid at all times.

The valve housing 10 has a pair of cylindrical reciprocating valves 20 and 21 mounted therein which are connected by means of links 22 to the opposite ends of a pivoted lever 23. The lever 23 is suitably supported for pivotal movement in the housing 10, as by the pivot pin 24. The connecting of the valves 20 and 21 to the pivoted or rocking lever 23 insures simultaneous movement of the two valves so that when one valve is moving into its open or unseated position, the other valve is moved into its closed or seated position. The lower ends of the valves 20 and 21 seat on suitable valve seats 25 and 26 respectively.

The valves are moved into open position by the pistons 5 and 6 through the medium of a novel valve operating structure specifically shown in Figures 17 to 19 inclusive of the drawings. The valve operating structures include plungers 27 which are slidable in suitable bores 28 formed in the cylinder block 1. The lower ends of the plungers 27 project into the cylinders 2 and 3 as clearly shown in Figures 1 and 17 so that when the respective piston nears the upper end or terminus of its stroke, it will engage the lower end of the respective plungers 27 and move this plunger upwardly in the bore 28. For instance in Figures 1 and 17 of the drawings, the piston 6 is illustrated at the upper limit of its movement, at which time the plunger 27 actuated by the piston 6 is also moved upwardly to the limit of its upper movement. During the upper movement of the plunger 27, its upper end engages the lower end of the relatively short valve operating plunger 29 forcing this plunger upwardly against the compression of the spring 30. During its upward movement, the valve engaging and operating plunger 29 engages the bottom of the valve 21 and moves it upwardly off its seat 26 thereby opening the chamber 31 to admission of high-pressure motivating fluid through the passage 32 formed in the valve casing or housing 10. A secondary valve 33 is formed on each of the valve actuating plungers 29 intermediate its ends and these secondary valves 33 engage seats 34 carried by the cylinder block 1 at its upper end so as to prevent leakage of high-pressure motivating fluid past the plunger 29 and through the bore 28 into the cylinder when the piston therein is moving in a downward or suction stroke.

Springs 36 engage the plungers 27 and the flanges 37 on the plungers 29 for urging the plungers 27 downwardly away from the flanges 37 and into the respective cylinders, while the plungers 29 are moved out of valve actuating position by the springs 30. By particular reference to Figures 1 and 17 it will be noted that the plungers 27 are relatively long and also that they travel through a greater scope of movement than do the plungers 29. The latter plungers travel only a short distance, to lift the valves 20 or 21 only sufficient distance off their seats. Also it will be noted that the plungers 27 and 29 are of such length that they will at all times operate their respective valve 20 or 21, by actual physical contact if the springs 36 either break or do not have sufficient tension to exert the quick upward valve operating position or movement to the plungers 29.

The plungers 27 and the flanges 37 of the plungers 29 are fluted as shown at 38 so as to permit the leakage of any liquid pumped to run from the bores 28 back into the respective cylinders. These flutes which form open passageways back into the cylinders are necessary and desirable because the fluid pumped often contains sand or other foreign material which would have a tendency to cause seizure of the plungers if no provision were made to permit it to flow freely back into the cylinders.

The valve mechanism which controls the delivery of the motivating fluid to the cylinders also embodies means for preventing the stopping of the valves 20 and 21 is a neutral position and to insure their continued movement into seated or unseated positions once such movement has been started by the plungers 29. To provide for this insurance of proper positioning of the valves the rocking lever 23 has projection 40 formed thereon which terminates in a knife edge 41. The knife edge 41 engages a ball 42 which is carried by a yieldably mounted seat 43. The seat 43 is slidably mounted in a suitable carrying housing 44 and it is urged upwardly to maintain the ball in engagement with the projection 40 by a spring 45.

By particular reference to Figure 2 of the drawings it will be noted that the bore 46 of the seat 43 has a greater radius than the radius of the ball 42 and also that the ball 42 rests on a flat surface on the seat thereby rendering the ball unstable and preventing stoppage of the rocking lever 23 at any point between the terminals of its scope of movement. The ball 43 also engages the flat angular edges of the projection 40 after the lever has reached the terminal of its movement

and steadies the lever and prevents hunting movement or jiggling of the valves.

The valves 20 and 21 and the carrying member 44 have suitable drain openings 47 cut therein to permit drainage of any of the liquid pumped from out of the valves or the valve casing 10 in case such liquid should leak into the valve casing.

When one of the pistons is moving upwardly under action of the motivating fluid and pumping liquid out of the well the other piston is moving in the opposite direction and sucking liquid from the well into the pump and discharging the used motivating fluid from the lower end of its cylinder upwardly through its passage 13 or 14, and the respective distributing block 12 past the exhaust control valves 50, through the passages 51 and into the chamber 52 formed in the insert 53.

