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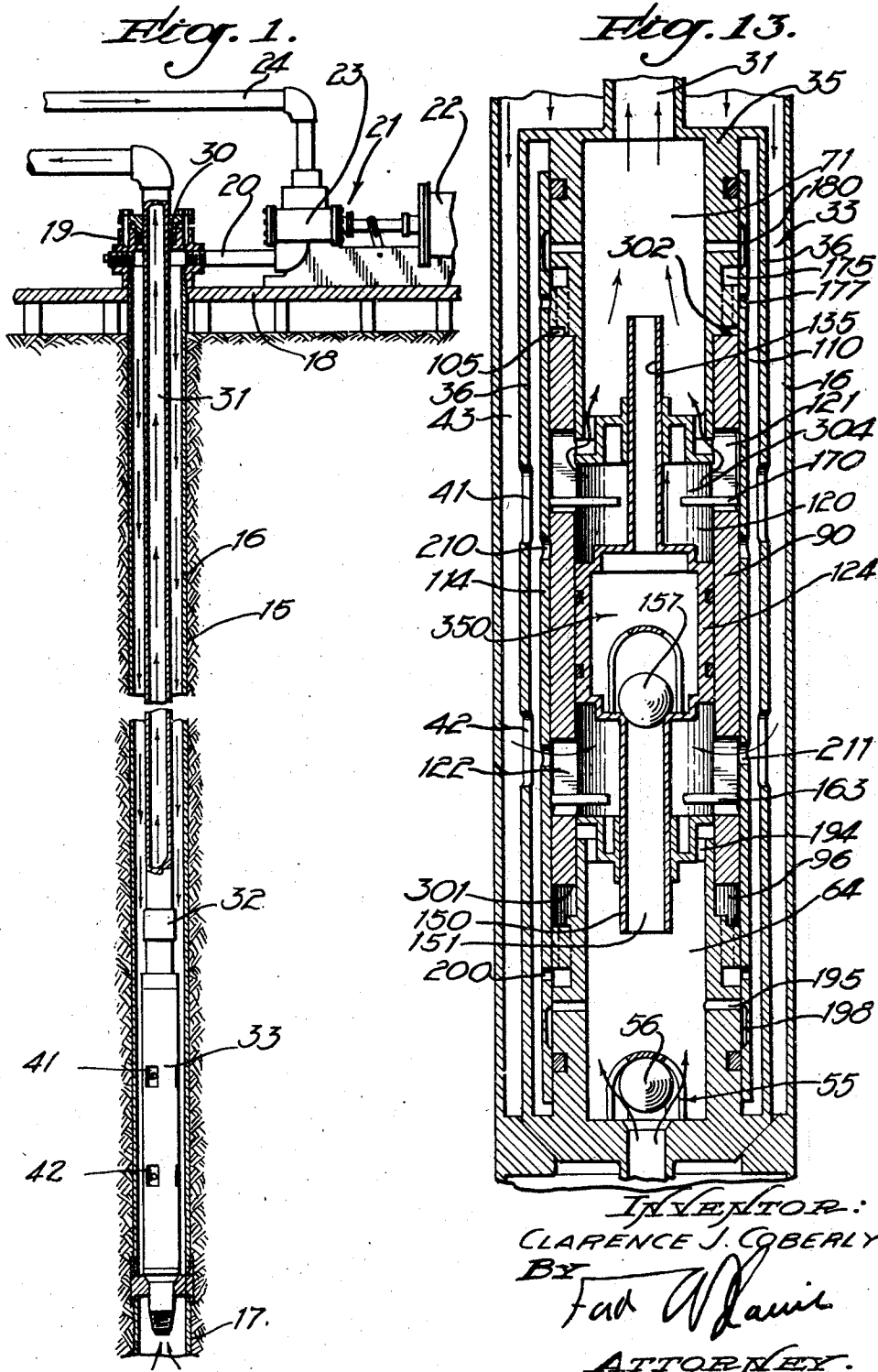
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DEEP WELL FLUID MOTOR PUMP

Filed April 5, 1926

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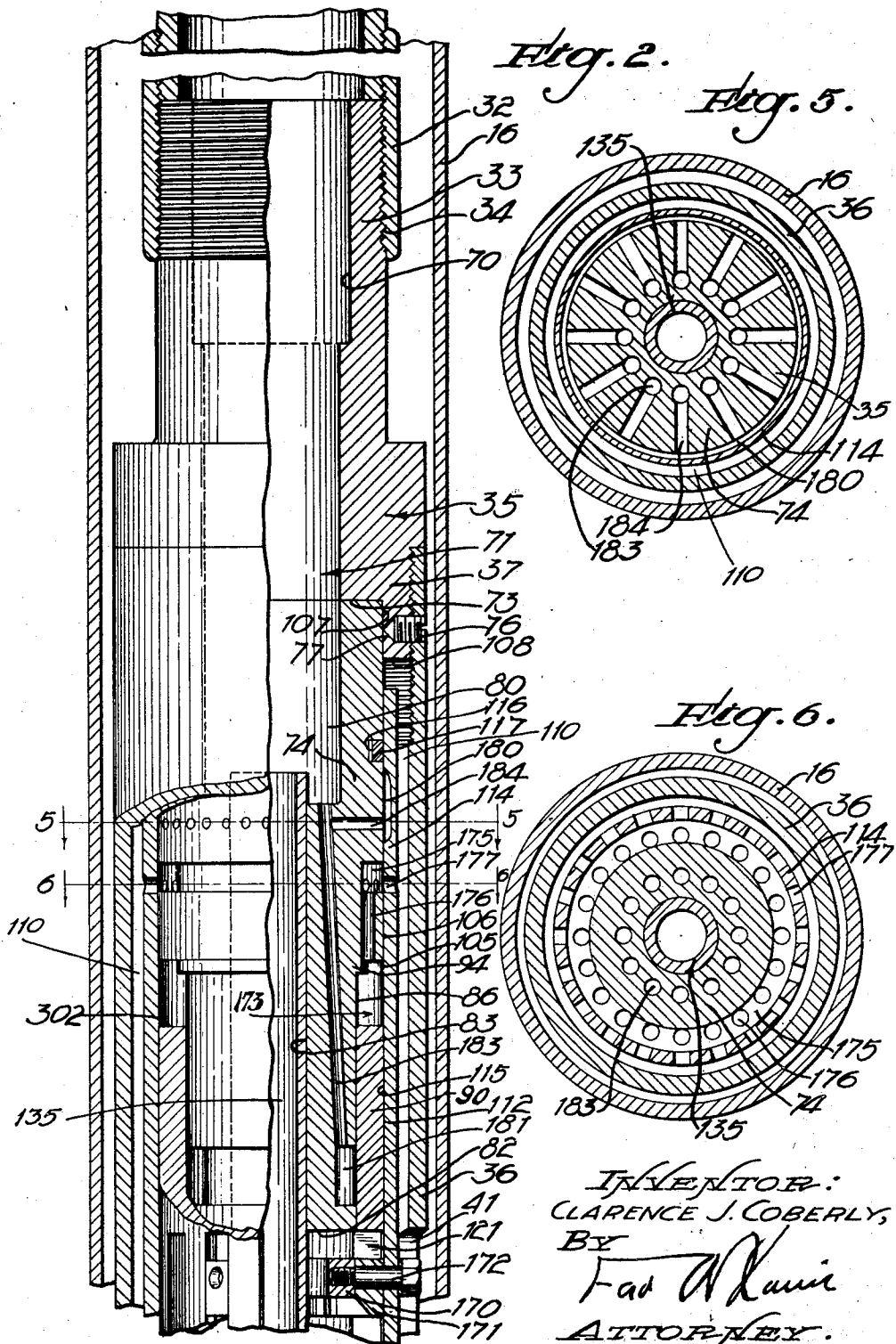
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DEEP WELL FLUID MOTOR PUMP

