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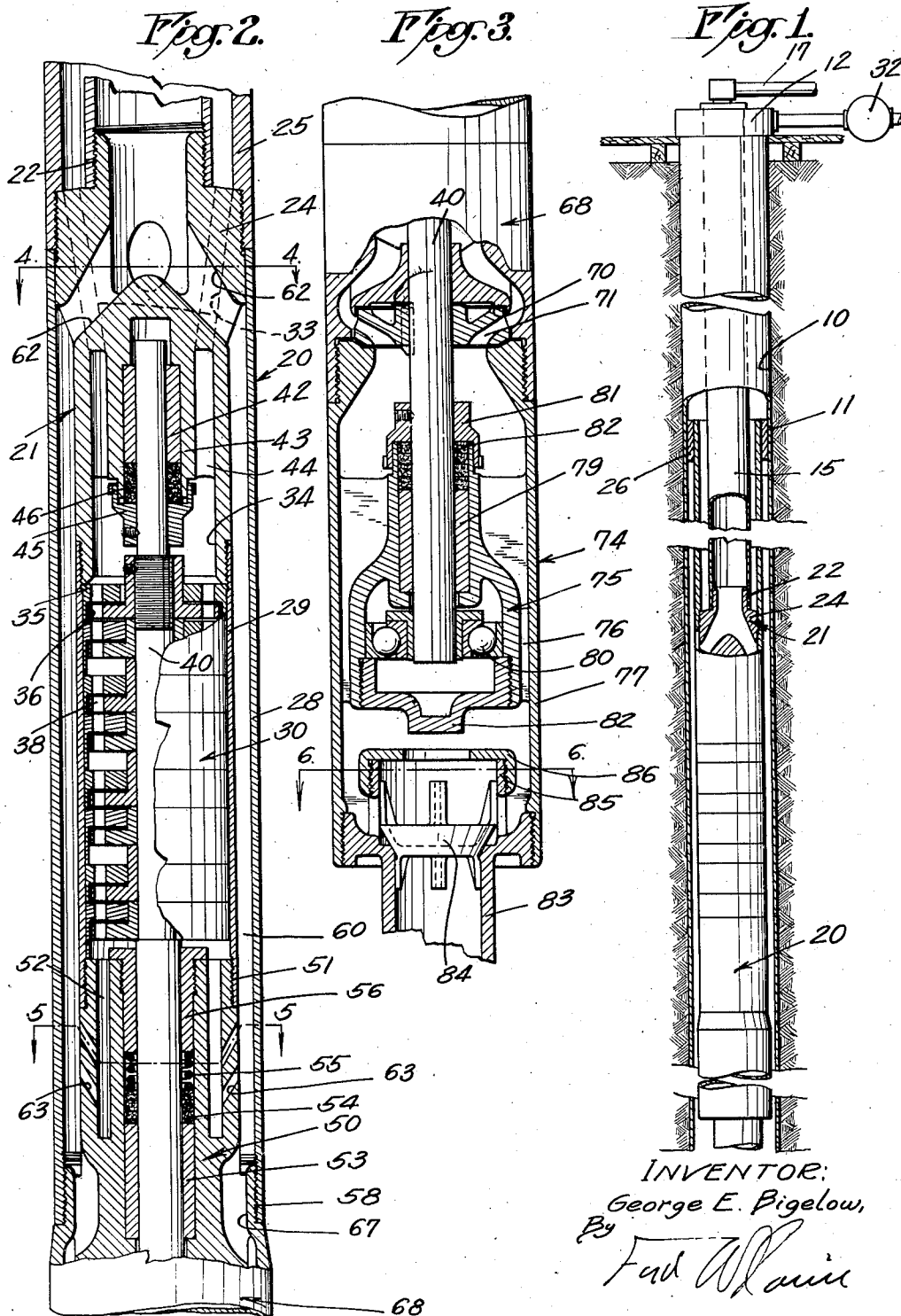
G. E. BIGELOW

