May 25, 1937. C. J. COBERLY 2,081,220

LIQUID OPERATED PUMP

Filed July 18, 1932 4 Sheets-Sheet 1

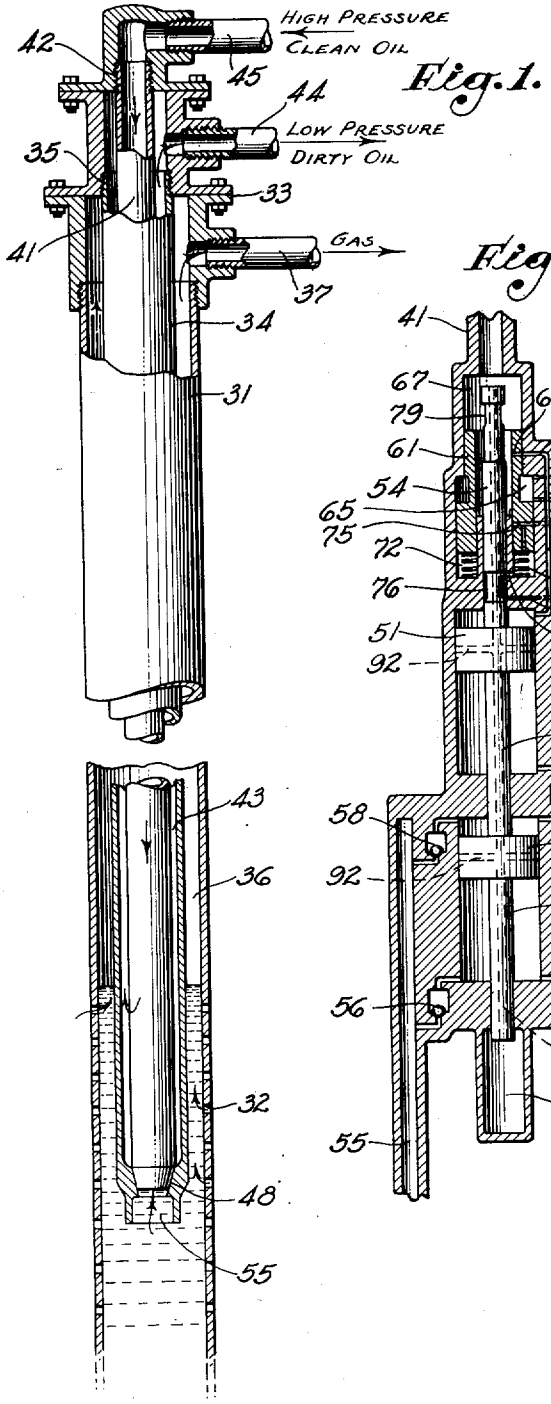



Fig. 1.




Fig. 2.

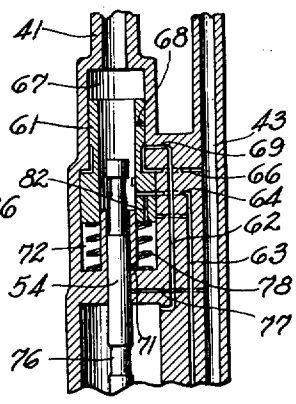



Fig. 3.

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May 25, 1937. C. J. COBERLY 2,081,220

LIQUID OPERATED PUMP

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Fig. 4.

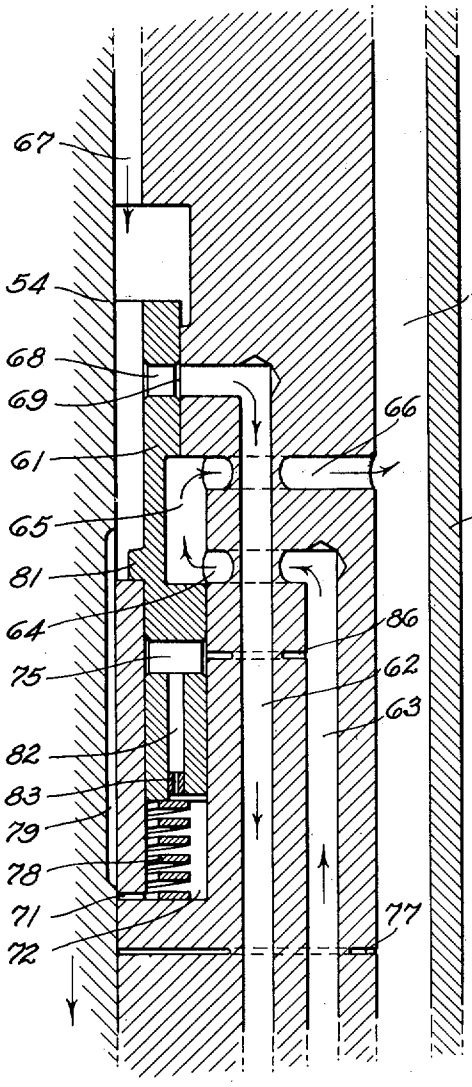
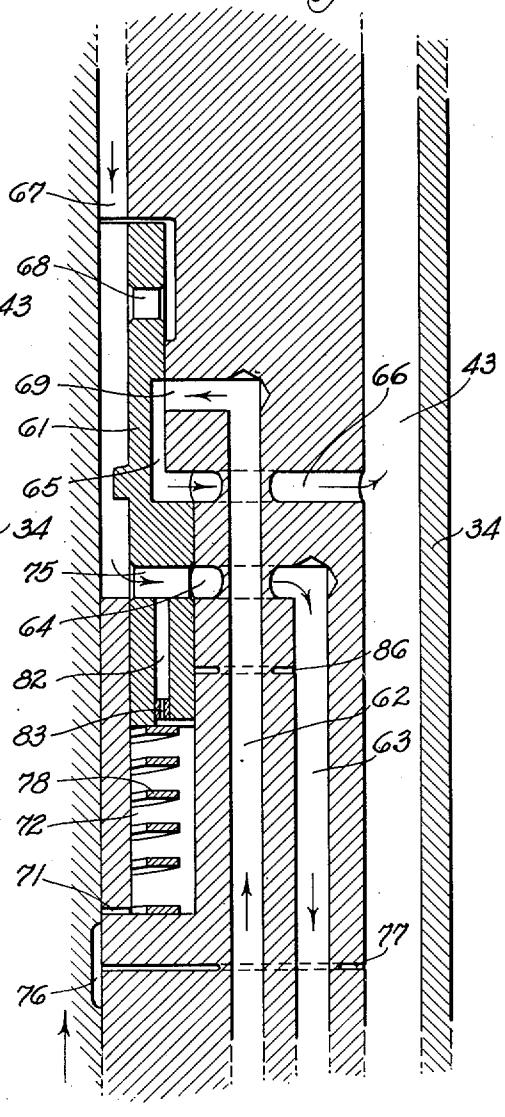



Fig. 5.