The exhaust valve structures each have upper valve cone sections 54 which act on the valve seats 55 and the lower conical sections 56 which project into the conical recesses 57 in the distributing blocks 12. The exhaust valves 50 are connected by suitable rods 58 to a rocking arm 59 so as to insure simultaneous movement of the exhaust valves when the valve 21 is in open position, as shown in Figures 1 and 2 of the drawings, the motivating fluid entering the valve housing 10 from the pipe 11 will pass through the passages 26' (Fig. 2) and downwardly through the passages 12' (Fig. 10) in the distributing block 12, into and through the passages 14 and 15 and against the piston 6 for actuating it. At the same time the motivating fluid entering the chamber 57 through the passage 57' will set the exhaust valve 56. As the piston 6 is moved under power of the motivating fluid it will move the piston 5 due to the connection between the pistons. Also as the exhaust valve 56 is closed it will, through the lever connection 59, open the exhaust valve 55 permitting the exhaust of motivating fluid from the cylinder 2. The exhausting motivating fluid will pass through the passages 12' into the space 57 and thence through the passage 51 into the chamber 52. From the chamber 52 the exhausting gas or fluid will pass through the check valve 79 into the pump casing passage 68, where it will mingle with the oil being pumped and activating the oil to facilitate its discharge from the well.

When the pistons are moving downwardly in suction stroke (see Figure 12) the liquid to be pumped is drawn through suitable check valves 60 into the passages 61 and from these passages into the cylinders. When the pistons move upwardly under action of the motivating fluid the force of the discharging liquid which has previously been drawn into the cylinder will actuate the check valves 60 to prevent discharge of the liquid therethrough, and it will unseat the ball valves 62, moving them off their seats 63 and against the seats 64 formed on the lower or inlet ends of the initial discharge pipes 65. The fluid being pumped or discharged passes into the space 66 which is formed in the cylinder block and from there through the various openings 67 in the inlet ends of the initial discharge pipes 65. The initial discharge pipes 65 extend upwardly into the final discharge pipe 68 of the pump structure through which the liquid pumped passes to its final discharge in the surface of the ground in which the well that is being pumped is drilled. The initial discharge pipes 65 have distributors 69 formed upon their upper ends which project upwardly into the final discharge pipe 68 beyond the upper end of the insert 53. The distributors 69 have a plurality of radially spaced relatively small openings 70 formed therein which discharge the liquid being pumped into the final discharge pipe 68 in relatively small streams, substantially at right angles to the normal flow of the liquid in the final discharge pipe. The distributors 69 also have a plurality of larger emergency openings 71 drilled therein above the normal outlet openings 70. The passage of the discharging liquid through the emergency openings 70 is normally prevented by a ball valve 72 which is held on its seat 73 by a spring 74. The tension of the spring 74 is regulated by adjustment of the adjustable tensioning plug 75 in the upper end of the distributor 69. Should the openings 70 become clogged so as to prevent the normal discharge of the pumped liquid the building up of pressure in the initial discharge pipes 65 below the ball valves 72 would, when such built up pressure reached or exceeded a predetermined degree, unseat the ball valves 72 and permit the liquid to be discharged through the larger emergency outlets 71.

The spring tensioning plug 75 has a plurality of drain openings 76 therein to permit drainage through or past the plug of any liquid which might settle thereon and it is also provided with a relatively large central ball 77 for the same purpose and also to permit the outlet into the final discharge pipe 68 of any of the pumped liquid which might not pass out through emergency openings 71 and which might leak past the ball 72.

In the present pump the exhausting motivating fluid is delivered into the final discharge pipe 68 where it mingles with the discharging liquid and it still being under pressure will add impetus to the flow of the discharging liquid and consequently enhance the pumping action of the pump. The exhausting motivating fluid passes from the chamber 52 through the passages 78 through the valve structures 79 and into the final discharge pipe below the level of the openings 70 through which the liquid enters the final discharge pipe. The valve structures 79 may be of any suitable type of check valve so as to prevent pumped liquid from passing downwardly into the chamber 52 and thence downwardly into the remaining parts of the pump. As clearly shown in Figure 7 of the drawings the exhausting motivating fluid enters the final discharge pipe 68 parallel to the axis of the discharge pipe and in the same direction as the normal flow liquid through the final discharge pipe. It will therefore be noted that the pumped liquid enters the final discharge pipe 68 in small streams flowing transversely to the line of flow of the exhausting motivating fluid. Such action results in a more intimate mixture of the motivating fluid and the liquid being pumped, resulting in a smoother delivery or discharge action of the pump and also permitting the utilization of the maximum effect of the lifting of the exhausting motivating fluid for carrying the liquid upwardly and out of the discharge pipe 68. The improved pump is particularly designed for use in pumping deep petroleum wells and the motivating fluid in most of such instances is the gas which forms in the well so that there is no disadvantage, and, in fact, there are advantages to be derived by the intimate mixing of the liquid being pumped with the exhausting motivating fluid.