1,818,455

DEEP WELL OIL TURBINE PUMP

Filed April 19, 1928

2 Sheets-Sheet 1



INVENTOR:
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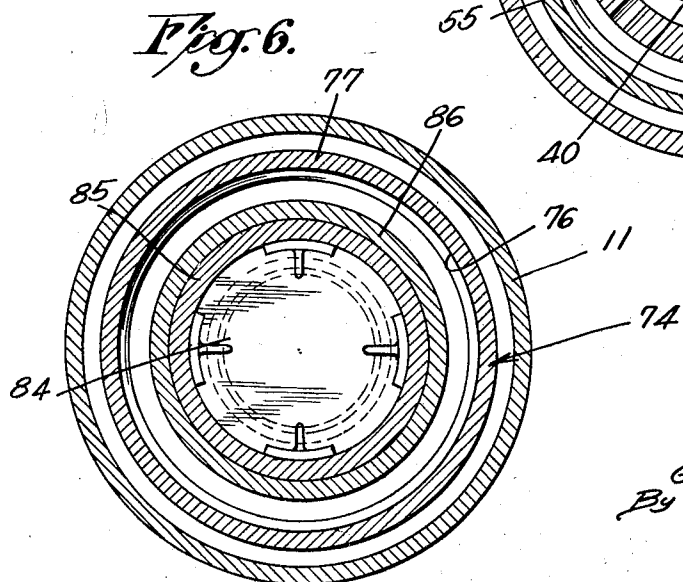
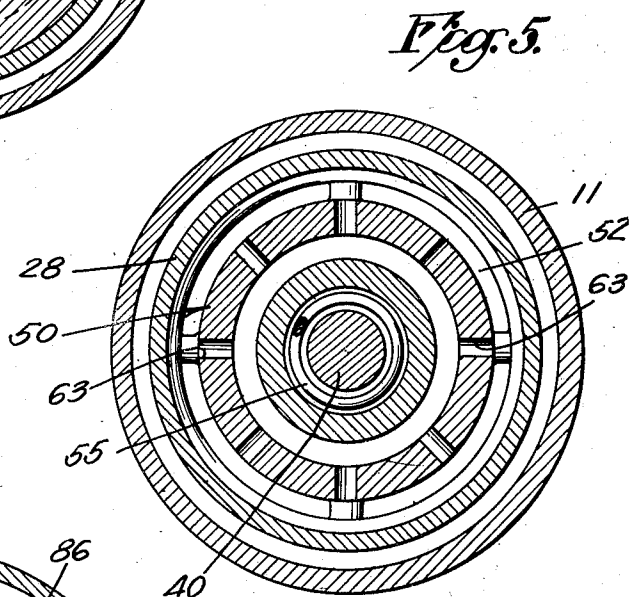
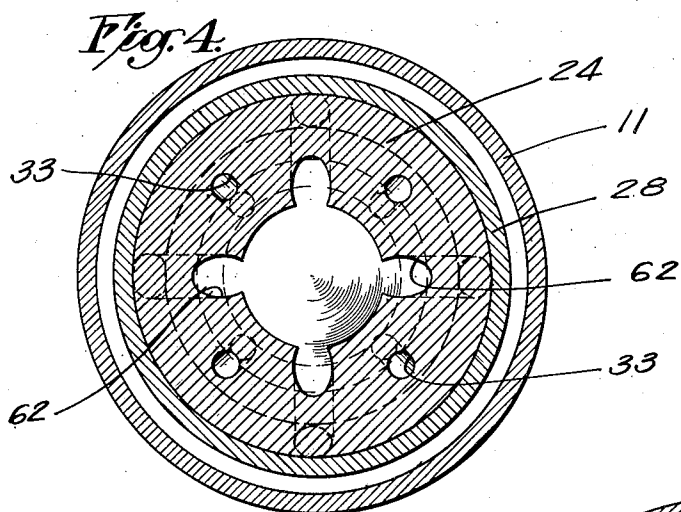
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DEEP WELL OIL TURBINE PUMP

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2 Sheets-Sheet 2



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DEEP WELL OIL TURBINE PUMP

Application filed April 19, 1928. Serial No. 271,213.

My invention relates to the deep well pumping art, and more particularly to a combination of turbine and gas-lift pump for use in such a well.