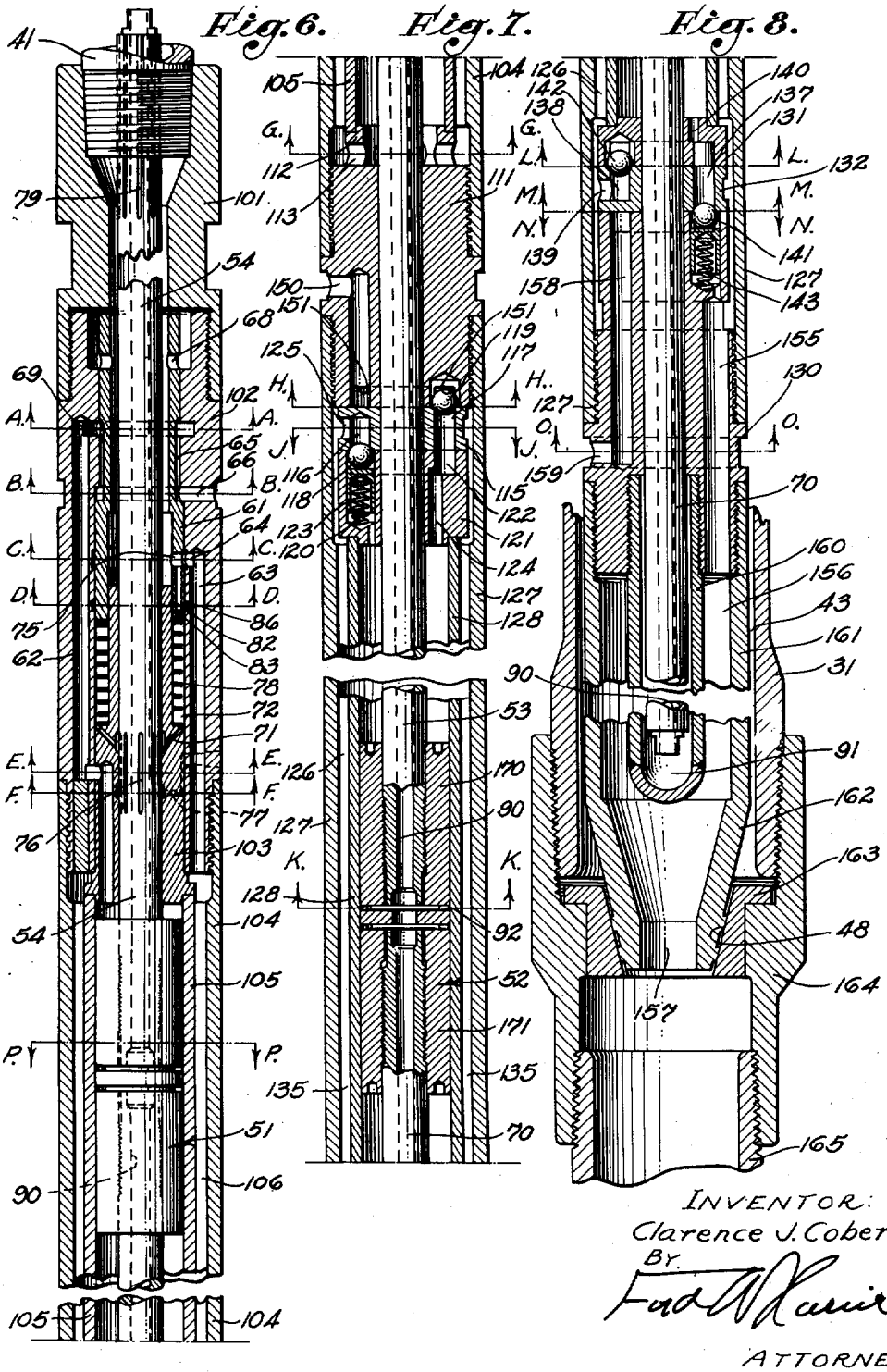



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LIQUID OPERATED PUMP

Filed July 18, 1932 4 Sheets-Sheet 3




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May 25, 1937. C. J. COBERLY 2,081,220

LIQUID OPERATED PUMP

Filed July 18, 1932 4 Sheets-Sheet 4

Fig. 9.

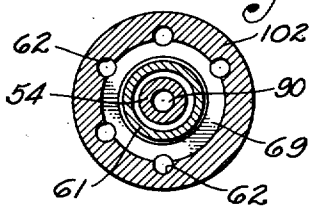



Fig. 14.

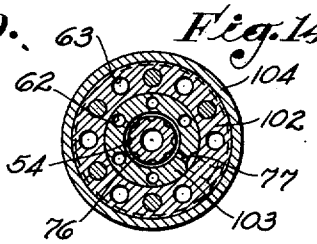



Fig. 19.

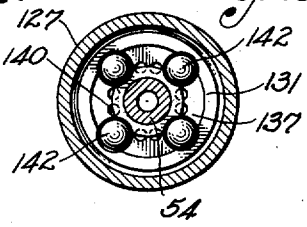



Fig. 10.

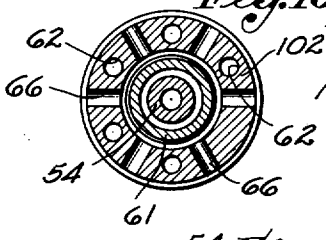



Fig. 15.

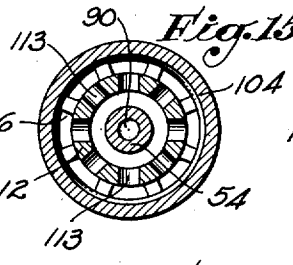



Fig. 20.

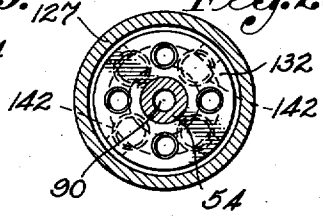



Fig. 11.

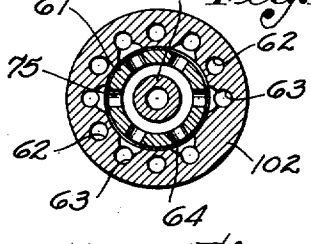



Fig. 16.

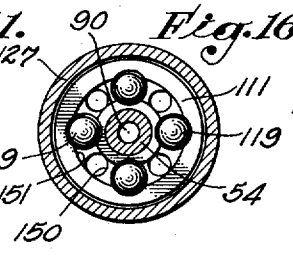



Fig. 21.

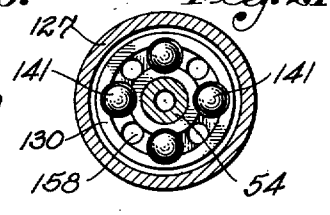



Fig. 12.

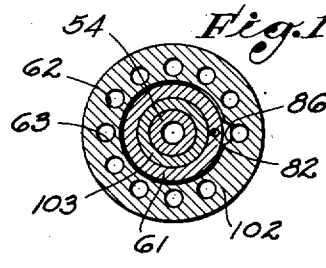



Fig. 17.

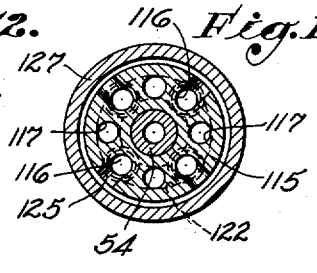



Fig. 22.

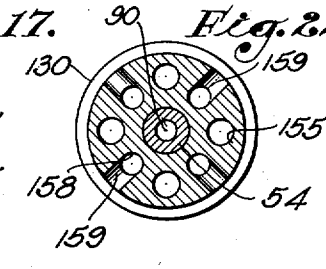



Fig. 13.

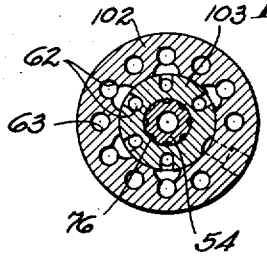



Fig. 18.

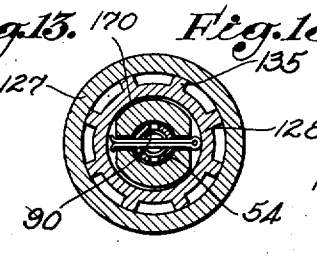
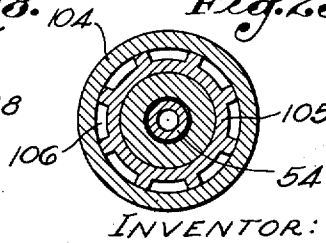



Fig. 23.




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Patented May 25, 1937 2,081,220

# UNITED STATES PATENT OFFICE

2,081,220

## LIQUID OPERATED PUMP

Clarence J. Coberly, Los Angeles, Calif., assignor, by mesne assignments, to Ro Ko Corporation, Reno, Nev., a corporation of Nevada

Application July 18, 1932, Serial No. 623,171

34 Claims. (Cl. 103—46)

My invention relates to pumps and particularly to pumps which are adapted to be immersed in the fluid in a well and to be operated by a column of liquid under pressure. Such pumps are adapted to be used in oil wells and particularly in deep oil wells from which it is difficult to pump the fluid using the conventional type of pump operated mechanically through sucker rods.

Various types of liquid operated pumps have been devised in which the conventional sucker rods are dispensed with and the pump is actuated by liquid under pressure forced downwardly thereto from a pressure producing source located above the surface of the ground. These liquid actuated pumps may be broadly divided into two classes; namely, the alternating type in which the actuation of the pump is accomplished by variations in pressure in the actuating fluid so that it alternately flows up and down in the supply pipe leading to the pump, and the direct type in which the oil in the supply pipe is maintained under a more or less constant pressure and flows constantly in one direction. My invention relates to the direct type of pump.

In the direct type of liquid actuated pumps the oil is pumped from the well through a pump which is actuated by a fluid motor usually immediately adjacent the pump, this fluid motor being actuated by liquid under pressure delivered thereto by a supply pipe.

It is an object of my invention to provide a pump of this character which will have relatively few moving parts, which will be very positive in its operation, and which will be double acting so as to provide a large capacity.

It is a further object of my invention to provide special means for maintaining an efficient lubrication of the pump and to prevent undue wear of the working parts of the pump and the motor.

Further objects and advantages will be made evident hereinafter.

Referring to the drawings, which are for illustrative purposes only:

Fig. 1 is a general assembly view, partly in section, showing the method of assembling the pump in the well.

Fig. 2 is a diagrammatic sectional view of the pump, the parts being shown in the positions they assume at the beginning of the down-stroke.

Fig. 3 is a diagrammatic sectional view of a portion of the pump shown in Fig. 2 with the parts in the position they assume at the beginning of the up-stroke.