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5 Sheets-Sheet 2



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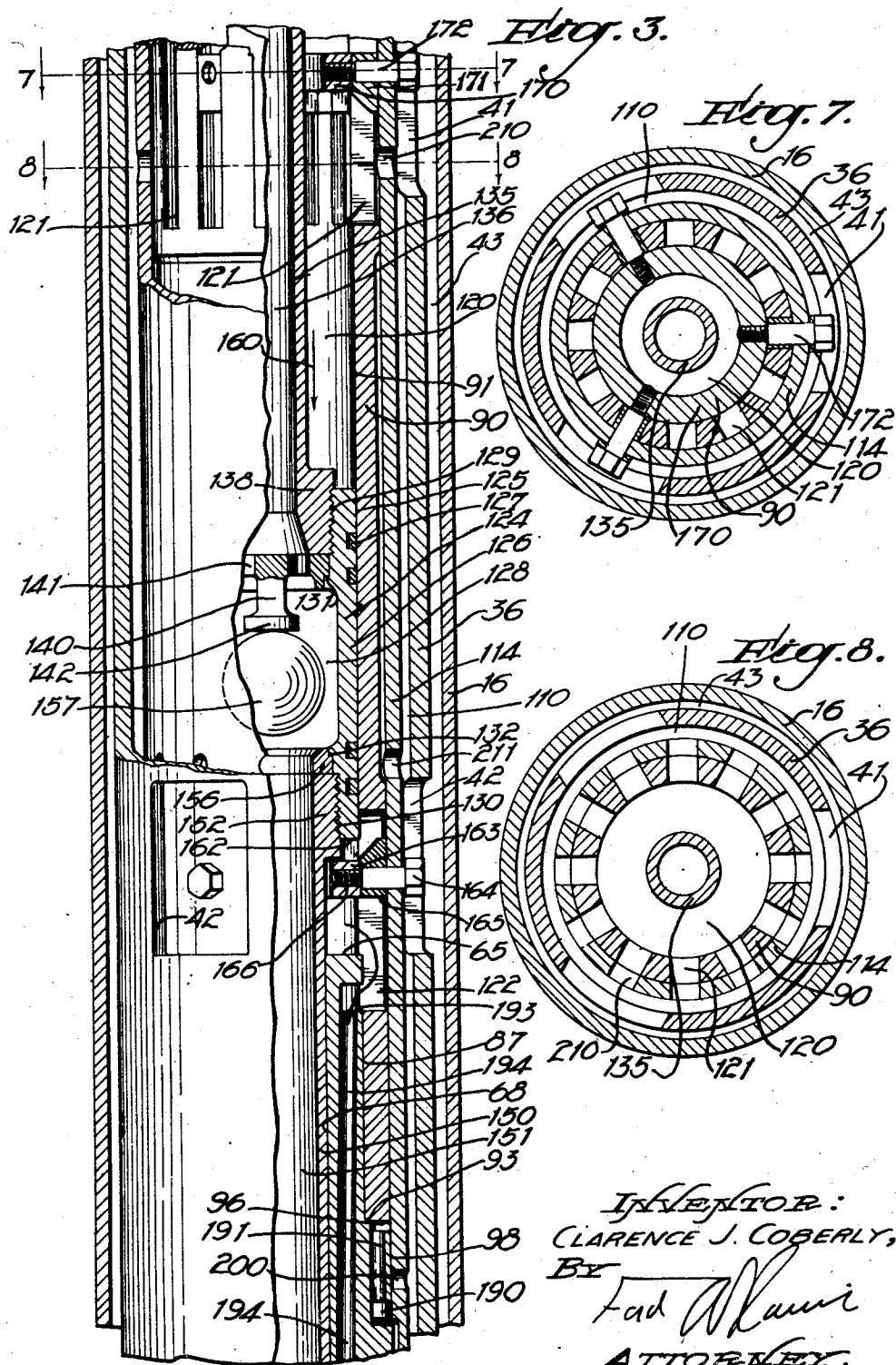
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DEEP WELL FLUID MOTOR PUMP

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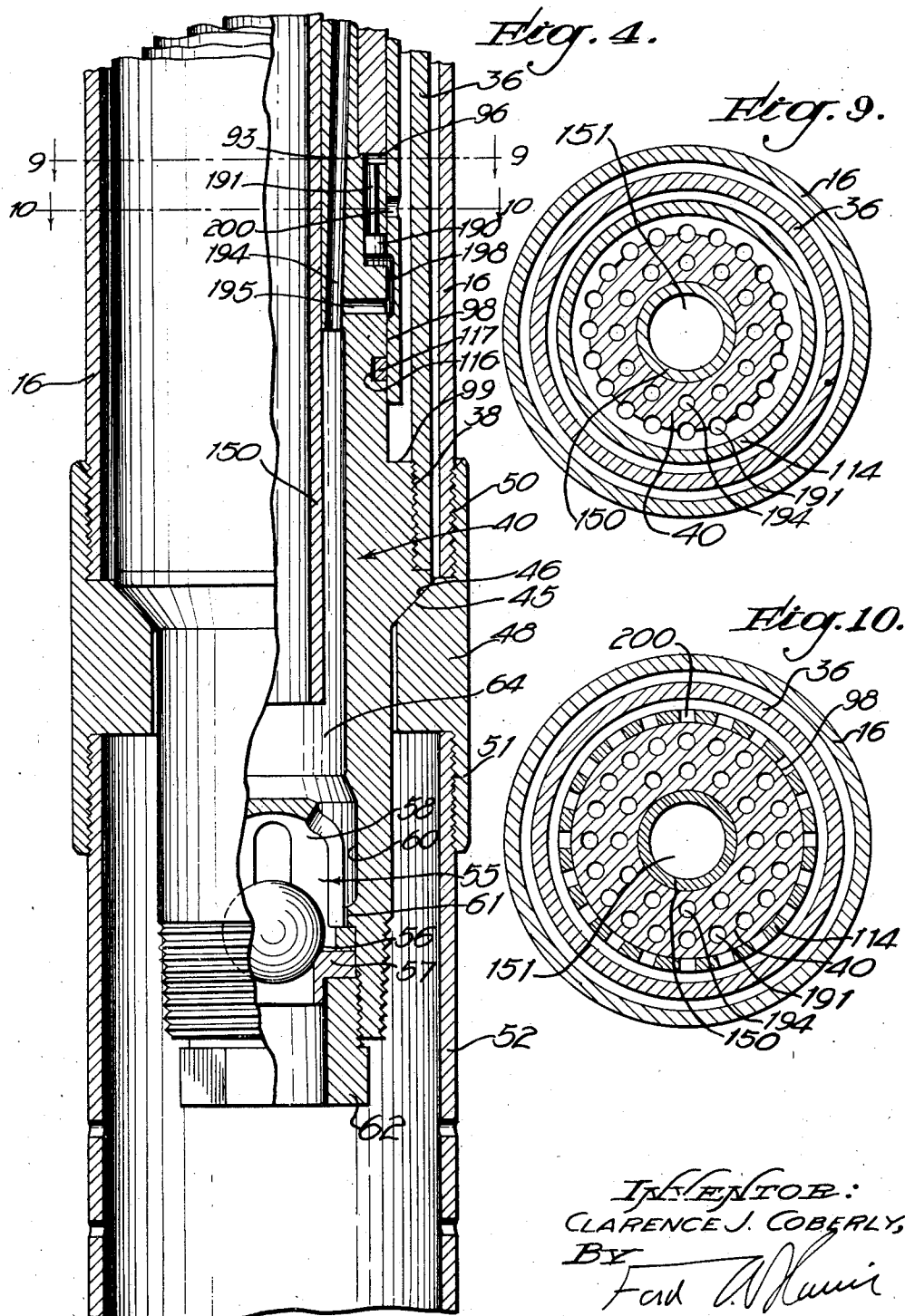
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DEEP WELL FLUID MOTOR PUMP