It is common practice to pump shallow wells by means of a turbine pump. Such a pump ordinarily comprises a pump unit situated in the well, this unit being driven by a motor at the surface of the ground. The type of pump unit usually utilized has a series of impellers mounted on a shaft, this shaft extending upward and being directly connected to the motor. In deep wells, such a pump cannot be satisfactorily installed due to the difficulty experienced in the stretch of the line shaft, and in the difficulty of correctly positioning the impellers in the impeller chambers.

Thus, in wells exceeding several hundred feet in depth, it is necessary to provide a different type of pump. Oil wells, for instance, are usually several thousand feet deep, and in pumping these wells it is customary to use a reciprocating pump, this pump being oscillated by a string of sucker rods extending to the surface of the ground. The efficiency of such a reciprocating pump is low and its capacity is limited.

Another type of pump utilized in deep wells is of the gas-lift type. In this type of pump, gas is forced downward in the well, either continuously or intermittently, this gas carrying the oil upward therewith when again rising to the surface of the ground. In some wells, it is found that sufficient submergence of the gas-lift apparatus is not possible, owing to the low standing level of the oil in the well.

I have invented a combined gas-lift and turbine pump, this pump being adapted to be installed in a well and to be operated by a flow of gas or other fluid supplied thereto from the surface of the ground.

It is an object of my invention to provide a pumping unit of the combined gas-lift and

turbine type, this unit being operated by a flow of gas or other fluid from the surface of the ground.

Another object of my invention is to provide a novel method of delivering the driving fluid to such a pump.

In the practical operation of my pumping unit, I prefer to use a compressed gas such as air as a driving fluid, this gas being effective in raising the well-fluid to the surface of the ground.

It is an object of my invention to provide a combined gas-lift and turbine pump, the gas eventually being injected into the body of well-fluid moving upward from the turbine pump.

Still other objects of my invention lie in the provision of a novel fluid motor.

Further objects and advantages of my invention will be made evident hereinafter.

Referring to the drawings:

Fig. 1 is a utility view illustrating one installation of my invention.

Fig. 2 is a partially sectioned view of the turbine motor of my invention.

Fig. 3 is a partially sectioned view of the lower end of the turbine pump.

Fig. 4 is a cross-sectional view taken on the line 4-4 of Fig. 2.

Fig. 5 is a cross-sectional view taken on the line 5-5 of Fig. 2.

Fig. 6 is a cross-sectional view taken on the line 6-6 of Fig. 3.

Referring particularly to Fig. 1, I illustrate a well 10 in which a well casing 11 has been set. The upper end of this well casing is closed by a suitable head 12. Supported from the head 12, and extending downward inside the well casing 11 is a discharge pipe 15, this discharge pipe being adapted to carry upward a mixture of pumping liquid and gas, this mixture being discharged through a pipe 17 at the surface of the ground.

Supported inside the well casing 11 on the lower end of the discharge pipe 15 is a pump

unit 20 of my invention. This pump unit comprises an upper member 21 which is threadedly received by the lower end of the discharge tube, as indicated by the numeral

22. A body portion 24 of the upper member 21 is externally threaded, and an intermediate tube 25 is threaded thereto. This intermediate tube extends a distance above the pump unit 20, and is suitably sealed in fluid-tight relation with the well casing 11 at its upper end by a seal 26. This seal may be of any desired form and is in itself not a part of this invention.

Also extending downward from the body portion 24, and suitably secured thereto is a motor shell 28, this shell being cylindrical in shape. A lower portion of the upper member 21 extends downward a distance into the shell 28 and supports at its lower end a motor casing 29 forming a part of a fluid-operated motor 30. This fluid-operated motor may be of any desired high-speed type. I prefer to use a motor which is operated by a compressed gas supplied thereto by a pump 32 at the surface of the ground, this pump communicating with the annular space between the discharge pipe 15 and the well casing 11 so as to force a compressed gas downward therethrough.