Fig. 4 is a diagrammatic sectional view of the valve mechanism with the parts in the position they assume just prior to the upward movement of the valve.

Fig. 5 is a diagrammatic sectional view of the parts in the position they assume just prior to the downward movement of the valve.

Fig. 6 is a vertical section through the upper portion of a pump constructed in accordance with my invention, the left-hand half of this section being taken on a plane at 30° from the plane of the right-hand half of the section.

Fig. 7 is a sectional view of the central portion of the pump, a portion of which is shown in Fig. 6.

Fig. 8 is a section through the lower portion of this pump, the left-hand halves of Figs. 7 and 8 being taken on a plane at 45° from the plane of the right-hand halves of these figures.

Fig. 9 is a section on a plane represented by the line A—A of Fig. 6.

Fig. 10 is a section on a plane represented by the line B—B of Fig. 6.

Fig. 11 is a section on a plane represented by the line C—C of Fig. 6.

Fig. 12 is a section on a plane represented by the line D—D of Fig. 6.

Fig. 13 is a section on a plane represented by the line E—E of Fig. 6.

Fig. 14 is a section on a plane represented by the line F—F of Fig. 6.

Fig. 15 is a section on a plane represented by the line G—G of Fig. 7.

Fig. 16 is a section on a plane represented by the line H—H of Fig. 7.

Fig. 17 is a section on a plane represented by the line J—J of Fig. 7.

Fig. 18 is a section on a plane represented by the line K—K of Fig. 7.

Fig. 19 is a section on a plane represented by the line L—L of Fig. 8.

Fig. 20 is a section on a plane represented by the line M—M of Fig. 8.

Fig. 21 is a section on a plane represented by the line N—N of Fig. 8.

Fig. 22 is a section on a plane represented by the line O—O of Fig. 8.

Fig. 23 is a section on a plane represented by the line P—P of Fig. 6.

Fig. 1 shows a typical assembly of parts used in the practice of my invention. In this figure **31** is the casing of the well which may be perforated near the lower end as shown at **32**, and which is secured at its upper end in gas-tight relationship with a casing head **33**. Carried inside the casing **31** is a string of tubing **34** which is threaded as shown at **35** in the casing head **33**, the space **36**

between the tubing 34 and the casing 31 being hereinafter referred to as the gas space.

This gas space at its lower end communicates directly with the oil in the well and a gas pipe 37 is provided which is threaded in the casing head 33, through which gas may be taken off from the upper portion of this space. This gas may be allowed to freely escape into the air, in which event gas at substantially atmospheric pressure will be maintained in the gas space 36, or the pipe 37 may be connected to suitable pressure or vacuum producing means so that the space 36 may be maintained either above or below atmospheric pressure.

Carried inside the tubing 34 is a pressure pipe 41 which is threaded in the casing head as shown at 42, the space 43 between the supply pipe 41 and the tubing 34 being hereinafter referred to as the exhaust space. A low pressure oil pipe 44 connects to the upper end of this space, being threaded in the casing head 33. This pipe 44 may lead to a gas trap or suitable storage, neither of which is shown. A high pressure oil pipe 45 is threaded in the casing head 33 and delivers oil under pressure to the interior of the supply pipe 41. This supply of oil may be derived from a pump or other suitable means not shown. It is desirable for the proper operation of the invention that the oil supplied through the pipe 45 be free from sand or other gritty material.

In the lower end of the tubing 34 I provide a conical seat 48 which is engaged by a similar seat carried on the lower end of the supply pipe 41 or upon a member attached thereto, as will hereinafter be explained. The purpose of the conical seat 48 is to close the lower end of the exhaust space 43 and to allow the supply pipe 41 and the various members attached thereto to be withdrawn vertically from the tubing 34 without disturbing the tubing. The supply pipe 41 carries the pump and liquid motor, as will hereinafter be explained. In practice when the pump is in operation a high pressure is maintained inside the supply pipe 41 for the purpose of actuating the motor, as will hereinafter be explained.

The operation of the mechanism shown in detail in Figs. 6 to 22 inclusive will be better understood if the general principles upon which the pump operates are first explained and for this purpose Figs. 2, 3, 4, and 5 have been made. It should be understood that these drawings do not represent the actual method of assembling the elements, and that they are provided merely for the purpose of facilitating an understanding of the method of operation of the invention.

Referring to Fig. 2, it will be seen that the pump includes a motor piston 51 and a pump piston 52, these pistons being connected by a piston rod 53. Projecting upwardly from the motor piston 51 is an upper plunger 54, and projecting downwardly from the pump piston 52 is a lower plunger 70. The motor piston 51 drives the pump piston 52 through the piston rod 53, these pistons being reciprocable in their individual cylinders, as will hereinafter be explained.

The pump which I employ is of the double acting type; that is to say, both the space above the piston 52 and the space below the piston are effective in pumping oil. Oil is drawn through a supply opening 55 from the well. On the upstroke, this oil is taken through a valve 56 into the space below the piston, oil simultaneously being forced out from the space above the piston through a valve 57 into the exhaust space 43, which in the actual pump is the space between the supply pipe and the tubing. On the downstroke of the pump oil is taken from the space 55 through a valve 58 into the space above the piston, oil being forced out from the space below the piston into the exhaust space 43 through a valve 59. For the purpose of regulating the supply of fluid to the motor, I provide a valve 61 which slides in a valve chamber above the motor piston, and which controls the flow of liquid under pressure from inside the supply pipe 41. Fluid is supplied to the motor cylinder through passages 62 and 63, the passage 62 leading to the upper end of the cylinder, and the passage 63 leading to the lower end.

The operation of the valve will be better understood by a reference to Figs. 4 and 5 in which the parts are not shown assembled in the manner actually used by me in the pump shown in Figs. 6 to 23 inclusive, Figs. 4 and 5 being merely diagrams to illustrate the method of operation of the actual mechanism.

In Fig. 4 the valve 61 is shown in its lower position and in Fig. 5 it is shown in its upper position. With the valve 61 in its lower position, the lower end of the motor cylinder is in open communication with the exhaust space 43 through the passage 63, a port 64, a central groove 65 in the valve 61, and a port 66. Due to this communication the space below the piston 51 is at substantially exhaust pressure, this pressure being very much below the pressure maintained inside the oil supply pipe 41. The oil supply pipe delivers pressure to a pressure space 67 shown in Fig. 2, a portion of this space being shown in Figs. 4 and 5. The space 67 (and all space connecting therewith) is constantly under the maximum supply pressure and with the valve in the position shown in Fig. 4, oil under this pressure is delivered through an opening 68 in the valve through a port 69 into the passage 62 from which oil is delivered to the space above the piston 51.

With the valve in the position shown in Fig. 4, it will be seen that pressure is exerted on the top of the piston 51 tending to force it down, the space below the piston being in open communication with the exhaust space 43 so that liquid can escape from below the piston into the exhaust space. As the piston 51 moves downwardly, the upper plunger 54 also moves downwardly. This upper plunger 54 is grooved as shown at 79, this groove being of sufficient length to provide an open communication from the space 67 to a port 71 which communicates with a space 72 below the end of the valve 61. As the plunger 54 continues to move downwardly from the position shown in Fig. 4, the port 71 provides an open communication with the space 67 through the groove 79, and oil under pressure is delivered to the space 72.

It will be noted that the portion of the valve 61 below the groove 65 is of greater diameter than the portion of the valve above this groove. The portion of the valve above the groove 65 is constantly subjected to the full supply pressure, but when this supply pressure is also admitted to the space 72, this pressure acting on the larger area of the lower end of the valve tends to force the valve 61 upwardly; that is to say, the valve operates on the principle of differential pressures, the upward pressure on the larger area of the lower end of the valve overcoming the downward pressure on the smaller upper end of the valve.

It will be noted from an inspection of Figs. 4 and 5 that the groove 65 is always in open communication with the exhaust space 43 through

the port 66, and a low pressure always exists in this space.

The admission of high pressure oil to the space 72 through the port 71 as just described forces the valve 61 from the position shown in Figs. 2 and 4 to the position shown in Fig. 5. In the position shown in Figs. 3 and 5, the passage 62 communicating with the space above the piston 51 is in open communication with the exhaust space 43 through the port 69, the groove 65 of the valve, and the port 66. The space below the piston 51 is in open communication with the pressure space 67 through the port 64 and through a port 75 formed in the valve 61. In the position of the valve shown in Figs. 3 and 5 high pressure oil is therefore supplied to the space below the piston 51 and the oil above the piston 51 is allowed to escape through the passage 62 to the exhaust space 43. This causes the piston 51 to move upwardly.