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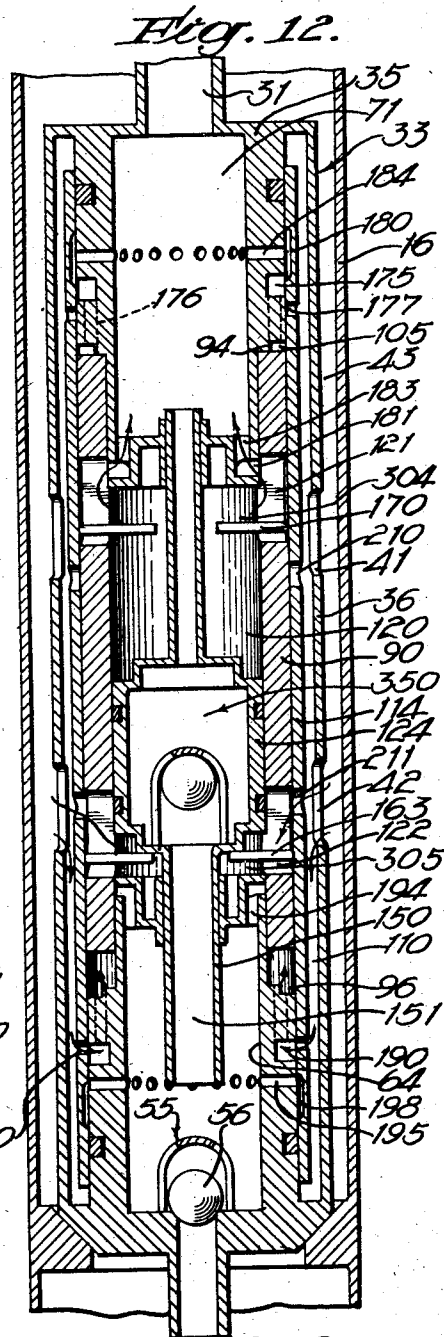
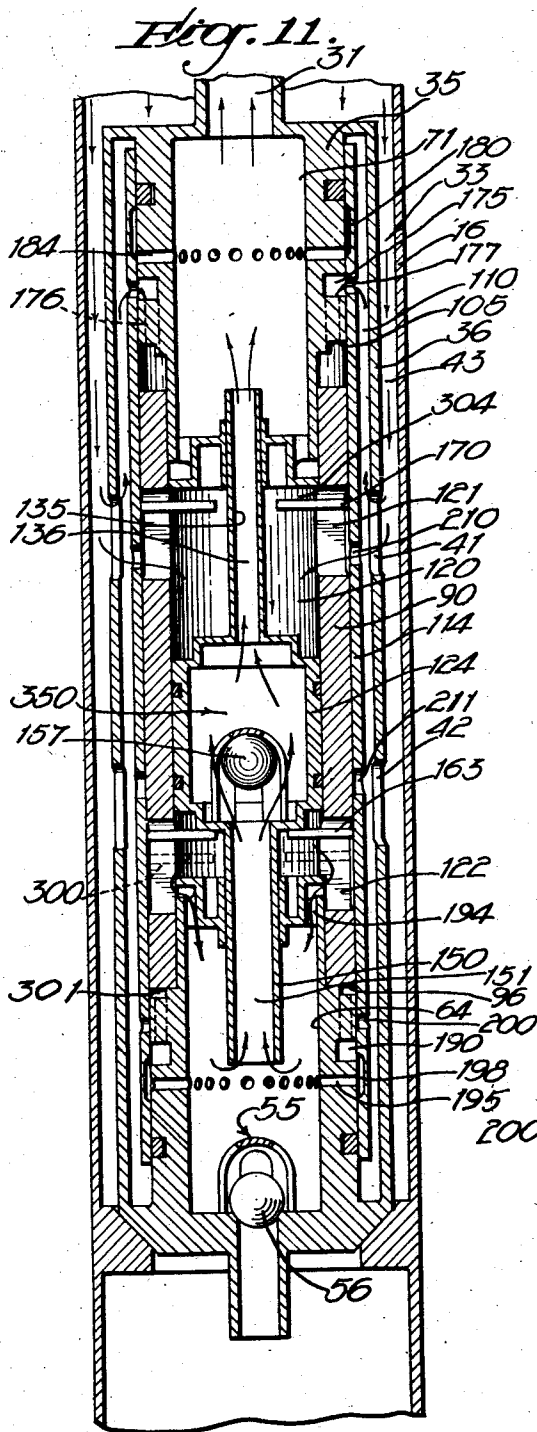
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5 Sheets-Sheet 5



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DEEP WELL FLUID MOTOR PUMP

Application filed April 5, 1926. Serial No. 99,729.

My invention relates to pumping equipment and more particularly to a deep well fluid motor pump.

In the art of pumping oil from deep wells many difficulties are encountered which, in spite of the immense amount of effort expended in improving deep well pumping equipment, have not been overcome. The reciprocating sucker rod pump which is in almost universal use today is notably inefficient.

Many attempts to design a fluid motor pump to take the place of the reciprocating sucker rod deep well pump have yielded no satisfactory result. This form of pump has a fluid pump and a fluid motor for operating the pump, these being adapted to be disposed at the bottom of a deep well and to be operated by a column of oil leading downwardly through a pipe from the top of the well to the motor. Oil is injected into the upper end of the motor supply pipe to maintain a certain pressure at the lower end thereof. Well oil discharged by the pump is mixed with operating oil exhausted from the motor, and flows upwardly through the casing surrounding the motor supply pipe.

One reason for the previous failure of this kind of pump is that if it is necessary to stop the flow of operating oil to the motor for more than a very short period of time, and thus halt the flow of the oil being discharged upwardly through the well casing, in which the motor pump and supply pipe are disposed, the sand suspended in the discharged oil settles into the lower end of the well casing, closing the discharge and exhaust ports of the motor pump and packing around and over the pump so solidly that the pump cannot either be operated again or drawn to the surface and cleaned out.

My fluid motor deep well pump is secured to the lower end of a line of pump tubing which passes down the well through the oil string or innermost well casing. The space between the lower end of the motor pump and the oil string is sealed tight. An operating fluid, preferably light crude oil, is pumped down the well between the pump tubing and the oil string. This operating fluid passes

through the motor pump and is exhausted up through the pump tubing. In passing through the motor pump the operating fluid causes the pump to draw well oil from the bottom of the well and discharge it up into the pump tubing.

Thus the sand carrying oil discharged from the motor pump is conveyed upwardly through the same tubing to the lower end of which the motor pump is attached. It is impossible, therefore, for the motor pump to be sanded in at the bottom of the well for if the operation of the motor pump should be halted for a considerable time, the sand would settle entirely within the pump tubing. If this was sufficient in quantity to clog the motor pump, it could be raised for cleaning purposes to the surface of the ground by drawing the pump tubing from the well.

It is therefore an object of my invention to provide a deep well fluid motor pump, the operation of which may be halted without danger of the motor pump being sanded in at the bottom of the well.

In many previous deep well fluid motor pumps, as well as in the sucker rod pump, a fluid pressure having a head of several thousand feet is imposed upon the upper end of the pump plunger. This fluid pressure, being unbalanced by an equal fluid pressure beneath the plunger, tends to force sand between the barrel and the plunger. This rapidly wears the surfaces of the barrel and plunger, causing a leakage of oil around the plunger.

In my deep well motor pump, the motor and the pump are combined so as to have an entirely novel relation to each other. My motor pump has a body comprising a perforated outer shell and upper and lower heads secured in the ends of this shell. The pump plunger is divided into upper and lower halves, each of which slides in one of two pump barrels formed in the upper and lower body heads. The upper and lower plungers are solidly secured at their inner ends to a motor piston which slides in a motor cylinder disposed between the upper and lower body heads. The motor piston and

cylinder, and the pump plungers and barrels, are all concentric with each other and cylindrical in form. A valved conduit is formed through the piston-plunger unit for the passage of fluid.

Valved means are provided for supplying well oil to an inlet chamber formed in the lower head below the lower pump barrel. A discharge chamber is also formed in the upper head, above the upper pump barrel, which communicates with the lower end of the pump tubing.

The piston-plunger unit is adapted to be reciprocated, well oil being pumped upwardly through it into the pump tubing by this reciprocation. Reciprocation of the piston plunger unit is accomplished by the admission of operating fluid from outside the pump alternately into opposite ends of the motor cylinder. Operating fluid is exhausted into the inlet chamber from the lower end of the motor cylinder during the down stroke of the piston-plunger unit and operating fluid is exhausted from the upper end of the motor cylinder into the discharge chamber during the upward stroke of the piston-plunger.

Except for the substantial fluid-tight fit of the plungers in their barrels, these barrels would communicate between the upper and lower ends of the motor cylinder and the inlet and discharge chambers, respectively. The clean oil fluid pressure in the motor cylinder is always higher than the sandy well oil fluid pressure in either of the body head chambers. The clean oil thus always flows, in a very thin film, from the motor cylinder to the head chambers, between the plungers and their respective barrels, keeping their areas of contact free from sand.

It is another object of my invention, therefore, to provide a deep well fluid motor pump in which clean oil is disposed on the opposite end of a plunger from the end thereof which contacts well oil, the clean oil being maintained at a constantly higher pressure than the well oil during the operation of the pump.

