Jan. 17, 1933. G. E. BIGELOW 1,894,393

TURBINE PUMP

Filed May 31, 1927 2 Sheets-Sheet 1

Fig. 1.

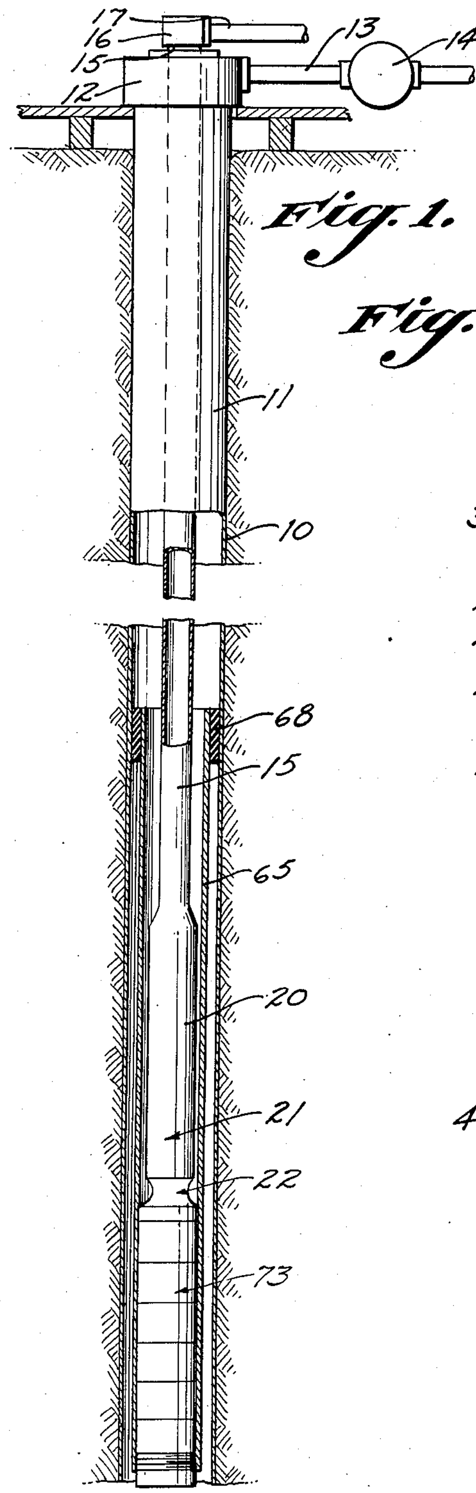

Fig. 2.