The upper plunger 54 is provided with a groove 76, this groove being of sufficient length to provide an open communication between the port 71 and a port 77 which communicates with the exhaust space 43. With the plunger 54 in its extreme upper position, which occurs as the plunger moves upwardly from the position shown in Fig. 5, the space 72 is connected to the exhaust space 43, the high pressure is relieved from the space 72, and the high pressure oil from the pressure space 67 acts upon the top of the valve 61 and forces it back into the position shown in Fig. 4.

A compression spring 78 is provided in the space 72 which acts upon the valve 61, tending to hold it in its upper position. This spring is not absolutely necessary to the operation of the pump but insures the valve being initially in the upper position when it is desired to start operations. A stop 81 is provided on the valve to limit its downward movement.

For the purpose of locking the valve 61 in either its upper or lower position when the plunger 54 is in any intermediate position, I provide a port 82 in the valve, this port having a very small orifice 83 communicating with the space 72. The upper end of the port 82 communicates with the port 75. This port 75 communicates with the passage 63 through a port 86 with the valve in its lower position as shown in Fig. 4. With the valve in this position there is therefore an open communication between the passage 72 and the exhaust space 43 through the orifice 83, the port 82, the port 75, the port 85, the passage 63, the groove 65 in the valve, and the port 66. In other words, with the valve in the lower position as shown in Fig. 4, exhaust pressure is maintained in the lower end of the valve until the plunger 54 has moved to its extreme lower position and admits high presure oil to the space 72 through the groove 79.

With the valve in the upper position as shown in Fig. 5, full supply pressure is maintained in the space 72 through the port 75, the port 82, and the orifice 83 until this space 72 is open to exhaust by the groove 76 in the plunger 54.

The purpose of the port 82 and the orifice 83 is therefore to lock the valve in its upper and lower positions. It is, however, necessary that the orifice 83 be very small. This will be understood from the following explanation.

With the parts in the position shown in Fig. 4, the space 72 is at exhaust pressure. As soon as the groove 79 opens this space to supply pressure through the orifice 71, high pressure oil rushes into the chamber 72, and if the orifice 83 were large, this high pressure oil would discharge through the orifice 83 as fast as it entered the chamber 72, and passing through the port 82, the port 75, and the port 85, would be delivered into the passage 63, passing therethrough into the exhaust space 43. By making the orifice 83 very small, the amount of high pressure oil which can be drained out of the chamber 72 through the orifice 83 is very small and pressure rapidly builds up in the chamber 72 to a sufficient degree to move the valve before any appreciable amount of oil can flow through the orifice 83. At the moment the valve starts upwardly from the position shown in Fig. 4, there is a small spurt of oil through the orifice 83 into the port 82, but as soon as the valve moves upwardly a short distance, the port 86 is closed and this spurt stops. Similarly, the parts being in the position shown in Fig. 5 and the chamber 72 containing high pressure oil, as soon as the oil from the chamber 72 can escape through the groove 76 and the port 77 into the exhaust space 43, there is a spurt of high pressure oil through the orifice 83 into the chamber 72. The supply of oil through the orifice 83 is not sufficient, however, to build up pressure in the chamber 72 and the valve moves downwardly. As the valve 61 moves downwardly, the port 75 is closed to the high pressure source of supply and the flow of oil through the orifice 83 ceases.

The method of operation of the device shown diagrammatically in Fig. 2 is as follows:

Assuming that the parts are in the position shown in that figure and that the plunger 54 has moved upwardly a small distance further than that shown in Fig. 4 so that the ports 71 and 77 are connected through the groove 76, the valve 61 will have been forced down into the position shown in Fig. 2 and Fig. 4. In this position the valve 61 connects the space below the piston with the exhaust space 43 and connects the space above the piston 51 with the pressure space 67. High pressure oil therefore flows from the pressure space 67 in to the space above the motor piston 51 and low pressure oil is forced out of the space below the piston into the exhaust space 43.

Just before the piston 51 reaches its extreme lower position, the groove 79 in the upper plunger 54 connects the port 71 with the high pressure space 67 and the valve moves upwardly into the position shown in Fig. 5. In this position high pressure oil is admitted from the pressure space 67 to the space below the motor piston 51 and low pressure oil escapes from above this piston to the exhaust space 43 as the piston 51 moves upwardly. Just before the piston 51 reaches its upper position as shown in Fig. 2, the ports 71 and 77 are again connected through the groove 76 and the valve 61 is forced downwardly and the cycle just described is repeated.

In brief, the valve 61 controls fluid pressure which moves the piston 51, the piston 51 moves the plunger 54, and the plunger 54 controls fluid pressure which moves the valve 61. As a result, the motor piston 51 is reciprocated and reciprocates the pump piston 52. It will be noted that the low pressure oil from the motor cylinder and the oil pumped by the pump cylinder both flow into the exhaust space 43. High pressure oil therefore flows downwardly through the supply pipe 41 and is used to actuate the motor (its proper distribution in the motor being made by the valve 61) and it then flows upwardly with the oil being pumped through the exhaust space

43 to the oil outlet pipe 44 through which it passes to suitable storage.

Many oil wells produce considerable sand or gritty material which is suspended in the oil, and which is quite abrasive. Since the proper operation of the pump requires a very close fit between mutually movable surfaces, it is necessary to reduce the abrasive action between these surfaces. This I accomplish by thoroughly removing any solid particles of abrasive matter from the high pressure oil before delivering this oil to the upper end of the supply pipe 41. I do not show any means of doing this but it can readily be accomplished by centrifugal devices and/or filters. This clean high pressure oil is delivered to all wearing surfaces as will now be explained.

Through the center of the plunger 54, the piston rod 53, and the plunger 70, a hole 90 is provided which delivers high pressure clean oil from the high pressure space 67 to a closed cavity 91 into which the plunger 70 projects. The oil in the cavity 91 being under higher pressure than the oil below the pump piston 52 (which is never at a pressure materially higher than the pressure in the exhaust space 43), this clean oil tends to work upwardly around the outside of the plunger 70 and to prevent the oil being pumped from working into the space between the plunger 70 and the inner walls of the opening in which it slides. A number of small holes 92 also conduct this high pressure oil from the hole 91 to the working periphery of the pump piston 52 and the periphery of the motor piston 51, thus insuring positive clean oil lubrication thereof. The upper plunger 54 has no contact with the oil being pumped, and its upper end projects into the pressure space 67 which is always full of high pressure clean oil and thus constantly lubricated. I have found that by the use of clean oil as a motive liquid and as a lubricant for the working parts, I can provide a pump which will lift sandy oil without rapid wear of the working parts.

As previously explained, Figs. 2 to 5 inclusive are intended to be diagrammatic. A pump constructed as shown therein would be perfectly operative, but owing to space limitations it could not be used in deep oil wells which in some cases have casing 31 not over four inches inside diameter. For use in such locations I provide a compact form of pump as shown in Figs. 6 to 22 inclusive.

The design of a pump assembly having an outside diameter of less than four inches and capable of operating with high pressure oil presents great spatial and constructional difficulties. My methods of solving these difficulties will be evident from the following description.

The pump shown in Figs. 6 to 23 operates in the same manner as the pump shown in Fig. 2 and the main elements are the same in both pumps.

Referring to Fig. 6, the supply pipe 41 is threaded in a collar 101 into which is threaded an outer valve body 102. The valve 61 fitting and sliding in the valve body 102 has the same general characteristics as the valve 61 shown in Figs. 2 to 5 inclusive, although of somewhat different dimensions. It has the circumferential groove 65, ports 68, 75, and 82, and the small orifice 83. The spring 78 is shown in the cavity 72.

The valve body has the passages 62 and 63, and the ports 69, 66, 64, and 86. For convenience the valve body is made in two pieces, the inner valve body 103 fitting inside the outer valve body 102 and having the ports 71 and 77 formed therein. The plunger 54 slides freely and fits tightly in the inner valve body 103 and is provided with the grooves 76 and 79.

Threaded on the lower end of the valve body 102 is an outer motor barrel 104 and situated inside of and concentric therewith is an inner motor barrel 105 which has an inner cylindrical surface fitting closely around the motor piston 51 which is joined to the plunger 54. The inner barrel 105 is provided with longitudinal grooves 106 in its outer surface and fits so tightly in the outer barrel 104 that the latter must be heated before the barrels can be assembled, the outer barrel 104 then shrinking upon the inner barrel 105 and reinforcing the same. The grooves 106 form part of the passage 63 leading to the space inside the inner barrel 105 below the motor piston 51. The upper end of the inner barrel 105 abuts against the lower end of the inner valve body 103.

Threaded in the lower end of the outer barrel 104 is an upper intermediate member 111. This member has an upward projection 112 upon which the inner barrel 105 seats. The projection 112 has ports 113 forming a part of the passage 62. The parts 102, 104, 105, and 111 are assembled with the outer barrel 104 very hot and the shrinkage of this barrel not only grips the inner barrel 105 radially, but it also contracts longitudinally and firmly seats the upper end of the inner barrel 105 on the inner valve body 103 and the lower end of the inner barrel 105 on the projection 112. I have found by assembling the parts in this manner, that I provide a structure capable of withstanding hydrostatic pressures of several thousand pounds per square inch, which is necessary in a structure used for the purposes of my invention. The piston rod projects through the intermediate member 111 in fluid-tight relationship therewith.