The exhaust of clean oil from the motor cylinder into the inlet and discharge chambers, as above outlined, is made through ports which direct the exhausted clean oil against the surface of the plunger which is emerging, at the time, from the outer mouth of its respective pump barrel. This thoroughly washes down the friction surface of each plunger during each cycle of the motor pump. Also any sandy well oil which might otherwise be disposed around the plungers when they project into their respective head chambers, is displaced by clean oil which prevents access of sand to the wearing surfaces of the pump plungers and barrels.

Another object of my invention is to provide a means in which the clean operating

oil exhausted from the motor is utilized to wash down the plungers where these project from their respective barrels, thus preventing the access of sandy well oil to the friction surfaces of the plungers.

The exhaust of clean oil from the motor cylinder into the inlet chamber, besides washing the lower plunger, washes the standing valve, preventing any deposit of sand from forming which would interfere with the operation of this valve.

It is another object of my invention to provide a means in which the clean operating oil exhausted from the motor is utilized to wash the standing valve of the pump.

In order to cause the upward flow of oil through the pump tubing to continue during the down stroke of the piston-plunger, the lower plunger and barrel are made of larger diameter than the upper plunger and barrel.

A further object of my invention is to provide a means in which upper and lower plungers cause a net upward discharge of fluid on the downward movement of the plungers due to a difference in the diameters of said plungers.

The control of ports admitting operating fluid to alternate ends of the motor cylinder and of exhaust ports concurrently releasing fluid from the opposite end of the motor cylinder is accomplished through a fluid shifted valve. This valve is in the form of a tubular member which not only acts as a valve but forms the cylindrical shell of the motor cylinder, thus combining two parts in one and simplifying the construction of my motor pump.

Yet another object of my invention is to provide a deep well fluid motor pump in which a tubular motor control valve also forms the shell of the motor cylinder.

The position of the fluid shifted valve is controlled by a mechanically shifted valve, the latter being formed as a cylindrical sleeve slidably fitting upon the outside of the fluid shifted valve member, and mechanically shiftable by the piston-plunger on its approach to its end positions. The members of my deep well fluid motor pump including the piston, the plungers, the pump barrels, the motor cylinder and valve member, and the mechanically shiftable valve are all formed concentric with each other and are disposed in the perforated housing shell so that an annular space remains between the housing shell and the mechanically shiftable valve to serve as a passageway for admitting operating oil to the inlet ports. Moreover, the parts used in this concentric construction are economically produced, no castings with cored cavities being necessary. Also this concentric construction makes possible the utmost utility of the limited space available in the bottom of a well in which to place a pump.

Other objects and advantages will be evident in the following specification and accompanying drawings in which:

Fig. 1 is a diagrammatic view showing a well with which the motor pump of my invention is associated.

Fig. 2 is a fragmentary view, partly in section, of the upper portion of my motor pump.

Fig. 3 is a fragmentary view, partly in section, illustrating the middle portion of my motor pump.

Fig. 4 is a fragmentary view, partly in section, illustrating the lower portion of my motor pump.

Fig. 5 is a horizontal sectional view taken on the line 5—5 of Fig. 2.

Fig. 6 is a horizontal sectional view taken on the line 6—6 of Fig. 2.

Fig. 7 is a horizontal sectional view taken on the line 7—7 of Fig. 3.

Fig. 8 is a horizontal sectional view taken on the line 8—8 of Fig. 3.

Fig. 9 is a horizontal view taken on the line 9—9 of Fig. 4.

Fig. 10 is a horizontal sectional view taken on the line 10—10 of Fig. 4.

Fig. 11 is a diagrammatic sectional view showing the mechanism of my motor pump in which the piston-plunger member is approaching its lowermost position.

Fig. 12 is a similar view to Fig. 11 showing the piston-plunger in its normal lowermost position.

Fig. 13 is a view similar to Fig. 11 showing the piston-plunger midway between its extreme positions and traveling upwardly.

Referring specifically to the drawings, Fig. 1 shows a well 15 in which an oil string of well casing 16 is disposed leading from the bottom 17 of the well 15 upwardly through the floor 18 of the derrick of the well. Above the floor 18 a casing head 19 is screwed upon the upper end of the oil string 16. A pipe 20 connects the casing head 19 with the exhaust end of a high pressure fluid pump 21. The pump 21 has a steam cylinder 22 and a compressing cylinder 23 which has an inlet pipe 24 through which it may draw fluid from a tank or other sources of supply (not shown). Passing through a packing gland 30 in the casing head 19 is a pump tubing 31 which extends downwardly through the oil string 16 to a point near the bottom 17 of the well 15. Upon the lower end of the tubing 31 is a coupling 32 which joins the tubing 31 to the motor pump 33 of my invention.

Threadedly received in the lower end of the coupling 32 is a threaded end 34 of an upper body head 35 of my motor pump. A body housing formed by a cylindrical shell 36 is provided with internal threads at its upper end which are adapted to threadedly receive a lower annular threaded shoulder 37 of the upper head 35, as shown in Fig. 2.

The shell 36 extends downwardly and has internal threads 38 at its lower end in which a lower body head 40 is threadedly received. Openings 41 and 42 are formed in the shell 36 to allow operating fluid which may be disposed in a space 43 between the oil string and the motor pump 33 to pass inwardly through the shell 36. The shell 36 thus holds the heads 35 and 40 in fixed vertical spaced relationship and co-axially aligned.

Provided upon the lower body head 40 is an outer conical seat 45 which rests upon and forms a fluid-tight joint with a seat 46 formed upon a special joint member 48 having upper and lower internally threaded coupling portions 50 and 51, the coupling 50 threadedly receiving the lower end of the oil string 16 and the coupling 51 threadedly receiving a perforated pipe 52. In the lower end of the lower body head 40 is provided a standing valve 55 in which a ball 56 rests upon a seat 57 and is retained against displacement by a cage 58.

The standing valve 55 is disposed in an opening 60 formed centrally in the lower end of the lower body head 40 and is held securely against a shoulder 61, formed in the opening 60, by a nipple 62. Communicating with the opening 60 is a well-oil inlet chamber 64 which is formed centrally in the lower body head 40. The lower body head 40 extends upwardly above the upper end of the inlet chamber 64 to an upper face 65. Formed centrally in the lower body head 40 so as to communicate between the upper face 65 and the inlet chamber 64 is a cylindrical cavity forming a lower pump barrel 68, the purpose of which will be described later.

A central opening 70 is formed in the upper body head 35 which communicates between the lower end of the pump tubing 31 and a discharge chamber 71 also formed in the upper body head 35. The upper head 35 has a socket 73 in which a lower extension 74 is adapted to fit. This extension is retained therein by a set screw 76 which is threadedly tapped into a threaded hole 77 formed through the shell 36 and the lower threaded shoulder 37 of the upper head 35. This extension 74 has a central cavity 80 therein which forms the lower portion of the discharge chamber 71. In the present description and claims the extension 74 will be considered as an integral part of the upper body head 35, the joint just described between the upper head 35 and the extension 74 thereof being necessary purely for the purpose of making the motor pump easier to assemble.

From the lower end of the cavity 80 the upper body head 35 extends downwardly to a lower flat face 82. Connecting the space below the face 82 with the discharge chamber 71 is a cavity forming an upper pump barrel 83. The cylindrical shell 36 is of such length that the faces 65 and 82 are main-

tained a fixed distance apart, as shown in Figs. 2, 3 and 4.

Formed upon the upper head 35 and extending upwardly from the face 82 is an external cylindrical surface 86. Formed on the upper portion of the lower head 40 and extending downwardly from the face 65 is an external cylindrical surface 87 of the same diameter as the surface 86 and co-axially aligned therewith. A cylindrical tubular member 90, having an internal cylindrical surface 91 of such diameter as to make a fluid-tight fit upon the cylindrical surfaces 86 and 87, is disposed between the upper and lower heads 35 and 40 so that the opposite ends of the tubular member 90 slidably fit over the surfaces 86 and 87. The surface 87 terminates at its lower end at an annular shoulder 93 formed upon the lower head 40, and the surface 86 terminates at its upper end at an annular shoulder 94 formed upon the upper body head 35. An annular recess 96 surrounds the shoulder 93, and an external cylindrical surface 98 is formed on the lower head 40 so as to extend downwardly from the recess 96 to a shoulder 99 which is formed to extend inwardly from the upper end of the threaded portion 38 of the lower body head 40. An annular recess 105 is formed in the upper head 35 about the annular shoulder 94. The surface of the recess 105 joins an external cylindrical surface 106 formed on the upper head 35 which extends upwardly to join co-extensively with the outer cylindrical surface 107 of the upper end of the extension 74 which fits neatly into the socket 73. A flat face 108 is formed upon the lower end of the threaded shoulder 37, which face 108 forms the upper wall of an annular enclosed space 110 which is bounded by the shell 36 on the outside and by the heads 35 and 40 on the ends and by the tubular member 90 on the inside.