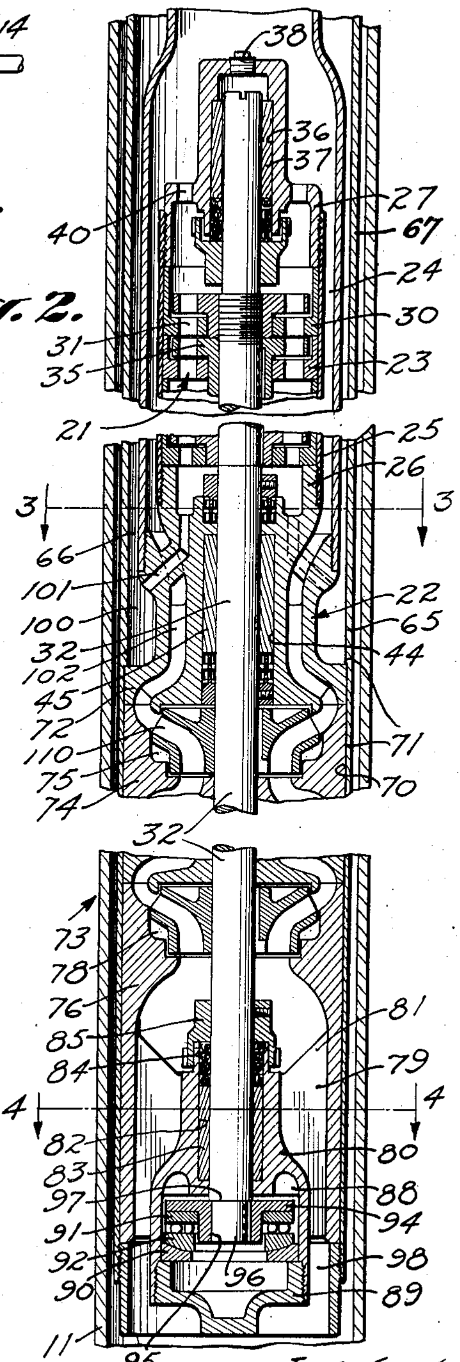

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Fig. 5.

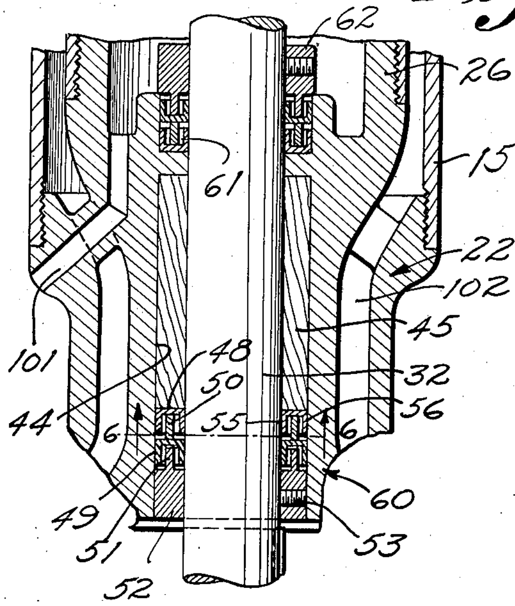


Fig. 3.

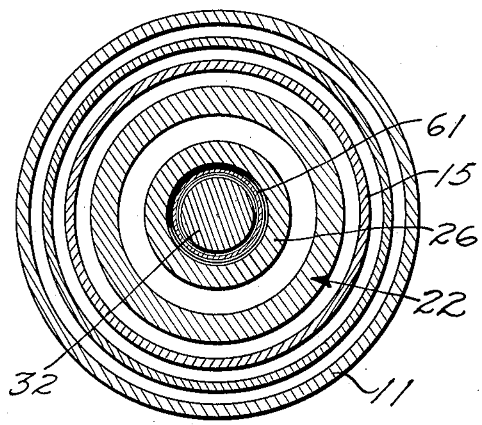


Fig. 6.

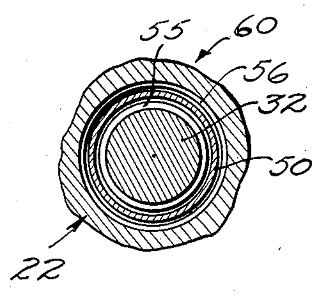
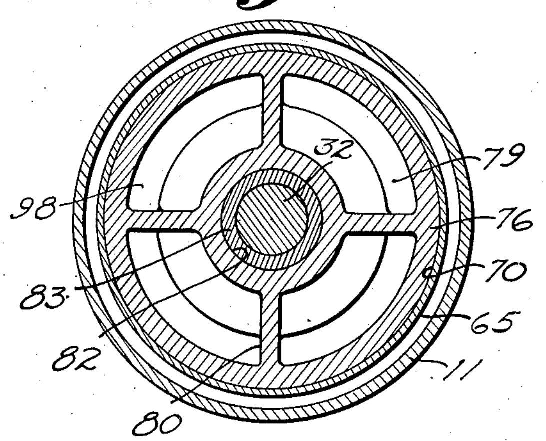


Fig. 4.



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UNITED STATES PATENT OFFICE

GEORGE E. BIGELOW, OF HUNTINGTON PARK, CALIFORNIA

TURBINE PUMP

Application filed May 31, 1927. Serial No. 195,258.

My invention relates to vertical turbine pumps, and particularly to pumps which are adapted for elevating water or oil to the surface of the ground.