Held in fluid-tight relationship with the bottom of the intermediate member 111 is an upper valve seat member 115, this member having inlet ports 116 and outlet ports 117 therein, these holes being closed by balls 118 and 119. The balls 118 are held in their upper position by compression springs 120. Situated below the upper valve seat member 115 and held in fluid-tight relationship therewith is an upper valve retaining member 121, this member having a cavity 122 which communicates with all of the ports 117 and also communicates with cavities 123 in which the springs 120 are placed. These cavities 123 communicate through a port 124 with the space above the pump piston 52. All of the ports 116 communicate through ports 125 with a space 126 between an outer pump barrel 127 and an inner pump barrel 128. This space is at all times in open communication with the oil in the well to be pumped, as will be hereinafter explained. The balls 119 are free to move upwardly in cavities 151 which communicate through ports 150 with the exhaust space 43.

The outer pump barrel 127 is threaded to the intermediate member 111 at its upper end and is threaded at its lower end on a lower intermediate member 130. The inner pump barrel 128 abuts against a lower valve retaining member 131 which in turn abuts against a lower valve seat 132. The outer pump barrel 127 is threaded in place while very hot and due to its contraction is shrunk tightly against ribs 135 formed on the outer surface of the inner pump barrel 128.

The shrinkage of the outer pump barrel 127 acting in compression on the inner pump barrel 128, tends to force the members 115, 121, 128,

131, 132, and 130 solidly together so as to form fluid-tight joints therebetween.

The lower valve seat 132 is provided with ports 137 and 138, the ports 138 communicating with the space 126 through ports 139, and the ports 137 communicating through ports 140 with the space below the motor piston 52. Balls 141 and 142 close the ports 137 and 138, the balls 141 being held in their upper position by compression springs 143.

A port 155 extending through the lower intermediate member 130 communicates with a space 156 which in turn communicates with an opening 157. A port 158 is formed in the lower intermediate member 130 and communicates through a port 159 with the exhaust space 43 formed between the casing 31 and the tubing 34. The opening 157, the space 156, the port 155, and the space 126 together correspond to the supply opening 55 of Fig. 2. The opening 157, space 156, and the port 155 act as inlet openings to admit oil to the space 126. Oil is drawn from the space 126 on the down-stroke of the pump, through the port 125, the balls 118 being pulled downwardly to admit oil to the cavity 122, and through the port 124 to the space above the pump piston 52, and oil is drawn inwardly into the space below the piston 52 on the up-stroke of the pump due to the ball 142 lifting and drawing oil through the port 139 and delivering it through the port 140 to the space below the pump piston 52. Oil is forced outwardly from the space inside the inner pump barrel 128 above the piston 52 on the up-stroke of the pump through the port 124 and the port 150 due to the balls 119 lifting, this oil entering the exhaust space 43, and oil is also forced into this exhaust space on the down-stroke of the pump through the ports 140, 137, 158, and 159 due to the valve 141 being forced downwardly.

A member 160 threaded in the lower intermediate member 130 provides the cavity 91 into which the lower plunger projects. Threaded on the bottom of the lower intermediate member 130 is a member 161 having a conical end 162 which fits in fluid-tight relationship with the conical seat 48 formed on a member 163. The member 163 is secured in fluid-tight relationship in a coupling member 164 which is threaded to the bottom of the tubing 31. The bottom of the coupling 164 may also be threaded for the reception of tubing 165 which may extend down into the oil in the well, or which may be connected to a gas anchor if desired.

The pistons 51 and 52 are identical in construction and have members 170 and 171 threaded for the reception of the piston rod 53 and the plungers 70 and 54, the piston rod and plungers having the central opening 90 therethrough. The openings 92 extend radially from the central hole 90 so as to supply clean oil to the outer periphery of the pistons as previously explained.

The operation of the pump proper has been previously explained in connection with Fig. 2 and the actual construction of the pump shown in Figs. 6, 7, and 8 will be understood from the foregoing description.

My invention comprises a device including a fluid motor and a pump placed adjacent thereto and operated thereby, said motor and pump being situated in a well and having the function of pumping liquid from said well, said function being performed by forcing liquid under pressure downwardly from a source of fluid supply to said motor, the motor then operating the pump, which forces the liquid to be pumped to flow upwardly through the well.

The embodiment of my invention shown in the drawings includes various elements, all of which are not necessarily parts of the inventions defined by the following claims, the elements having various functions performed in various ways, which may be defined as follows:

First, an outer tubing suspended in the well and into which the pump delivers the fluids pumped and into which the motor discharges the fluid used to actuate the motor after said fluid has so operated the motor, said tubing having the function of delivering all of said fluids to the surface of the ground, said function being performed by providing an impervious wall surrounding a central opening through which said fluids are free to pass, said impervious wall being of sufficient strength to resist any pressure to which it is subjected during the operation of the device.

Second, an inner tubing having the function of conducting operating fluid from the source of fluid supply to the pump, said function being performed by providing an impervious wall surrounding a central opening through which said fluids can pass, said impervious wall having sufficient strength to resist any pressure to which it is subjected during the operation of the device.

Third, a structure having the function of enclosing the pump and motor and other parts, said function being performed by providing parts of sufficient strength and suitable form.

Fourth, a seal having the function of providing a fluid-tight closure between said structure and said inner tubing, said function being performed by walls forming surfaces on said structure and said tubing which can be brought into gas-tight relationship with each other.

Fifth, a motor piston sliding in gas-tight relationship in a pump cylinder formed in said structure, said piston having the function of absorbing energy from the actuating fluid and delivering said energy to the pump, this function being performed by applying fluid pressure to said piston and transmitting the force so produced through a mechanical connection between said motor piston and said pump piston.

Sixth, a pump piston having the function of pumping oil, this function being performed by drawing oil into the pump cylinder through an inlet valve and forcing said oil out of said cylinder through an outlet valve.

Seventh, inlet valves for the pump, each having the function of preventing the flow of fluid from the pump cylinder through an inlet opening, which function the valve performs by seating whenever this flow occurs, the valve lifting to allow fluid to flow into said cylinder.

Eighth, outlet valves for the pump, each valve having the function of preventing fluid from entering the pump cylinder through an outlet opening, which function the valve performs by seating whenever this flow occurs, the valve lifting to allow fluid to flow out of said cylinder.

Ninth, a main valve having the function of controlling the application of fluid pressure to the motor piston, this function being performed by the valve shifting its position to deliver the fluid to different ports.

Tenth, an auxiliary valve having the function of controlling the application of fluid pressure to the main valve, this function being performed by the auxiliary valve shifting its position to deliver the fluid to different ports.

I claim as my invention:

1. In a device of the character described, the combination of: walls forming a cylinder and including heads at either end thereof; a piston sliding in liquid-tight relationship in said cylinder between said heads; a piston rod rigidly secured to said piston and passing through both the upper and the lower heads in slidable, liquid-tight relationship with said heads; a passage extending through said piston rod; a wall surrounding said piston rod after it has passed through one of said heads and forming a lubricating liquid cavity about said rod; and means for delivering lubricating liquid to said cavity through said passage in said rod.

2. In a device of the character described, the combination of: walls forming a motor cylinder; a motor piston sliding in fluid-tight relationship with the walls of said cylinder; walls forming a pump cylinder coaxial with said motor cylinder; a pump piston sliding in fluid-tight relationship with the walls of said pump cylinder; and a piston rod connecting said motor piston and said pump piston and having a projecting portion passing axially in fluid-tight relationship through the walls of said motor cylinder into a cavity separated from said motor cylinder, and a projecting portion passing axially in fluid-tight relationship through the walls of said pump cylinder into a cavity separated from said pump cylinder, said rod having an open passage extending therethrough and connecting said cavities, said pistons having openings therein through which lubricant from one of said cavities may be passed from said passage to said cylinder walls.

3. The combination of: walls surrounding a cylindrical opening; a piston sliding in said opening in fluid-tight relationship with the walls thereof; a piston rod rigidly connected to said piston and passing in fluid-tight relationship through said walls, one extension of said rod passing through said walls at one side of said piston, and another extension of said rod passing through said cylinder walls at the other side of said piston, said piston rod with its extensions having an open passage through which lubricant may be passed to openings in said piston, said openings being connected to said passage and so placed that they deliver lubricant to the periphery of said piston; means for balancing the pressures on the outer ends of said extensions; walls forming a closed cavity into which one of said extensions projects; and means for delivering lubricant to said passage.