The tubular member 90 has an outer cylindrical surface 112 which is of the same diameter and which is co-axially aligned with the surfaces 98 and 106 formed on the lower and upper heads 35 and 40 respectively. A mechanically operated valve sleeve 114 is disposed in the inner portion of the space 110, and the inner cylindrical surface 115 thereof fits slidably with a fluid-tight fit upon the surfaces 98, 106, and 112. The outer portion of the space 110 is left vacant, as shown. Retained in suitable recesses 116 formed in the cylindrical surfaces 98 and 106 are expansion rings 117 which press against the inner cylindrical surface 115 of the sleeve 114, frictionally retaining this sleeve against longitudinal displacement from any given position by the application of less than a given pressure.

Bounded at the upper and lower ends by the flat surfaces 82 and 65 of the upper and lower heads respectively and on the outside by the inner cylindrical surface 91 of the

tubular member 90 is a motor cylinder 120. At the upper and lower ends thereof are radial series of ports 121 and 122 respectively which are formed in the wall of the member 90 so that the individual slots are equally spaced from each other.

Disposed in the cylinder 120 is a motor piston 124 which has an outer cylindrical surface 125 which fits in fluid-tight sliding engagement with the inner surface 91 of the member 90. This piston 124 has a shell portion 126, the outer surface 125 of which is recessed to provide seats for packing rings 127 which expand outwardly against the inner surface 91 of the member 90 and yieldingly resist longitudinal movement of the piston 120 in the member 90.

The shell portion 126 has a central cavity 128 which communicates through openings 129 and 130 with the upper and lower ends respectively of the piston 124. At the juncture of the cavity 128 and the openings 129 and 130 are formed shoulders 131 and 132. Slidably disposed in the upper pump barrel 83 formed in the upper head 35, and making a fluid-tight fit therewith, is an upper pump plunger 135 through which a central opening 136 extends. Formed upon the lower end of the upper plunger 135 is a threaded head portion 138 which is threadedly received into internal threads which are provided in the upper end of the opening 129 in the motor piston 124. Seated against the shoulder 131 and held firmly thereagainst by the plunger head portion 138 is a ball stop member 140 which has holes 141 which communicate between the inner cavity 128 of the plunger 126 and the central opening 136 of the upper plunger 135. The ball stop member 140 has a downward extending projection 142, the purpose of which will be described later.

Slidably disposed in the lower pump barrel 68, and adapted to make a fluid-tight fit therewith, is a lower pump plunger 150 which has a central opening 151 extending throughout the length thereof. At the upper end of the plunger 150 a threaded head portion 152 is formed which is screwed into the threads provided in the lower end of the opening 130 in the piston 124. Held tightly in place between the shoulder 132 and the upper end of the threaded head 152 is a working ball valve seat 156. Resting upon the seat 156 is a working valve ball 157.

As will be seen by reference to Fig. 3 the motor piston 124 is adapted to slide up and down in the tubular member 90 and in this view it is shown moving downwardly in the direction of the arrow 160 and approaching its lowermost normal position in the member 90. In Figs. 2, 3 and 4 the rest of the mechanism of the pump is shown in the position which it maintains throughout the downward stroke of the piston 124 in the member 90. Moreover, the piston 124 is

shown in Fig. 3 at the moment at which the lower surface 162 thereof comes in contact with a lower contact member, in the form of a crown ring 163, which is disposed about the lower plunger 150 in the lower end of the motor cylinder chamber 120. This ring 163 is secured to the sleeve 114 by means of bolts 164 which pass through suitable apertures formed in the sleeve 114, through apertured spacing blocks 165, each of which is disposed in a port 122 and which snugly fills the space between the ring 163 and the sleeve 114, the inner end of the bolts 164 being threadedly received in suitably threaded holes 166 provided in the ring 163.

Disposed in the upper end of the cylinder chamber 120 is an upper contact member in the form of an inverted crown ring 170 which is secured, through blocks 171 disposed in the ports 121, to the sleeve 114 by bolts 172 in the same manner as the ring 163 is secured to the shell 114 by the bolts 164.

By reference to Figs. 2 and 3 it will be noted that the lower end of the tubular member 90 is in contact with the shoulder 93 while the upper end of the member 90 is disposed downwardly at a distance from the shoulder 94. This distance is the amount of longitudinal play which the member 90 has in a tubular-member chamber 173 when this member slides upon the cylindrical surfaces 86 and 87 formed upon the body heads 35 and 40 respectively.

An external annular recess 175 is formed in the outer cylindrical surface 106 of the upper body head 35 a distance above the recess 105. Holes 176 are bored to connect the recess 175 with the recess 105 when the sleeve 114 is in the position in which it is shown in Fig. 2. Upper ports 177 provided in this sleeve open a passageway from the space 110, through the annular recess 175 and the holes 176 to the recess 105, these ports, together with the recess 175 and the holes 176, forming an intake means to the upper end of the tubular-member chamber. An internal annular recess 180 is formed in the inner cylindrical surface 115 of the sleeve 114 a distance above the location of the ports 177, the purpose of the recess 180 being described later.

An external annular recess 181 is formed in the outer cylindrical surface 86 a distance above the conjunction of the flat surface 82 therewith. Connecting the recess 181 with the discharge chamber 71 are holes 183, the recess 181 and holes 183 cooperating to form a discharge passage through the upper head 35. Ports 184 are drilled in through the lower portion of the upper pump head 35 to communicate between the upper ends of the holes 183 and the outer cylindrical surface 106, the holes 184 being located a given distance above the external annular recess 175 so as to allow the recess 180 to bridge

the ports 184 and the recess 175 when the valve sleeve 114 is in a lower position, the ports 184 at this time cooperating with the recesses 180 and 175 and the holes 176 to form an exhaust means for the upper end of the tubular-member chamber 173.

An external annular recess 190 is formed in the surface 98 of the lower body head 40 a distance below the recess 96 and is connected to the recess 96 by holes 191 bored in the head 40. An annular recess 193 is formed in the outer surface 87 of the head 40 a distance below the juncture of this surface and the flat upper end 65 of the head 40. Holes 194 bored in the head 40 connect the recess 193 with the well oil inlet chamber 64. Communicating between the cylindrical surface 98 on the lower head 40 and the lower end of the holes 194 are holes 195.

As shown in Fig. 4 an internal annular recess 198 is formed in the inner cylindrical surface 115 of the sleeve 114 such a distance from the lower end of the sleeve 114 that when the latter is in the position shown in Figs. 2, 3 and 4 the recess 198 will set up a communication between the recess 190 and the holes 195, thus connecting the recess 96 with the well-oil inlet chamber 64 in a manner to form an exhaust means from the lower end of the tubular-member chamber 173. Lower ports 200, which are similar in function to the upper ports 177, are formed in the lower end of the sleeve 114 a distance above the recess 198. In the position of the parts shown in Figs. 2, 3 and 4 the lower ports 200 will be opposite the portion of the cylindrical surface 98 which lies between the recesses 96 and 190 and, due to the fluid-tight fit between the sleeve 114 and the cylindrical surface 98, these ports will be closed. When, however, the valve sleeve 114 is in an uppermost position, the lower ports 200 will communicate with the lower end of the tubular-member chamber 173 through the recess 190 and the holes 121, thus forming an intake means to this lower end.

Operating fluid intake passages 210 and 211 are formed in the sleeve 114 at levels just below and just above the location of the bolts 172 and 164 respectively.

The operation of my pump is as follows:

Referring to Figs. 11, 12 and 13 which show diagrammatically three operating positions of the parts of my pump, it will be noted that Fig. 11 diagrammatically shows the pump at the same moment in its complete cycle of operation as that at which it is structurally illustrated in Figs. 2, 3 and 4. In the Figures 11, 12 and 13 the contact members 163 and 170 are shown, for convenience, as rods which are secured upon the sleeve 114 and, projecting inwardly through the ports 121 and 122 perform the same functions as the combined structure of the bolts 164 and 172 and the crown rings 163 and

170. The flow of fluid in Figs. 11, 12 and 13 is indicated by arrows.

In Fig. 11 operating fluid, which is forced down the oil string 16 by the steam pump 21, passes around the upper head 35 of the motor pump 33 into the space 43 between the oil string 16 and the outer shell 36 of the motor pump. From the space 43, the operating fluid passes through the openings 41 and 42 in the shell 36 into the space 110.