The body portion 24 of the upper member 21 has gas ports 33 therein, these ports communicating between the annular space formed between the discharge pipe and the intermediate tube 25 and an intake chamber 34 formed in the lower portion of the upper member 21. This gas then passes through one of a number of deflecting vanes 35, these vanes being so shaped as to form runner chambers 36 therebetween. These deflecting vanes are adapted to direct the flow of gas in a proper direction to impinge on a series of turbine runners 38, each of these turbine runners being mounted on a shaft 40 in such a position as to rotate in one of the runner chambers 36. After leaving the uppermost turbine runner 38, the gas passes through the next adjacent deflecting vane and its course is again turned so as to be effective in rotating the turbine runner 38 next below.

Each of the turbine runners 38 cooperate to rotate the shaft 40 about its axis. This shaft is suitably journaled in an upper bearing 42 supported in the intake chamber 34 in a bearing housing 43, this housing being supported by webs 44. The sleeve bearing 42 itself may be of any desired material, such as bronze, babbitt or lignum-vitæ. A protecting cap 45 secured to the shaft 40 below the bearing housing 43 protects this bearing, this protection being made complete by a series of packing rings 46 compressed between the protecting cap 45 and the bearing 42.

The shaft 40 is again journaled below the motor 30 in an intermediate member 50 of my invention. This intermediate member 50 threadedly receives the lower end of the mo-

tor casing 29, as indicated by the numeral 51, and is adapted to receive the exhaust gases from the motor 30, these gases passing downward through cavities 52 therein. The journaling action between the shaft 40 and the intermediate member 50 takes place in a sleeve bearing 53 suitably packed by packing rings 54 which are compressed by a spring 55. A gland 56 threadedly received by the intermediate member 50 makes this compression possible.

The lower end of the motor shell 28 is threadedly received by the intermediate member 50, as indicated by the numeral 58. Formed between the motor shell 28 and the motor 30 is a fluid passage 60, this fluid passage communicating with the interior of the discharge pipe 15 through outlet ports 62 formed in the body portion 24 of the upper member 21. The fluid passage 60 also is in communication with the cavities 52 through passages 63. As best shown in Figs. 2 and 5, these passages 63 are rather small in diameter and are spaced around the intermediate member 50. It should also be noticed that the passages 63 extend upward at an acute angle so that the exhaust gas from the motor 30 is injected into the fluid passage 60 in an upward direction.

The fluid passage 60 is also in communication through passages 67 with the discharge of a turbine pump 68 which is secured to the lower end of the intermediate member 50. This turbine pump may be of conventional design, and may be of as many sections as desired. Each of these sections has an impeller chamber 70 therein in which a pump impeller 71 is adapted to be rotated by means of the shaft 40 to which it is connected.

The turbine pump 68 is adapted to draw a well fluid upward through a lower member 74 which is secured to the lowermost pump section. This lower member has a bearing structure 75 therein, there being fluid passages 76 surrounding the bearing structure 75, and inside a cylindrical housing 77 of the lower member 74. The shaft 40 is adapted to be journaled in this bearing structure by means of a sleeve bearing 79 and a thrust bearing 80. These bearings are suitably protected by a cap 81 secured to the shaft, this cap compressing packing rings 82 against the sleeve bearing 79. The thrust bearing 80 is adapted to take the combined thrust of the motor 30 and the pump 68, this thrust being a combined pneumatic and hydraulic thrust derived from the turbine runners 38 and the pump impellers 71 respectively. The lower end of the bearing structure 75 is closed by a suitable cap 82 so that the bearing 80 may be kept submerged in a body of oil.

To the lower end of the cylindrical housing 77 is connected an intake pipe 83, this pipe being provided with a suitable check valve 84 adapted to slide vertically in a guiding struc-

ture 85. This guiding structure is closed by a cap 86, thus limiting the upward movement of the check valve 84. The function of the check valve is to prevent a return flow of any of the well fluid through the intake pipe 83.