4. A deep well pump of the kind described comprising a casing having a partition block secured in one end, a motor cylinder casing mounted on the said block, a piston in said casing, a piston rod on said piston, said rod being connected at its other end to a pumping piston, a block secured in the upper end of said casing, said block having a chamber therein providing a valve for delivering motive fluid to operate the said piston, and a fluid motor for operating the said valve, said block also having a chamber therein providing a pilot valve, means connected to the pilot valve and operable by movement of the main piston for delivering motive fluid to the said valve operating motor, substantially as set forth.

5. A deep well pump comprising a casing having a partition dividing it into two chambers, a motor cylinder mounted on the partition, a piston in said cylinder, a pumping cylinder mounted on the partition, a pumping piston in said cylinder, a common piston rod connecting said motor and said pumping pistons, a block secured in one end of said casing, said block having a chamber therein providing a valve for controlling motive fluid to operate the said piston and a fluid motor for operating the said valve, said block also having a chamber therein with a pilot valve mounted in the chamber, means connected to the pilot valve and operable by movement of the main piston for delivery of the motive fluid to the said valve operating motor, substantially as set forth.

6. In a deep well pump of the character described, the combination of: a valve body adapted to be secured to the lower end of a pressure fluid delivery tube; walls forming a power cylinder at the lower end of said valve body, there being passages extending from said valve body to the upper and lower ends of said power cylinder; a power piston operative in said power cylinder; control valve means in said valve body for controlling the delivery of pressure fluid into said passages and the opening of said passages to discharge in a manner to produce reciprocation of said power piston; a pilot rod extending upwardly from said power piston to said valve body to control the operation of said control valve means; a connecting rod extending downwardly from said power piston; a plug member at the lower end of said power cylinder having an opening through which said rod extends; a pumping cylinder connected to the lower end of said plug member; a pumping piston operative in said pumping cylinder, said pumping piston being connected to the lower end of said connecting rod; upper and lower check valve means for said pumping cylinder for controlling the intake and discharge of a fluid by said pumping cylinder; an extension rod extending downwardly from said pumping piston and through said lower check valve means; means forming a fluid chamber receiving the lower portion of said extension rod; and means for delivering said pressure fluid to said fluid chamber to provide a fluid pressure against said extension rod to balance the fluid pressure against the end of said pilot rod.

7. In a deep well pump of the character described, the combination of: a valve body adapted to be secured to the lower end of a pressure fluid delivery tube; walls forming a power cylinder at the lower end of said valve body, there being passages extending from said valve body to the upper and lower ends of said power cylinder; a power piston operative in said power cylinder; control valve means in said valve body for controlling the delivery of pressure fluid into said passages and the opening of said passages to discharge in a manner to produce reciprocation of said power piston; a pilot rod extending upwardly from said power piston to said valve body to control the operation of said control valve means; a connecting rod extending downwardly from said power piston; a plug member at the lower end of said power cylinder having an opening through which said rod extends; a pumping cylinder connected to the lower end of said plug member; a pumping piston operative in said pumping cylinder, said pumping piston being connected to the lower end of said connecting rod; upper and lower check valve means for said pumping cylinder for controlling the intake and discharge of a fluid by said pumping cylinder; an extension rod extending downwardly from said pumping piston and through said lower check valve means; and means forming a fluid chamber receiving the low-

er portion of said extension rod, there being a passage through said pilot rod, said power piston, said connecting rod, said pumping piston, and said extension rod for delivering said pressure fluid to said fluid chamber to provide a fluid pressure against said extension rod to balance the fluid pressure against the end of said pilot rod.

8. In a deep well pump of the character described, the combination of: a valve body adapted to be secured to the lower end of a pressure fluid delivery tube; walls forming a power cylinder at the lower end of said valve body, there being passages extending from said valve body to the upper and lower ends of said power cylinder; a power piston operative in said power cylinder; control valve means in said valve body for controlling the delivery of pressure fluid into said passages and the opening of said passages to discharge in a manner to produce reciprocation of said power piston; a pilot rod extending upwardly from said power piston to said valve body to control the operation of said control valve means; a connecting rod extending downwardly from said power piston; a plug member at the lower end of said power cylinder having an opening through which said rod extends; a pumping cylinder connected to the lower end of said plug member; a pumping piston operative in said pumping cylinder, said pumping piston being connected to the lower end of said connecting rod; upper and lower check valve means for said pumping cylinder for controlling the intake and discharge of a fluid by said pumping cylinder; an extension rod extending downwardly from said pumping piston and through said lower check valve means; and means forming a fluid chamber receiving the lower portion of said extension rod, there being a passage through said pilot rod, said power piston, said connecting rod, said pumping piston, and said extension rod for delivering said pressure fluid to said fluid chamber to provide a fluid pressure against said extension rod to balance the fluid pressure against the end of said pilot rod, and there being fluid passages connecting the exterior of said pumping piston with said passage therethrough.

9. In a deep well pump of the character described, the combination of: a valve body adapted to be secured to the lower end of a pressure fluid delivery tube; walls forming a power cylinder at the lower end of said valve body, there being passages extending from said valve body to the upper and lower ends of said power cylinder; a power piston operative in said power cylinder; control valve means in said valve body for controlling the delivery of pressure fluid into said passages and the opening of said passages to discharge in a manner to produce reciprocation of said power piston; a pilot rod extending upwardly from said power piston to said valve body to control the operation of said control valve means; a connecting rod extending downwardly from said power piston; a plug member at the lower end of said power cylinder having an opening through which said rod extends; a pumping cylinder connected to the lower end of said plug member; a pumping piston operative in said pumping cylinder, said pumping piston being connected to the lower end of said connecting rod; upper and lower check valve means for said pumping cylinder for controlling the intake and discharge of a fluid by said pumping cylinder; an extension rod extending downwardly from said pumping piston and through said lower check valve means; and means forming a fluid chamber receiving the lower portion of said extension rod, there being a passage through said pilot rod, said power piston, said connecting rod, said pumping piston, and said extension rod for delivering said pressure fluid to said fluid chamber to provide a fluid pressure against said extension rod to balance the fluid pressure against the end of said pilot rod, and there being fluid passages in said power and pumping pistons leading outwardly from the passages therein to the external faces thereof.

10. In a deep well pump of the character described, the combination of: a valve body adapted to be secured to the lower end of a pressure fluid delivery tube; walls forming a power cylinder at the lower end of said valve body, there being passages extending from said valve body to the upper and lower ends of said power cylinder; a power piston operative in said power cylinder; control valve means in said valve body for controlling the delivery of pressure fluid into said passages and the opening of said passages to discharge in a manner to produce reciprocation of said power piston; a pilot rod extending upwardly from said power piston to said valve body to control the operation of said control valve means; a connecting rod extending downwardly from said power piston; a plug member at the lower end of said power cylinder having an opening through which said rod extends; a pumping cylinder connected to the lower end of said plug member; a pumping piston operative in said pumping cylinder, said pumping piston being connected to the lower end of said connecting rod; upper and lower check valve means for said pumping cylinder for controlling the intake and discharge of a fluid by said pumping cylinder; an extension rod extending downwardly from said power piston and through said lower check valve means; and means forming a fluid chamber receiving the lower portion of said extension rod, there being a passage through said pilot rod leading to said power piston, and a passage in said power piston connecting the exterior thereof with said passage in said pilot rod, for delivering fluid under pressure to the space between said power piston and the wall of said power cylinder for the purpose of lubrication.

11. In a deep well pump of the character described, the combination of: a valve body adapted to be secured to the lower end of a pressure fluid delivery tube; walls forming a power cylinder at the lower end of said valve body, there being passages extending from said valve body to the upper and lower ends of said power cylinder; a power piston operative in said power cylinder; control valve means in said valve body for controlling the delivery of pressure fluid into said passages and the opening of said passages to discharge in a manner to produce reciprocation of said power piston; a pilot rod extending upwardly from said power piston to said valve body to control the operation of said control valve means; a connecting rod extending downwardly from said power piston; a plug member at the lower end of said power cylinder having an opening through which said rod extends; a pumping cylinder connected to the lower end of said plug member; a pumping piston operative in said pumping cylinder, said pumping piston being connected to the lower end of said connecting rod; upper and lower check valve means for said pumping cylinder for controlling the intake and discharge of a fluid by said pumping cylinder;

an extension rod extending downwardly from said pumping piston and through said lower check valve means; and means forming a fluid chamber receiving the lower portion of said extension rod; there being a passage through said pilot rod, said power piston, and said connecting rod leading to said pumping piston, and an opening in said pumping piston connecting the exterior thereof with said passage, for delivering fluid under pressure to the outer surface of said pumping piston.