From the space 110 the operating fluid flows through the ports 177 into the annular recess 175 and through the holes 176 and thus enters the recess 105 and holds the member 90 downward in the position shown. In the view shown in Fig. 11 the sleeve 114 is shown in its normal uppermost position, and with the sleeve 114 in this position and the tubular member 90 in downward position, the intake passages 210 and ports 121 are in registry so that operating fluid passes from the space 110 into the upper end of the cylinder 120 and forces the piston 124 downwardly. While the member 90 and the sleeve 114 are in the above noted positions the ports 122 are disposed downwardly so as to set up communication between the lower end of the cylinder 120 and the inlet chamber 64 through the recess 193 and the holes 194 which form a discharge passage through the lower head 40.

As the plunger moves downwardly this obviously permits escape of the operating fluid disposed in the bottom end of the chamber 120 into the well-oil inlet chamber 64. The ports 121 are also disposed downwardly, shutting off communication between the upper end of the pump cylinder 120 and the upper discharge chamber 71 through the recess 181 and the holes 183. Also the intake passage 211 is now disposed upwardly out of registry with the ports 122 and the fluid-tight contact of the cylindrical surface 115 of the sleeve 114 with the outer cylindrical surface 112 of the member 90 closes communication between the ports 122 and the space 110 outside of the sleeve 114. Also lower ports 200 are out of registry with the external annular recess 190 and therefore communication through the ports 200 between the space 110 and the recess 190 is shut off. The internal annular recess 198, however, now overlaps both the external annular recess 190 and the holes 195, opening communication between the recess 96 and the well oil inlet chamber 64.

The upper and lower plungers 135 and 150 and motor piston 124 form a unitary piston-plunger member 350 which now moves downwardly. As the lower plunger 150 projects into the inlet chamber 64 the fluid which it displaces must find escape therefrom as well as a quantity of fluid equivalent to that exhausted into this chamber from the lower end of the cylinder 120. The standing valve ball

56 resists any downward flow of fluid out of the inlet chamber 64. Therefore, the fluid in this chamber must escape upwardly through the opening 151 in the lower plunger 150. As the fluid flows upwardly through the opening 151 the working valve ball 157 is lifted, the fluid passes through the cavity 128 in the piston 124, through the holes 141 in the ball cage 140, and upwardly through the opening 136 in the upper plunger 135. The fluid flowing upwardly through the piston-plunger member 350 during its downward movement and entering the discharge chamber 71 is considerably in excess of the displacement of the upper pump plunger which is withdrawn from the interior of the discharge chamber 71 during this downward movement. A flow of fluid from the discharge chamber 71 upwardly into the string of oil tubing 81 is therefore maintained during the downward stroke of the piston-plunger member 350.

Fig. 12 shows the piston-plunger 350 in its lowermost normal position. In this position the member 350 has moved downward a sufficient distance from the position in which it is shown in Fig. 11 so that the bottom face 162 of the piston 124, by engaging the contact member 163, moves the mechanically operated sleeve valve 114 downwardly the normal distance of its throw, into the position in which it is shown in full lines in Fig. 12. The position of the stops 163 for this position are indicated by dotted lines 300 in Fig. 11.

When the sleeve 114 is thus moved into its normal downward position the internal annular recess 180 is caused to set up communication between the ports 184 and the annular recess 175, thus opening the exhaust means from the upper end of the tubular-member chamber 173 into the discharge chamber 71. Also the lower ports 200 are moved downwardly opposite the recess 190 to set up a communication between the space 110 and the recess 96. The operating fluid at once rushes through the ports 200, the recess 190, and the holes 191, into the lower end of the tubular-member chamber 173 and exerts a force against the lower face 301 of the tubular member 90. The fluid pressure in the discharge chamber 71 being lower than that of the operating fluid admitted into contact with the lower face 301 of the member 90, the fluid is expelled from above the upper face 302 of the member 90 into the chamber 71, and the member 90 rises under the impulse of the operating fluid until the upper face 302 thereof comes in contact with the shoulder 94.

Thus the member 90 and the sleeve 114 assume their new relationship which is shown in Fig. 12. Here the ports 121 are disposed upwardly so as to set up communication between the upper end of the motor cylinder 120 and the discharge chamber 71 through the recess 181, and the exhaust holes 183 which

form a discharge passage through the upper head 35. Also the intake passages 210 are mismatched downwardly from the ports 121 so as to shut off communication between the space 110 and the upper end of the motor cylinder 120. The ports 122 are moved upwardly so as to shut off communication between the lower end of the cylinder 120 and the well oil inlet chamber 64, and the ports 211 are moved downwardly so as to register with the ports 122 and set up a communication between the space 110 and the lower end of the motor cylinder 120. Thus the piston-plunger member 350 is shown in Fig. 12 in its normal position at the termination of a downward stroke and the beginning of an upward stroke.

Operating fluid, flowing into the lower end of the motor cylinder 120, now moves the piston-plunger member 350 upwardly. Fig. 13 shows the piston-plunger 350 in the middle of an upward stroke. As the member 350 starts upwardly from the position in which it is shown in Fig. 12, the working valve 157 drops into closed position as it is shown in Fig. 13. With the closing of the working valve 157 and the upward movement of the plungers, a suction is imposed on the well oil inlet chamber 64. This opens the standing valve 55 and draws well oil into the chamber 64 from the inside of the perforated pipe 52. The working valve 157 being closed on the upward movement of the piston-plunger member 350, the plungers on this stroke act as the solid unit. Inasmuch as no fluid passes through the piston-plunger member 350 on this stroke the protrusion of the upper pump plunger 135 into the discharge chamber 71 decreases the space for fluid in this chamber and compels an equal quantity of fluid to flow out of this chamber up into the pump tubing 31. Moreover the fluid which flows from the upper end of the motor cylinder 120 into the discharge chamber 71 during the up stroke of the piston-plunger 350 causes an equal amount of fluid, in addition to that displaced by the upper pump plunger, to flow upwardly from the chamber 71 into the pump tubing 31.

It will thus be seen that on both the upward and downward strokes of the plungers a mixture of the operating fluid and the well oil is forced upwardly from the pump into the pump tubing 31. Inasmuch as a very short interval elapses between the finishing of one stroke of the piston-plunger member and the commencing of a stroke in the opposite direction, the flow of mixture of operating fluid and well oil upwardly from the pump into the tubing 31 is comparatively continuous. This is a great advantage inasmuch as the flow of oil upwardly through the tubing 31 is maintained at practically a constant rate and it is not necessary to expend effort in overcoming the inertia of the oil at each

stroke of the pump as is necessary with many pumps, including the sucker rod reciprocating pump.

If it is anticipated that, for any reason, the piston 124 might, due to unusual working conditions, overrun its "normal" end positions, the parts of my pump are capable of being proportioned to facilitate perfect functioning of the pump, as above described, in spite of this overrun. For instance, in Fig. 12, the sleeve 114 is shown in its "normal" downward position; yet when the piston 124 moved the sleeve 114 to this position, had the switching of inlet and exhaust ports at opposite ends of the motor cylinder chamber 120 been completed a small fraction of a second later than it was, the reversal in direction of travel of the piston 124 would have been delayed. This would have resulted in the piston 124 continuing downwardly a slight distance beyond its "normal" downward position.

In the proportion of the parts of my pump, as shown in the diagrammatic views of Figs. 11, 12 and 13, an overrun beyond normal end positions of the piston 124 sufficient to move the upper stop members 170 across the space 304, or move the lower stop members across the space 305, is allowed for. This overrun allowance is made sufficiently large in actual construction so that at no time will it be possible for the piston-plunger member 350 to come into forcible contact with a non-yielding portion of the pump's structure.

From the above description it will be seen that I have produced a fluid motor pump which will do away with the greatest troubles now experienced in deep well pumping. The wearing qualities of my pump will far exceed those of any pump previously designed for the same use. This will be due, mainly, to the low difference in the pressures imposed upon the opposite ends of the working elements, it not being necessary that this pressure exceed 600 pounds to the square inch. This is but a small part of the difference in the pressures upon the opposite ends of a reciprocating plunger operated by a sucker rod in the bottom of a 5000 foot well. Another feature contributing to the lasting qualities of my deep well fluid motor pump is the regular washing down of all bearing surfaces of the pump.