The ordinary centrifugal pump construction consists of a pump unit which is located at the bottom of a well. This pump unit consists of a shell having chambers in which impellers are adapted to rotate. A column pipe extends from the pump unit to the surface of the ground, and extending from the pump unit inside the column pipe is a pump shaft. At the surface of the ground is a pump head to which the shaft is connected, and by means of which it is rotated so as to drive the impellers of the pump. Such centrifugal pumps operate very successfully in shallow wells, but in deep wells they have failed because of the fact that the pump shaft will stretch and the impellers are thus allowed to drop into engagement with the lower walls of the impeller chambers, cutting away both the walls and the impellers.

It is the main object of my invention to provide a centrifugal pump which is adapted for deep well use.

My invention, described briefly, consists of a turbine pump unit having a turbine motor disposed immediately above it. The turbine motor is operated by fluid which is delivered thereto from the surface of the ground. There have been other pumps of this general nature, but they have had no success for the following reason:

The fluid for operating the turbine motor has been supplied to it downward from the upper end and therefore exerts a down thrust on the rotor thereof.

The weight on the shaft which extends through the pump unit and through the turbine motor is carried by a thrust bearing. The thrust bearing is capable of supporting the weight imposed thereon by the column of liquid being elevated to the surface of the ground but is unable to withstand this weight plus the weight resulting from the downward thrust of the fluid on the rotor of the turbine motor.

It is an object of my invention to provide a deep well centrifugal pump of the nature mentioned in which the thrust of the fluid operating the turbine motor will tend to decrease the load on the thrust bearing of the mechanism.

One difficulty with such pumps in the past has been that the thrust bearing has worn out very rapidly.

It is correspondingly an object of my invention to provide a turbine operated centrifugal deep well pump in which the thrust bearing will have a long life.

Wooden radial bearings are generally used in deep well centrifugal pumps but these wear out rapidly due to the well liquid carrying abrasive material into these bearings.

Another object of my invention is to provide a deep well centrifugal pump in which a radial bearing thereof is protected to prevent any abrasive material getting into the bearing.

Other objects and advantages will be made apparent in the following description and in the accompanying drawings, in which

Fig. 1 is a diagrammatic view illustrating the manner in which the pump of my invention is installed therein.

Fig. 2 is a fragmentary vertical sectional view illustrating the details of the pump.

Figs. 3 and 4 are horizontal sectional views taken on the correspondingly numbered lines of Fig. 2.

Fig. 5 is an enlarged detailed view illustrating the improved sand packing of my invention.

Fig. 6 is a horizontal sectional view taken on the line 6—6 of Fig. 5.

Referring in detail to the drawings, 10 indicates a well which may be an oil or water well in which a casing 11 is disposed. The upper end of the casing 11 projects above the surface of the ground and is provided with a casing head 12 into which an operating fluid-supply pipe 13 having a pump 14 is connected so as to communicate with the interior of the casing 11. The usual vertical hole is provided centrally in the casing head 12 and a pump tubing 15 passes through this hole and extends downward inside the casing 11. A fitting 16 is provided on the upper end of the tubing 15 which connects the tubing with a pipe 17 which may lead to any suitable storage for pumped liquid, not shown.

The pump tubing 15 is diagrammatically shown as unitary in Fig. 1, but may be formed in the usual manner of any number of sections, the lowermost of which is belled to form a tubular motor housings 20 which supports the motor-pump 21 of my invention at a suitable depth in the casing 11. The motor housing 20 is internally threaded at its lower end and threadedly receives a base member 22 of the motor 23 of the motor-pump 21 so that an annular space 24 is formed between the motor 23 and the housing 20.

The motor 23 has a tubular motor shell 25, the mouths of which are threaded, the lower mouth being screwed downward upon an uppermost neck 26 of the base member 22. A head member 27 is screwed into the upper mouth of the shell 25. A series of tubular inserts 30 are of such diameter as to fit slidingly into the shell 25, these inserts having an aggregate length so as to be held compressed together by contact of the endmost of the inserts 30 with the neck 26 and the head member 27 when these are screwed into a shell 25, as shown. Baffle walls 31 having suitable openings therein are formed upon the inserts 30 to project inward in radial planes at suitable intervals.