12. In a deep well pump of the character described, the combination of: a motor element adapted to be installed at the bottom of a well, there being a piston rod extending down from said motor element; a pumping cylinder secured to the lower end of said motor element, there being fluid inlet passages in the wall of said cylinder and fluid discharge passages extending outwardly from the upper end of said cylinder; intake and discharge check valve means in the upper end of said cylinder connected to said passages so as to control the flow of fluid into and out of the upper end of said cylinder; a plug connected to the lower end of said cylinder, said plug having a passage from end to end thereof for conducting fluid to be pumped to said passages of said cylinder, there being a discharge passage leading downwardly from the upper end of said plug and out through the side wall thereof for the discharge of fluid; and intake and discharge valve means at the upper end of said plug connecting said inlet and discharge passages of said plug with the lower interior space of said cylinder.

13. In a deep well pump of the character described, the combination of: a motor element adapted to be installed at the bottom of a well, there being a piston rod extending down from said motor element; a pumping cylinder secured to the lower end of said motor element, there being fluid inlet passages in the wall of said cylinder and fluid discharge passages extending outwardly from the upper end of said cylinder; intake and discharge check valve means in the upper end of said cylinder connected to said passages so as to control the flow of fluid into and out of the upper end of said cylinder; a plug connected to the lower end of said cylinder, said plug having a passage from end to end thereof for conducting fluid to be pumped to said passages of said cylinder, there being a discharge passage leading downwardly from the upper end of said plug and out through the side wall thereof for the discharge of fluid; intake and discharge valve means at the upper end of said plug connecting said inlet and discharge passages of said plug with the lower interior space of said cylinder; a fluid inlet pipe connected to the lower end of said plug; and a fluid discharge pipe extending upwardly around the exterior of said cylinder from a point below the outlet end of said discharge passage of said plug.

14. In a deep well pump of the character described, the combination of: an intermediate plug for connecting together a power cylinder and a pumping cylinder, said plug comprising a body having the ends thereof prepared for connection to said cylinders and having a discharge passage leading from one end thereof to a position intermediate the ends thereof and then leading outwardly to the exterior of the body.

15. A deep well pump of the kind described comprising a casing having a partition block secured in one end, a motor cylinder casing mounted on the said block, a piston in said casing, a piston rod on said piston, said rod being connected at its other end to a pumping piston, a block secured in the upper end of said motor cylinder casing, said last mentioned block having a chamber therein providing a valve for delivering motive fluid to operate the said motor piston, and a fluid motor for operating the said valve, said block also having a chamber therein providing a pilot valve, means connected to the pilot valve and operable by movement of the first mentioned motor piston for delivering motive fluid to the said valve operating motor, substantially as set forth.

16. A deep well pump comprising a casing having a partition dividing it into two chambers, a motor cylinder mounted on the partition, a piston in said cylinder, a pumping cylinder mounted on the partition, a pumping piston in said cylinder, a common piston rod connecting said motor and said pumping pistons, a block secured in one end of said motor cylinder, said block having a chamber therein providing a valve for controlling motive fluid to operate the said piston and a fluid motor for operating the said valve, said last mentioned block also having a chamber therein with a pilot valve mounted in the chamber, means connected to the pilot valve and operable by movement of the first mentioned motor piston for delivery of the motive fluid to the said valve operating motor, substantially as set forth.

17. In a combined motor and pump adapted to be inserted in a well and to pump liquid therefrom, the combination of: a motor mechanism including a motor cylinder; a pump mechanism including a pump cylinder; walls confining a first column of high pressure fluid and conducting said fluid from a suitable source of high pressure fluid to said motor; walls confining a second column of fluid and conducting same from the pump to the outlet of the well; valve means for alternately applying said columns to either end of said motor cylinder; a motor piston sliding in liquid-tight relationship in said motor cylinder and having an upper rod connected thereto and passing in liquid-tight slidable relationship through the walls of said motor cylinder; an intermediate rod operatively connected to said motor piston and passing in liquid-tight slidable relationship through the walls of said motor cylinder into said pump cylinder; a pump piston sliding in liquid-tight relationship in said pump cylinder and operatively connected to said intermediate rod; and a lower rod secured to said pump piston and passing in slidable liquid-tight relationship in the walls of said pump cylinder.

18. In a combined motor and pump adapted to be placed in a well and to pump liquid therefrom, the combination of: a motor mechanism including a motor cylinder; walls confining a column of high pressure liquid and conducting said liquid from a suitable source of high pressure liquid to said motor; walls confining a column of liquid at lower pressure than said high pressure liquid and conducting said liquid at lower pressure from said pump to the outlet of the well; a motor piston forming a part of said combined motor and pump; means for so applying said columns to said motor piston as to cause it to reciprocate; a pump assembly comprising walls forming a pump cylinder, said walls including an upper head and a lower head; a pump piston sliding in liquid-tight relationship in said cylinder between said heads; an upper piston rod rigidly

connected to said pump piston and passing in slidable, liquid-tight relationship through said upper head, said upper rod being rigidly connected to said motor piston at a point above where it passes through said upper head; an inlet valve for said pump cylinder in said upper head; an outlet valve for said pump cylinder in said upper head; a lower piston rod passing in slidable, liquid-tight relationship through said lower head; an inlet valve for said pump cylinder in said lower head; and an outlet valve for said pump cylinder in said lower head.

19. In a device of th character described, the combination of: walls confining a column of high pressure fluid; walls forming a pump cylinder; a pump piston in said cylinder; piston rod means secured to said piston and extending both ways therefrom through the end walls of said pump cylinder, one end of said rod means projecting into said column of pressure fluid the action of which applies a force tending to move said rod means; and means for balancing said force of said fluid tending to move said rod means, said means exerting an opposing force on said rod means.

20. In a device of the character described, the combination of: walls confining a column of high pressure fluid; walls forming a pump cylinder; a pump piston in said cylinder; piston rod means secured to said piston, one end of said rod means extending through one end wall of said cylinder and the other end of said rod means extending through the other end wall of said cylinder; and means for supplying said pressure fluid to both ends of said piston rod means so that the fluid pressures acting on both ends thereof will be substantially balanced.

21. A pumping mechanism of the character described, including: walls confining a column of high pressure fluid; a motor including walls forming a motor cylinder having a motor piston therein; a pump mechanism including walls forming a pump cylinder having a pump piston therein; an upper piston rod secured to said motor piston and extending through an end wall of said motor cylinder, the upper end of said upper rod being exposed to the action of said high pressure fluid exerting a downward force tending to move said upper rod downwardly; an intermediate piston rod connecting said motor piston and said pump piston; a lower piston rod secured to said pump piston and extending through an end wall of said pump cylinder; and means for exerting an upward force on said lower piston rod tending to balance said downward force on said upper piston rod.

22. In a device of the character described, the combination of: a fluid operated motor including walls forming a cylinder; a motor piston in said cylinder having a passage communicating with the periphery thereof, walls confining a column of high pressure fluid and conducting same from a suitable source to said motor; valve means for supplying said high pressure fluid to said motor cylinder so as to actuate said piston; a piston rod secured to said motor piston and extending through an end wall of said motor cylinder, said rod having an opening therein communicating with said high pressure fluid and with said passage so that said fluid may be conveyed through said opening and said passage to the periphery of said piston to lubricate it.

23. A pumping mechanism of the character described, including: a motor including walls forming a motor cylinder having a motor piston therein; a pump mechanism including walls forming a pump cylinder having a pump piston therein; an upper rod secured to said motor piston and extending through an end wall of said motor cylinder; an intermediate rod connecting said motor piston and said pump piston, said intermediate rod being of the same diameter as said upper rod; and a lower rod secured to said pump piston and extending through an end wall of said pump cylinder, said lower rod being of the same diameter as said upper and intermediate rods.

24. A pumping mechanism of the character described including: walls forming a motor cylinder; a motor piston slidably disposed in said motor cylinder; walls forming a pump cylinder and arranged coaxially with said motor cylinder; a pump piston slidably disposed in said pump cylinder; a piston rod operatively connecting said motor piston to said pump piston; means conducting a column of fluid under high pressure to said pumping mechanism; means comprising a master valve and a pilot valve operatively associated with each other to control the admission of said high pressure fluid into said motor and the exhaust of said fluid from said motor; walls forming passageways for a second column of fluid and for conducting the same from said pumping mechanism to a discharge outlet; said pilot valve being connected with said motor piston and being adapted to be actuated thereby to control movement of said master valve by controlling the application thereto of fluid derived from said columns; admission valve means through which said pump piston can draw well fluid into said pump cylinder on both its up-stroke and down-stroke; and discharge valve means through which said pump piston can expel well fluid from said pump cylinder into said passageways for said second column of fluid on both its up-stroke and down-stroke.

25. A pumping mechanism, such as defined in claim 24, in which the master valve is coaxially arranged with the pump and motor cylinders.

26. A pumping mechanism, such as defined in claim 24, in which the pilot valve is rigidly connected with the motor piston.