While in the foregoing description and in the accompanying drawings the various features

forming the present invention such as the valve mechanism for controlling the delivery of the motivating fluid, the plunger structures for operating such valves and the method or manner of discharging the pump liquid into the final discharge pipe have been illustrated and described in connection with a particular type of deep well pump, it is to be understood that the inventive and novel features of these various structures may be employed with any suitable mechanism or any other type of deep well pump where applicable, without departing from the spirit of the present invention. It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention as defined by the claims.

What is claimed is:

1. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, plungers actuated by said pistons for operating said valves, said plungers having flutes cut therein to permit flow of liquid along the plungers.

2. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means actuated by said pistons for operating said valves, said means including plungers engaged by said pistons, valve engaging plungers adapted to be moved in valve operating movement by contact with said piston engaged plungers, and means normally urging said piston engaged plungers out of contact with said valve engaging plungers.

3. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means actuated by said pistons for operating said valves, said means including plungers engaged by said pistons, valve engaging plungers adapted to be moved in valve operating movement by contact with said piston engaged plungers, said piston operated plungers having a relatively long stroke, said valve engaging plungers having a relatively short stroke.

4. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means actuated by said pistons for operating said valves, said means including plungers engaged by said pistons, valve engaging plungers adapted to be moved in valve operating movement by contact with said piston engaged plungers, said piston operated plungers having a relatively long stroke, said valve engaging plungers having a relatively short stroke, and means normally urging said piston engaged plungers out of contact with said valve engaging plungers.

5. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means actuated by said pistons for operating said valves, said means including plungers engaged by said pistons, valve engaging plungers adapted to be moved in valve operating movement by contact with said piston engaged plungers, said piston operated plungers having a relatively long stroke, said valve engaging plungers having a relatively short stroke.

6. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means actuated by said pistons for operating said valves, said means including plungers engaged by said pistons, valve engaging plungers adapted to be moved in valve operating movement by contact with said piston engaged plungers, said piston operated plungers having a relatively long stroke, said valve engaging plungers having a relatively short stroke, said plungers having flutes connected longitudinally therein.

7. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means for operating said valves, and means for preventing said valves from stopping in a neutral position, valves controlling the exhaust of motivating fluid from said cylinders, and means whereby the operating of said motivating fluid supply control valves will operate said exhaust control valves.

8. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means for operating said valves, means for preventing said valves from stopping in a neutral position, valves controlling the exhaust of motivating fluid from said cylinders, means whereby the operating of said motivating fluid supply control valves will operate said exhaust control valves, and a pivoted lever connecting said exhaust control valves whereby the closing of one exhaust valve will open the other exhaust valve.

9. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means for operating said valves, means for preventing said valves from stopping in a neutral position, valves controlling the exhaust of motivating fluid from cylinders, means whereby the operating of said motivating fluid supply control valves will operate said exhaust control valves, said exhaust valves having opposed valve surfaces formed thereon, and valve seats cooperating with said opposed surfaces whereby said exhaust valves will prevent the leakage of pressure motivating fluid into the cylinders during the exhausting stroke thereof.

10. In a deep well pumping motor, a pair of

adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means actuated by said pistons for operating said valves, said means including plungers engaged by said pistons, valve engaging plungers adapted to be moved in valve operating movement by contact with said piston engaged plunger, means normally urging said piston engaged plungers out of contact with said valve engaging plungers, and means for preventing stopping movement of said valves when in a neutral position.

11. In a deep well pumping motor, a pair of adjacent cylinders, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means actuated by said pistons for operating said valves, said means including plungers engaged by said pistons, valve engaging plungers adapted to be moved in valve operating movement by contact with said piston engaged plunger, means normally urging said piston engaged plungers out of contact with said valve engaging plungers, and means for preventing stopping movement of said valves when in a neutral position, a valve housing for said valves, said valves provided with drain openings to prevent accumulation of liquid in the valves and valve housing.

12. In a deep well pumping motor, a housing, a pair of adjacent cylinders in said housing, a piston in each of said cylinders, means connecting said pistons for simultaneous movement, means for supplying motivating fluid to said cylinders at one end of said pistons, valves for controlling the supply of motivating fluid to said cylinders, means for connecting said valves for simultaneous movement in opposite directions, means for actuating said valves, said valve actuating means normally out of contact with said valves and moved into valve contacting and actuating movement under action of said pistons, valves controlling the exhaust of motivating fluid from said cylinders, means whereby the operating of said motivating fluid supply control valves will cause operation of said exhaust control valves, said exhaust control valves having opposed valve surfaces thereon, and valve seats cooperating with said opposed surfaces whereby said exhaust valves will prevent the leakage of pressure motivating fluid into the cylinders during the exhausting stroke of the pistons.

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