A motor pump shaft 32 extends vertically substantially throughout the length of the motor pump 21, and a plurality of turbine runners or wheels 35 are suitably keyed to the shaft 32 so that these wheels will rotate with the shaft within the spaces intervening between the baffle walls 31. The head member 27 is provided with a central chamber 36 into which the upper end of the shaft 32 projects and in which it is journalled by a suitable wooden bearing 37 in a manner well known in the art. A plug 38 is provided in the upper end of the head member 27 for the introduction of lubricant into the chamber 36. Holes or ports 40 are provided in the head 27 which communicate between the interior of the shell 25 and the interior of the upper portion of the motor housing 20.

The base number 22 has a central chamber 44 through which the shaft 32 passes and in which is disposed a wooden bearing 45 which journals the shaft 32. It is particularly desired to prevent sand reaching the wooden bearing 45 and the means for accomplishing this may be described with reference to Fig. 5. Annular packing rings 48 and 49 which are identical and of channel cross-section are inverted in the chamber 44 beneath the wooden bearing 45, the rings 48 and 49 being separated by a free ring 50. A ring 51 of the same size and shape as the ring 50 is disposed beneath the packing ring 49 and is formed integrally with a collar 52 which is secured by a set screw 53 to the shaft 32 so as to rotate in the mouth of the chamber 44. If any liquid, carrying particles of solid matter, attempts to force its way upward into the zone of the bearing 45 it must pass the packing rings 48 and 49. Inner and outer walls 55 and 56 of these rings, however, are constantly held in position by the rings 50 and 51 so that any liquid pressure exerted within the channel space of the rings 48 or 49 will cause the walls 55 and 56 to resiliently expand into fluid-tight contact with the shaft 32 and the surface of the chamber 44 respectively. Thus fluid is practically prevented from passing upwardly into the bearing 45.

The packing rings 48 and 49, the rings 50 and 51 and the collar 52 constitute a compound packing 60. Although it is not absolutely necessary, a chamber 61 may be formed in the upper portion of the base casting 22 of the same diameter as the chamber 44 and a compound packing 62 may be extended into the chamber 61, as shown in Fig. 5, the packing 62 being identical with the packing 60. Thus the bearing 45 is completely protected from infiltration thereinto of water carrying abrasive matter.

A tubular pump housing 65 encloses the motor 23 so as to form an annular space 66 between the motor housing 20 and the upper end of the pump housing 65, more particularly referred to as the outer shell 67. This outer shell forming the upper end of the pump housing 65 extends a short distance above the juncture of the pump tubing 15 and the motor housing 20 and is provided with a packer 68 at this point which forms a fluid-tight seal between the pump housing 65 and the well casing 11. The lower portion of the pump housing 65 has a counterbore 70 which forms an annular shoulder 71 in the interior of the housing 65. The lower end of the casting 22 is cylindrical in shape and forms a flange 72 which snugly fits the counterbore 70 and bears upwardly against the shoulder 71.

A pump body 73 includes a plurality of identical inserts 74 which are placed end to end and inserted within the counterbore 70, the uppermost of these inserts 74 contacting the lower face of the flange 72. Each insert 74 is provided with an impeller chamber 75. A base insert 76 constitutes the base of the pump body 73, and is contained in the counterbore 70 of the housing 65 so as to abut the lowermost insert 74. The insert 74 has an impeller chamber 78 formed in its upper portion and a pump fluid vestibule 79 communicating with the impeller chamber 78 and extending downward therefrom. A bearing shell 80 is centrally disposed in the vestibule 79 and is formed integrally with the insert 76 being connected thereto by vertical webs 81. A central chamber 82 is provided in the upper portion of the bearing shell 80 and receives a wooden bearing 83 in which the lower end of the shaft 32 is adapted to be journalled.