The operation of my invention is as follows:

A compressed gas is forced downward inside the casing 11 by means of the pump 32, this gas acting upon the turbine runners 38, in the manner previously described, so as to rotate the shaft 40 and the pump impellers 71. These pump impellers draw a well fluid upward through the intake pipe 83 and the check valve 84, and subsequently through each pump impeller 71, this fluid being then discharged into the passages 67 whence it passes upward through the fluid passage 60. The turbine pump 68 is not designed to force the oil or other fluid being pumped the complete distance to the surface of the ground. The pumping action of this pump is materially aided by the exhaust gases of the motor 30, these gases being injected into the rising well fluid in the fluid passage 60 through the passages 63. The passages 63 act as a very excellent mixing device for thoroughly mixing the gas and the fluid being pumped. This gas tends to rise through the fluid passage 60 to the discharge pipe 15, thus carrying the oil or other pumped fluid therewith. It should thus be clear that the pumping action obtained from my pump unit 20 is the summation of the action of the turbine pump 68 and the gas discharged from the motor 30, this gas being previously utilized in rotating the turbine runners of the motor 30.

Should the pump unit 20 be stopped, the check valve 84 will seat and will prevent any return flow of pumped fluid through the intake pipe 83. This is a desirable feature, for if the fluid were to leave the turbine pump 68, the gas passing through the passages 63 would not be effective in raising the pump fluid, and difficulty might be experienced in again starting the pump.

It should be noted that there is a peculiar relationship between the exhaust pressure of the motor 30 and the discharge pressure of the turbine pump 68. The ratios of these pressures remain practically constant regardless of the amount of compressed gas utilized in pumping the well 10. This is due to the fact that an increase of gas pressure will increase the rotation of the turbine runners 38 which, in turn, will increase the pumping action of the pump 68 so that the discharge pressure of the pump will be correspondingly increased as the discharge pressure of the motor is increased, a very desirable characteristic.

The upper member 21 having the crossing ports 33 and 62 is important to my invention. I have found that this arrangement of intake

and discharge to and from the pump unit 20 is much more efficient than other arrangements. This type of unit is also cheaper to construct and is simpler in operation than certain other types wherein the compressed gas has been forced upward through the motor shell 20 rather than downward as in my invention.

I claim as my invention:

1. In a deep well pump the combination of: a shell; a fluid motor mounted in said shell, there being a fluid passage therebetween; a discharge pipe extending upward from said motor for pumped and motor discharge fluids; a pump secured adjacent said motor and operatively connected therewith; and a member providing an outlet port for the discharge of pumped fluid communicating between said fluid passage and said discharge pipe, and providing a port for directing the flow of the motor operating fluid into said motor.

2. A combination as defined in claim 1 in which said motor operating fluid is a gas, and including means for jetting the exhaust gas of said motor into the discharge of said pump in said fluid passage.

3. In a deep well pump the combination of: a discharge pipe; an upper member secured to said discharge pipe; a fluid-operated motor; an intermediate member, said motor being positioned between said upper and said intermediate members; a pump discharging into said discharge pipe; a shaft operatively connecting said motor and said pump; a lower member, said pump being positioned between said intermediate and said lower member; bearings in said upper and intermediate members, said bearings journalling said shaft; and a thrust bearing in said lower member, said thrust bearing taking the thrust of said shaft.

4. In a deep well pump the combination of: a well casing; a discharge pipe extending through said casing; a fluid motor supported at the lower end of said discharge pipe; a motor shell surrounding said motor, there being a fluid passage therebetween; a pump operatively connected to said motor, the discharge of said pump being directed upward in said fluid passage; means for sealing said casing and said shell in fluid-tight relationship; means for forcing a fluid between said discharge pipe and said casing, said fluid being adapted to operate said fluid motor; and a member above said motor adapted to direct said fluid into said motor and to direct said pump discharge into said discharge pipe.