The space economies effected by the concentric sleeve construction of my motor pump, and the uniting of the motor cylinder and the fluid operated motor valve in a single tubular member 90 not only make it possible to design my motor pump to have operating piston and plunger areas of ample size, but permit it to be constructed at a comparatively low cost.

I claim as my invention:

1. A device of the class described having:

a continuous peripheral wall; heads formed at the opposite ends of said wall to form a closed power chamber therein; a power piston slidingly disposed in said chamber; upper and lower pump plungers slidingly disposed in upper and lower pump barrels formed in said heads, said pump plungers being unitarily formed with said piston and co-axially slidable therewith; means for introducing a fluid under pressure alternately into opposite ends of said power chamber to cause the reciprocation of said power piston, a valved passageway being formed longitudinally through said unitary piston and plunger structure, a valved pumped fluid inlet chamber being formed in one of said heads to communicate with one end of said piston-plunger passageway, and a pumped fluid discharge chamber being formed in the other of said heads to communicate with the other end of said piston-plunger passageway; and means for exhausting fluid from said power chamber, before said piston, into said inlet or said discharge chambers in a manner to wash a friction surface of said motor pump.

2. A device of the class described having: a continuous peripheral wall; heads formed at the opposite ends of said wall to form a closed power chamber therein; a power piston slidingly disposed in said chamber; upper and lower pump plungers slidingly disposed in upper and lower pump barrels formed in said heads, said pump plungers being unitarily formed with said piston and co-axially slidable therewith; means for introducing a fluid under pressure alternately into opposite ends of said power chamber to cause the reciprocation of said power piston, a valved passageway being formed longitudinally through said unitary piston and plunger structure, a valved pumped fluid inlet chamber being formed in one of said heads to communicate with one end of said piston-plunger passageway, and a pumped fluid discharge chamber being formed in the other of said heads to communicate with the other end of said piston-plunger passageway; and means for exhausting fluid from said power chamber, before said piston, the fluid exhausted from one end of said cylinder flowing into said inlet chamber in washing relationship with the valve thereof.

3. In a fluid-operated deep well pump, the combination of: walls defining a pump chamber and a cylinder in communication through a cavity; a containing member adjacent said walls for retaining an operating fluid in contact with said walls; a unitary piston-plunger member providing a piston slidable in said cylinder and a pumping plunger extending through said cavity and into said pump chamber, said walls providing openings for conducting operating fluid from said containing member into opposite ends of

said cylinder; sleeve valve means for controlling the admission of operating fluid into said cylinder through said openings; and means for exhausting operating fluid from said cylinder.

4. In a deep well motor pump, the combination of: a tubular member providing a cylinder, said tubular member having two ports therein each adapted to alternatively conduct an operating fluid to and from said cylinder; heads on opposite ends of said cylinder; a piston reciprocable in said cylinder under the influence of said operating fluid; and means timed by the displacement of said piston for controlling the supply and exhaust of operating fluid to and from said ports.

5. In a deep well motor pump, the combination of: a tubular member providing a cylinder, said tubular member having two ports therein each adapted to alternatively conduct an operating fluid to and from said cylinder; heads on opposite ends of said cylinder; a piston reciprocable in said cylinder under the influence of said operating fluid; and a sleeve surrounding said tubular member and movable relative thereto, said sleeve having intake passages therein adapted to supply operating fluid to said ports.

6. In a deep well motor pump, the combination of: a tubular member providing a cylinder, said tubular member having two ports therein each adapted to alternatively conduct an operating fluid to and from said cylinder; heads on opposite ends of said cylinder; a piston reciprocable in said cylinder under the influence of said operating fluid; and a sleeve surrounding said tubular member and movable relative thereto, said sleeve being moved in response to a movement of said piston and having intake passages therein adapted to supply operating fluid to said ports.

7. In a deep well motor pump, the combination of: a pair of spaced heads having discharge passages therethrough; a tubular member movable relative to said heads, said tubular member providing a cylinder therein alternately communicable with said discharge passages as said tubular member is moved; a piston in said cylinder; and means actuated by a displacement of said piston for alternately supplying an operating fluid to each side of said piston, said means also controlling the movement of said tubular member.

8. In a deep well motor pump, the combination of: a pair of spaced heads providing discharge passages therethrough; a tubular member movable relative to said heads, said tubular member having a cylinder therein alternately communicable with said discharge passages as said tubular member is moved; a piston in said cylinder; and means for alternately supplying an operating fluid

to each side of said piston, said means also controlling the movement of said tubular member.

9. In a deep well motor pump, the combination of: a pair of spaced heads providing discharge passages therethrough; a tubular member movable relative to said heads, said tubular member having a cylinder therein alternately communicable with said discharge passages as said tubular member is moved; a piston in said cylinder; and a sleeve surrounding said tubular member and being movable by a displacement of said piston, said sleeve having intake passages registering with ports in said tubular member to alternately supply an operating fluid to each side of said piston, said tubular member being actuated by a flow of operating fluid controlled by said sleeve.

10. In a deep well motor pump, the combination of: a pair of spaced heads providing discharge passages therethrough; a tubular member movable relative to said heads, said tubular member having a cylinder therein alternately communicable with said discharge passages as said tubular member is moved; a piston in said cylinder; and a sleeve surrounding said tubular member and being movable by said piston, said sleeve having intake passages registering with ports in said tubular member to alternately supply an operating fluid to each side of said piston.

11. In a deep well motor pump, the combination of: a pair of spaced heads providing discharge passages therethrough; a tubular member movable relative to said heads, said tubular member having a cylinder therein alternately communicable with said discharge passages as said tubular member is moved; a piston in said cylinder; and a movable sleeve surrounding said tubular member, said sleeve having intake passages registering with ports in said tubular member to alternately supply an operating fluid to each side of said piston, said tubular member being actuated by a flow of operating fluid controlled by said sleeve.

12. In a deep well motor pump, the combination of: a pair of spaced heads providing discharge passages therethrough; a tubular member movable relative to said heads, said tubular member having a cylinder therein alternately communicable with said discharge passages as said tubular member is moved; a piston in said cylinder; and a movable sleeve surrounding said tubular member, said sleeve having intake passages registering with ports in said tubular member to alternately supply an operating fluid to each side of said piston.

13. In a device of the class described, the combination of: walls forming a cylinder; upper and lower heads providing discharge and inlet chambers communicating with said cylinder; a piston slidable in said cylinder;

a pair of pump plungers secured to said piston and passing respectively through said heads in fluid-tight relationship and into said chambers; and valve means for admitting an operating fluid under pressure to said cylinder between said piston and one of said heads and controlling the exhaust flow of operating fluid from between said piston and the other of said heads into one of said chambers.

14. In a device of the class described, the combination of: walls forming a cylinder; upper and lower heads providing discharge and inlet chambers communicating with said cylinder; a piston slidable in said cylinder; a pair of pump plungers secured to said piston and passing respectively through said heads in fluid-tight relationship and into said chambers; valve means for admitting an operating fluid under pressure to said cylinder between said piston and one of said heads and controlling the exhaust flow of operating fluid from between said piston and the other of said heads into one of said chambers; a working valve operating in an opening connecting said chambers; and a standing valve operating in an inlet opening connecting said inlet chamber with the fluid to be pumped.

15. In a deep well motor pump, the combination of: a pair of spaced heads; a tubular member defining a cylinder and being slidable relative to said heads; a piston in said cylinder; and a valve movable by said piston, said valve and said tubular member cooperating to control an admission and exhaust of an operating fluid to and from said cylinder to move said piston.

16. A combination as defined in claim 15 in which said tubular member contains ports registerable with discharge passages in said heads to exhaust said operating fluid from said cylinder.

17. In a deep well motor pump, the combination of: a pair of spaced heads at least one of which provides a pump barrel; a tubular member defining a cylinder and slidable relative to said heads; a piston in said cylinder; a valve movable by said piston, said valve and said tubular member cooperating to control the admission and exhaust of an operating fluid to and from said cylinder to move said piston; a pump plunger operated by said piston and reciprocable in said pump barrel; and valved means carried respectively by said plunger and the head providing said pump barrel whereby said plunger pumps a well fluid when reciprocated.