Suitable packing 84 is held downward in the chamber 82 against the bearing 83 by a collar 85 rigidly secured to the shaft 32. The bearing shell 80 is provided with a thrust bearing chamber 88 into which the extreme lower end of the shaft 32 projects. The portion of the shell 80 surrounding the chamber 88 is cylindrical and its mouth is internally threaded to receive a plug 89. A thrust bearing seat member 90 is formed with a semi-spherical upper seat and an anti-friction thrust bearing 91 rests thereon, the lower race 92 of which bearing has a semi-spherical face which contacts and is complementary with the upper seat of the member 90. The seat 90 supports the bearing 91 and is supported in turn by the plug 89.

A chair 94 rests within the bearing 91 and a central opening 95 of the chair 94 snugly receives an end portion 96 of the shaft 32. This end portion 96 has a smaller diameter than the body of the shaft 32 so that a shoulder 97 is formed at the juncture of the body of the shaft with the portion 96 thereof which rests upon the upper face of the chair 94 so that the weight of the shaft is transmitted to the anti-friction bearing 91. The lower mouth of the pump housing 65 is threaded internally so as to receive a threaded sleeve 98 which compresses the inserts 74 and 76 and the flange 72 of the casting 22 tightly together against the internal shoulder 71 of the housing 65.

The thrust bearing chamber 88 is preferably filled with a lubricant such as cup grease.

The motor base member 22 is of restricted diameter in its central portion so as to form an enlarged annular space 100 communicating with the lower end of the space 66. Openings 101 are formed in the casting 22 so as to communicate between the space 100 and the interior of the shell 25 at the lower end thereof. Passageways 102 are also formed in the base casting 22 which communicate between the impeller chamber 75 of the uppermost insert 74 so that pumped liquid which may be discharged from the uppermost of the chambers 75 will pass upwardly through the passage 102 into the lower end of the annular space 24. Impellers 110 are keyed to the shaft 32 so that one of these impellers is disposed in each of the chambers 75, as clearly shown in Fig. 2.

The operation of my fluid motor deep well pump is as follows:

The motor pump 21 of my invention is disposed in a lower portion of the casing 11 so that the impellers 110 of the pump are beneath the surface of the water in the casing 11, and so that the packer 68 substantially seals off the lower portion of the well from the upper portion thereof. Air or any other suitable gas is then forced by the pump 14 into the casing 11 so as to create a gas pressure in the annular space 100 of approximately 400 pounds to the square inch. The pressure of this gas may be more or less than this figure, which is given merely as an example of a workable pressure.

The operating gas passes from the annular space 100 through the passageways 101 into the lower end of the space within the shell 25 where it is directed by suitable openings in the lowermost of the baffle walls 31 against the lowermost turbine wheel 35. The gas then passes upward and is directed by the other baffle walls 31 so as to impact against each of the other turbine wheels 35 in rapid succession. The openings in the baffle walls 31 are formed in a manner well known to the art so that the gas thus directed against the turbine wheels 35 causes the shaft 32 to rotate at a high rate of speed. The gas exhausted from the turbine motor 23 passes upward through the holes 40 into the interior of the pump tubing 15.

As the shaft 32 rotates, the impellers 110 pump the liquid through the successive stages of the pump body 73 and from the uppermost stage, the liquid passes through the passageway 102 into the lower end of the annular space 24. This space connects with the lower end of the pump tubing 15 into which the pumped liquid passes. The pumped liquid thus passes into the same space into which the gas is being exhausted from the motor 23. The exhausted gas forms in bubbles and operates in the pumped liquid as an air lift.

It will be noted that the gas enters the motor 23 from beneath so that its impact against the turbine wheels 35 exerts a considerable upward force which counteracts any downward thrust imposed upon the shaft 32 by the head of liquid in the pump tubing 15. This feature saves the thrust bearing 91 from excessive wear so that the pump of my invention may be run a considerably longer time previous to drawing the pump from the well for giving attention to the thrust bearing than is the case with similar pumps now in operation.