5. In a deep well pump the combination of: a well casing; a discharge pipe extending through said casing; a fluid motor supported at the lower end of said discharge pipe; a motor shell surrounding said motor, there being a fluid passage therebetween; a

- pump operatively connected to said motor, the discharge of said pump being directed upward in said fluid passage; means for sealing said casing and said shell in fluid-tight relationship; means for forcing a fluid between said discharge pipe and said casing, said fluid being adapted to operate said fluid motor; a member above said motor adapted to direct said fluid into said motor and to direct said pump discharge into said discharge pipe; and a check valve below said pump, said check valve preventing any return flow of liquid through said pump.
6. In a deep well pump the combination of: a shell; a fluid motor mounted in said shell, there being a fluid passage therebetween; a pump positioned adjacent said motor and operatively connected thereto, said pump discharging into said fluid passage; and means for jetting the exhaust of said fluid motor in an upward direction into the lower portion of said fluid passage to assist the flow of said discharge of said pump.
7. In a deep well pump the combination of: a shell; a gas-operated fluid motor mounted in said shell, there being an annular fluid passage therebetween; a pump positioned adjacent said motor and operatively connected thereto, said pump discharging into said fluid passage; and means for introducing the exhaust gases of said fluid motor angularly upward into said fluid passage in a manner to be intermixed with the discharge of said pump to assist the upward flow thereof.
8. In a deep well pump the combination of: a shell; a fluid motor mounted in said shell, there being a fluid passage therebetween, said motor discharging an exhaust fluid into the pumped fluid; a discharge pipe extending upward from said motor; a pump secured adjacent said motor and operatively connected therewith; and walls defining an outlet port communicating between said fluid passage and said discharge pipe, said walls forming a port directing operating fluid from a space around said discharge pipe into said fluid motor.
9. In a deep well pump the combination of: a shell; a fluid motor mounted in said shell, there being a fluid passage therebetween; a discharge pipe extending upward from said motor; a pump secured adjacent said motor and operatively connected therewith; and a member closing the upper end of said fluid passage and providing an outlet port communicating between said fluid passage and said discharge pipe, and providing a port through which operating fluid is supplied to said fluid motor.
10. In combination in a deep well pump: a fluid motor supported in a well; a pump in said well; a shaft operatively connecting said motor and said pump, said pump exerting a downward hydraulic thrust on said shaft; means for forcing operating fluid downward through said fluid motor to rotate said shaft, said fluid exerting a downward thrust thereon; means for conducting the well fluid pumped by said pump; and a thrust bearing on said shaft for taking the combined downward thrusts exerted on said shaft by said motor and said pump.
11. In combination in a deep well pump: a pair of concentric pipes; a member secured to said pipes in a manner to close the annular space therebetween; and a fluid motor below said member, said member providing a discharge port for conducting the discharge of said fluid motor into the inner of said pipes, said member also providing a port for conducting operating fluid from said annular space into said fluid motor, said port and said discharge port crossing over each other in said member.
12. In combination in a deep well pump: upper and intermediate members; a discharge pipe extending upward from said upper member; a motor casing joining said members; a fluid motor in said motor casing; and a motor shell forming a fluid passage around said motor casing and being secured to said upper member, there being ports through said upper member for interconnecting said discharge pipe and said fluid passage and interconnecting the space around said discharge pipe to the interior of said motor casing, there being passages through said intermediate member and communicating between the interior of said motor casing and said fluid passage.
13. In a deep well pump the combination of: a shell; a fluid motor mounted in said shell, there being a fluid passage therebetween and an opening in said motor communicating between the interior of said motor and said fluid passage; a discharge pipe extending upward from said motor; a pump secured adjacent said motor and operatively connected therewith; and a member providing an outlet port communicating between said fluid passage and said discharge pipe and providing a port for directing the flow of the motor operating fluid into said motor.
14. In a deep well pump the combination of: a shell; a fluid motor mounted in said shell, there being a fluid passage therebetween; a discharge pipe extending upward from said motor for pumped and motor discharge fluids; a pump secured adjacent said motor and operatively connected therewith; and walls defining an outlet port communicating between said fluid passage and said discharge pipe, said walls forming a port directing operating fluid from a space around said discharge pipe into said fluid motor.
15. In a fluid-operated deep well pump, the combination of: a motor housing; a fluid-operated motor positioned in said housing;

a pump secured adjacent said motor and operatively connected therewith; and an outer shell around said motor housing and co-operating therewith in providing a space through which the motor operating fluid and the pumped fluid may pass upwardly.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 11th day of April, 1928.

GEORGE E. BIGELOW.

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