27. A pumping mechanism, such as defined in claim 24, in which the pilot valve is coaxial and rigidly connected with the motor piston.

28. A pumping apparatus including the combination of: a motor and pump adapted to be placed in a well to pump fluid therefrom; means adapted to confine a first column of fluid under high pressure and to conduct the same to said motor; means adapted to contain a second column of fluid and to conduct the same from said pump to a discharge means for said well; a motor piston reciprocable in said motor cylinder; a pump piston connected to said motor piston and reciprocable in said pump cylinder; a master valve for admitting fluid from said high pressure column to opposite ends of said motor to successively reciprocate said motor piston in opposite directions; master valve operating means associated with said motor piston and controlling movement of said master valve; inlet means successively admitting well fluid into opposite ends of said pump; and discharge means successively permitting discharge of well fluid from said opposite ends of said pump into said means for said second column of liquid, said master valve operating means controlling movement of said master valve by controlling the application thereto of fluid derived from said columns.

29. In a fluid operated well pump, the combination of: a well tubing extending from the

top of the well to a point near the bottom thereof; a fluid operated motor in said tubing, including a motor cylinder having a motor piston therein; a pump mechanism in said tubing below said motor, including a pump cylinder having a pump piston therein; means operatively connecting said pistons; means forming a seal between said pump mechanism and said tubing; means providing a production passage for fluid between said tubing and said motor cylinder and between said tubing and said pump cylinder; means comprising a master valve and a pilot valve operative to control the admission of fluid under high pressure into said motor and the exhaust of said fluid from said motor; said pilot valve being connected with said motor piston and being adapted to be actuated thereby to control movement of said master valve by controlling the application thereto of the fluid under high pressure and fluid derived from said production passages; inlet means for conducting well fluid into the lower end of said pump mechanism; a first inlet passage in said pump mechanism communicating between said inlet means and the upper end of said pump cylinder; a second inlet passage in said pump mechanism communicating between said inlet means and the lower end of said pump cylinder; an upper discharge passage communicating between the upper end of said pump cylinder and said production passage; a lower discharge passage communicating between the lower end of said pump cylinder and said production passage; and inlet and discharge valve means for controlling the inlet and discharge of well fluid through said inlet and discharge passages.

30. In a fluid operated well pump, the combination of: a well tubing extending from the top of a well to a point near the bottom thereof; a fluid operated motor in said tubing, including a motor cylinder having a motor piston therein, there being a first fluid-receiving space between said motor and said tubing; pump mechanism in said tubing below said motor, including a pump cylinder having a pump piston therein, there being a second fluid-receiving space between the upper end of said pump mechanism and said tubing, said first and second fluid-receiving spaces communicating with each other; means operatively connecting said pistons; means forming a seal between said pump mechanism and said tubing below said second fluid-receiving space; a pipe connected to the upper end of said motor for supplying operating fluid under pressure thereto; means comprising a master valve and a pilot valve for alternately delivering said operating fluid from said pipe to opposite ends of said motor cylinder so as to reciprocate said motor piston therein; inlet means in the lower end of said pump mechanism for conducting well fluid thereinto; a first inlet passage in said pump mechanism communicating between said inlet means and the upper end of said pump cylinder; a second inlet passage in said pump mechanism communicating between said inlet means and the lower end of said pump cylinder; an upper discharge passage communicating between the upper end of said pump cylinder and said second fluid-receiving space; a lower discharge passage communicating between the lower end of said pump cylinder and said second fluid-receiving space; and inlet and discharge valve means for controlling the inlet and discharge of well fluid through said inlet and discharge passages, said pilot valve being connected with said motor piston and being adapted to be actuated thereby to control movement of said master valve by controlling the application thereto of said motor operating fluid and fluid derived from said fluid-receiving spaces.

31. In a well pump mechanism, the combination of: a well tubing; a fluid operated motor in said tubing comprising a motor cylinder and a motor piston therein; a fluid pump in said tubing below said motor comprising a cylinder and a pump piston therein; means forming a seal between said tubing and said fluid pump; means providing a production passage for fluid between said tubing and said motor cylinder and between said tubing and said pump cylinder; means for alternately admitting operating fluid to opposite ends of said motor cylinder to reciprocate the motor piston therein; upper inlet means for conducting well fluid into the upper end of said pump cylinder; lower inlet means for conducting well fluid into the lower end of said pump cylinder; upper discharge means for conducting well fluid from the upper end of said pump cylinder to said production passage; lower discharge means for conducting well fluid from the lower end of said pump cylinder to said production passage; a rod connecting said motor piston to said pump piston; and a second rod connected to and extending beyond said pump piston to a point below said lower inlet and discharge means.

32. In a well pump mechanism, the combination of: a well tubing; a fluid operated motor in said tubing comprising a motor cylinder and a motor piston therein; means forming a first fluid-receiving space between said motor and said tubing; a fluid pump in said tubing comprising a pump cylinder and a pump piston therein; means forming a second fluid-receiving space between said pump and said tubing, said first and second fluid-receiving spaces being in communication with each other; means forming a seal between said fluid pump and said tubing below said second fluid-receiving space; means for alternately admitting operating fluid to opposite ends of said motor cylinder to reciprocate the motor piston therein; inlet means for respectively conducting well fluid into the upper and lower ends of said pump cylinder; discharge means for respectively conducting well fluid from the upper and lower ends of said pump cylinder to said second fluid-receiving space; a rod connecting said motor piston to said pump piston; and a second rod extending from said pump piston to a point below the inlet and discharge means in the lower end of said pump cylinder.

33. In a pumping mechanism for use in deep well pumps, the combination of: a well tubing having fluid inlet and outlet means, a fluid motor having a motor piston and being disposed within said tubing, said piston being adapted to be operated by fluid derived from a column of the same under high pressure; a fluid pump having a pump piston operatively connected to said motor piston and adapted to be actuated thereby, said pump also having inlet and discharge means for well fluid; and means comprising a master valve and a pilot valve operatively associated with said fluid motor to control the admission of said fluid under pressure into said motor to actuate said motor piston and also to control the exhaust of said fluid from said motor, there being passageways associated with said fluid motor and said pump into which exhaust fluid from said motor and the fluid discharged from said pump become intermixed, said pilot valve controlling

movement of said master valve by controlling the application thereto of the pressure of fluid derived from said high pressure fluid column and the pressure of fluid derived from the passageways containing said mixture of motor exhaust fluid and pump discharge fluid.

34. In a pumping mechanism for use in deep well pumps, the combination of: a well tubing having fluid inlet and outlet means, a fluid motor having a motor piston and being disposed within said tubing, said piston being adapted to be operated by fluid derived from a column of the same under high pressure; a fluid pump having a pump piston operatively connected to said motor piston and adapted to be actuated thereby, said pump also having inlet and discharge means for well fluid; and means comprising a master valve and a pilot valve operatively associated with said fluid motor to control the admission of said fluid under pressure into said motor to actuate said motor piston and also to control the exhaust of said fluid from said motor, there being passageways associated with said fluid motor and said pump into which exhaust fluid from said motor and the fluid discharged from said pump become intermixed, said pilot valve controlling movement of said master valve by controlling the application thereto of the pressure of fluid derived from said high pressure fluid column and the pressure of fluid derived from the passageways containing said mixture of motor exhaust fluid and pump discharge fluid, said master valve being responsive to pressure differentials and having one end surface of greater area than the opposite end surface thereof.

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## Disclaimer

2,081,220.—*Clarence J. Coberly*, Los Angeles, Calif. LIQUID OPERATED PUMP. Patent dated May 25, 1937. Disclaimer filed June 4, 1951, by the assignee, *Kobe, Inc.*

Hereby enters this disclaimer to claims 33 and 34 of said patent.

[*Official Gazette July 10, 1951.*]

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34. In a pumping mechanism for use in deep well pumps, the combination of: a well tubing having fluid inlet and outlet means, a fluid motor having a motor piston and being disposed within said tubing, said piston being adapted to be operated by fluid derived from a column of the same under high pressure; a fluid pump having a pump piston operatively connected to said motor piston and adapted to be actuated thereby, said pump also having inlet and discharge means for well fluid; and means comprising a master valve and a pilot valve operatively associated with said fluid motor to control the admission of said fluid under pressure into said motor to actuate said motor piston and also to control the exhaust of said fluid from said motor, there being passageways associated with said fluid motor and said pump into which exhaust fluid from said motor and the fluid discharged from said pump become intermixed, said pilot valve controlling movement of said master valve by controlling the application thereto of the pressure of fluid derived from said high pressure fluid column and the pressure of fluid derived from the passageways containing said mixture of motor exhaust fluid and pump discharge fluid, said master valve being responsive to pressure differentials and having one end surface of greater area than the opposite end surface thereof.

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