18. In a deep well motor pump, the combination of: body heads; a tubular member mounted upon said heads and shiftable thereon to discharge an operating fluid from a cylinder in said tubular member; a valve sleeve adjacent said tubular member, said tubular member and said valve sleeve cooperating to admit operating fluid to said cylinder; a piston disposed in said cylinder

and adapted to be moved by said operating fluid; a plunger operated by said piston and reciprocable in a pump barrel formed in one of said heads; and valved means whereby the reciprocation of said plunger pumps a well fluid.

19. A combination as defined in claim 18 in which said tubular member is shiftable by fluid pressure controlled by said valve sleeve.

20. In a deep well motor pump, the combination of: a pair of spaced heads; a tubular member slidable relative to said heads and defining a cylinder therein, said tubular member having ports communicable with said cylinder and with discharge passages through said heads; a valve sleeve cooperating with said tubular member and said heads to form a tubular-member chamber in which said tubular member is moved, said valve sleeve having intake passages which cooperate with said ports in said tubular member to alternately supply an operating fluid to opposite ends of said cylinder; and a piston adapted to reciprocate in said cylinder under the influence of said operating fluid.

21. In a deep well motor pump, the combination of: a pair of spaced heads; a tubular member slidable relative to said heads and defining a cylinder therein, said tubular member having ports communicable with said cylinder and with discharge passages through said heads; a valve sleeve cooperating with said tubular member and said heads to form a tubular-member chamber in which said tubular member is moved, said valve sleeve having intake passages which cooperate with said ports in said tubular member to alternately supply an operating fluid to opposite ends of said cylinder, said valve sleeve also having ports and recesses therein forming a part of intake and exhaust means to and from said tubular-member chamber to move said tubular member by fluid pressure; and a piston adapted to reciprocate in said cylinder under the influence of said operating fluid.

22. In a deep well motor pump, the combination of: a pair of spaced heads; a tubular member slidable relative to said heads and defining a cylinder therein, said tubular member having ports communicable with said cylinder and with discharge passages through said heads; a valve sleeve cooperating with said tubular member and said heads to form a tubular-member chamber in which said tubular member is moved, said valve sleeve having intake passages which cooperate with said ports in said tubular member to alternately supply an operating fluid to opposite ends of said cylinder; a piston adapted to reciprocate in said cylinder under the influence of said operating fluid; pump plungers formed on said piston and operable in barrels formed in said heads, said plungers and said piston having an opening

therethrough communicating with inlet and discharge chambers in said heads; a standing valve in said inlet chamber; and a working valve in said opening of said plungers and said piston.

23. In combination: walls forming inlet and discharge chambers; plungers extending successively into said chambers; a piston secured to said plungers, said piston being reciprocated by an operating fluid supplied alternately to opposite ends thereof, there being a valved passage communicating between said inlet and discharge chambers; and means for discharging the operating fluid from both ends of said piston into said chambers.

24. In combination: walls providing a cylinder therein; a piston reciprocable in said cylinder and having a cavity therein; walls defining inlet and discharge chambers; plungers connected to said piston and extending respectively into said inlet and discharge chambers, said plungers having openings therethrough communicating with said piston cavity and extending respectively into said chambers, the plunger extending into said inlet chamber being larger in diameter than the plunger extending into the discharge chamber; a working valve in said piston cavity; and a standing valve for a said inlet chamber.

25. In a deep well motor pump, the combination of: a pair of spaced heads having passages therethrough; and a tubular member movable relative to said heads and cooperating therewith in providing a cylinder, said tubular member having ports adapted to alternately connect said cylinder with said passages.

26. In a deep well motor pump, the combination of: a pair of spaced heads providing discharge passages; a tubular member movable relative to said heads and providing a cylinder, said tubular member having ports which are always in communication with said cylinder, said ports alternately connecting said discharge passages to said cylinder when said tubular member is moved; a piston in said cylinder; and means timed with said piston for supplying an operating fluid to said ports.

27. In a deep well motor pump, the combination of: a tubular member defining a cylinder; a slidable valve sleeve around said tubular member; a piston reciprocable in said cylinder; and means for moving said valve sleeve as a function of the position of said piston.

28. In a deep well motor pump, the combination of: a fluid-operated primary valve member defining a cylinder; a piston reciprocable in said cylinder; a secondary valve member slidably retaining said primary valve member and movable as a function of the

position of said piston; and fluid supply means communicating with said primary valve member through said secondary valve member whereby said secondary valve member controls the movement of said primary valve member.

29. In combination: a fluid-operated tubular member providing a cylinder; a piston reciprocable in said cylinder; and fluid supply means timed to operate as a function of the position of said piston for controlling the operation of said tubular member.

30. In combination: a head providing a chamber; a tubular member providing a cylinder, said head and said tubular member being relatively movable; a discharge passage through said head communicating between said cylinder and said chamber; a port in said tubular member adapted to register with said discharge passage when said head and tubular member are in a predetermined relative position; a cavity formed in said head and forming a pump barrel; a piston in said cylinder; a plunger movable by said piston and extending through said pump barrel and into said chamber; and means for supplying an operating fluid to said cylinder to move said piston toward said head when said tubular member and head are in said predetermined position whereby the fluid between said head and said piston is forced into said chamber through said discharge passage.

31. In a fluid-operated deep well pump, the combination of: walls defining a motor cylinder and a pumping chamber, said cylinder and said chamber being separated by a head; a piston-plunger structure including a piston reciprocable in said cylinder and a plunger extending in pumping relationship into said pumping chamber through a cavity formed in said head whereby a reciprocation of said plunger pumps well fluid through said pumping chamber; and valve means for alternately supplying an operating fluid to opposite ends of said piston, said valve means discharging the operating fluid compressed between said piston and said head into said pumping chamber.

32. In a pump adapted to be actuated by an operating fluid in a manner to pump a pumped fluid, the combination of: walls defining a cylinder; walls defining a pumping chamber; a piston-plunger structure providing a piston slidable in said cylinder and a hollow pumping plunger extending through said walls and into said pumping chamber; means for forcing pumped fluid through said plunger when said piston-plunger structure is reciprocated; means for successively supplying said operating fluid to said cylinder to move said piston-plunger structure; and discharge means communicating with said cylinder for conducting the operating fluid there-

from, said discharge means communicating with said pumping chamber and discharging said operating fluid thereinto in washing relationship with the surface of said pumping plunger.

33. In a fluid-operated deep well pump, the combination of: walls defining a motor cylinder and a pumping chamber, said cylinder and said chamber being separated by a head; a piston-plunger structure including a piston reciprocable in said cylinder and a plunger extending in pumping relationship into said pumping chamber through a cavity formed in said head whereby a reciprocation of said plunger pumps well fluid through said pumping chamber; and a fluid-actuated sleeve valve means surrounding at least a portion of said piston-plunger structure and controlling the admission of operating fluid to and discharge of operating fluid from both ends of said cylinder.

34. In a fluid-operated deep well pump, the combination of: walls defining a motor cylinder and a pumping chamber, said cylinder and said chamber being separated by a head; a piston-plunger structure including a piston reciprocable in said cylinder and a plunger extending in pumping relationship into said pumping chamber through a cavity formed in said head whereby a reciprocation of said plunger pumps well fluid through said pumping chamber; a sleeve valve means surrounding at least a portion of said piston-plunger structure and providing passages communicating with said cylinder for supplying operating fluid thereto; discharge means for said cylinder; wall defining an annular space around said sleeve valve means and communicating with said passages; and means for supplying an operating fluid under pressure to said annular space.

35. In a fluid-operated deep well pump, the combination of: walls defining a pumping chamber, an annular valve chamber, and a cylinder, said walls including a head separating said cylinder and said pumping chamber, said head including a hole through which operating fluid is discharged from said cylinder into the adjacent end of said pumping chamber; a piston-plunger structure including a piston reciprocable in said cylinder and a plunger extending through said head and into said pumping chamber in pumping relationship with the fluid therein, said fluid including the well fluid to be pumped; a sleeve valve movable in said valve chamber by fluid pressure and controlling the flow of said operating fluid which actuates said piston-plunger structure; and means for delivering operating fluid to said valve chamber in shifting relationship with said sleeve valve, said operating fluid being withdrawn from that end of said pumping chamber with which said hole communicates

whereby operating fluid rather than the well fluid being pumped is used to shift said sleeve valve.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 29th day of March, 1926.

CLARENCE J. COBERLY.

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