Attention is also directed to the fact that by the excluding of sand-bearing liquid from the wooden bearing 45 this bearing will have a much longer life than the corresponding bearing of other pumps. The pump of my invention is shown fragmentarily in Fig. 2, but the motor 23 as well as the pump 75 is preferably of considerable length so that it is of great importance that the intermediate main bearing 45 be kept from wearing. Should this bearing wear to any great extent a whipping of the shaft 32 would occur which would cause the impellers 110 to engage the walls of the impeller chamber 74, thus setting up considerable friction, so as to wear out these parts as well as decrease the efficiency of the pump.

While I have described my novel turbine

pump as being operated by a gas, it is of course understood that a liquid may be used as an operating fluid with equal facility. In pumping a water well this would be water while in pumping an oil well the operating liquid would be oil.

I claim as my invention:

1. In a fluid-operated deep-well pump, the combination of: a well casing set in a well; a pump housing removable from said well casing; packing means for sealing said well casing and said pump housing in fluid-tight relationship; a pump secured to said pump housing; a fluid-operated motor operatively connected to said pump; a pump tubing extending through said casing, said pump tubing communicating with the exhaust of said motor and the discharge of said pump; and means for forcing said fluid operating said motor between said pump tubing and said well casing.

2. In a fluid-operated deep-well pump, the combination of: a pump housing; a turbine pump secured to said pump housing; a fluid-operated motor operatively connected to said pump in said pump housing, there being a space between said motor and said pump housing; a pump tubing dividing said space into inner and outer annular spaces, one of said spaces forming a discharge passage for said pump; and means for forcing said fluid operating said motor downward through the other of said annular spaces and through said motor.

3. In a fluid-operated deep-well pump, the combination of: a pump housing; a turbine pump secured to said pump housing; a fluid-operated motor operably connected to said pump in said pump housing, there being an annular space between said motor and said pump housing; a pump tubing dividing said annular space into inner and outer annular spaces, said inner annular space forming a discharge passage for said pump; and means for forcing said fluid operating said motor downward through said outer annular space and upward through said motor.

4. A combination as defined in claim 3 in which said fluid is in the form of a gas, and including means for discharging said gas which is exhausted from said motor into said discharge passage along with the discharge from said pump.

5. In a fluid-operated deep-well pump, the combination of: a pump housing; a plurality of inserts mounted in said pump housing, said inserts providing pump impeller chambers; a base member above said inserts; a fluid-operated motor secured to said base member; turbine wheels in said motor; a shaft extending between said turbine wheels and said pump; impellers carried by said shaft in said pump impeller chambers, said base member providing passageways for conducting the fluid pumped by said impellers upward around said motor; a head member above said motor, said head member journalling said shaft; and a bearing shell below said inserts, said bearing shell containing a thrust bearing adapted to take the net thrust of said impellers and said turbine wheels.

6. A combination as defined in claim 5 including a bearing in said base member for journalling said shaft.

7. In a deep-well pump, the combination of: a pump housing; a turbine pump secured to said pump housing; a base member secured above said turbine pump; a fluid-operated motor operatively connected to said pump in said pump housing above said base member, there being a space between said motor and said pump housing; and a tubing dividing said space into inner and outer annular spaces, one of said annular spaces being connected to the intake end of said motor through an opening of said base member, and the other of said annular spaces being connected to the discharge of said turbine pump through a passageway of said base member.

8. In a deep-well pump, the combination of: a pump housing; a turbine pump secured to said pump housing; a base member secured above said turbine pump; a fluid-operated motor operatively connected to said pump in said pump housing above said base member, there being a space between said motor and said pump housing; and a tubing dividing said space into inner and outer annular spaces, said outer annular space forming an intake passage communicating with the lower end of said motor through a passageway of said base member, and said inner annular space forming a discharge passage for the fluid pumped by said turbine pump.

9. A combination as defined in claim 8 including means for discharging the exhaust of said fluid-operated motor into the rising flow of fluid discharged by said pump.

10. In a fluid-operated deep-well pump, the combination of: a motor housing; a fluid-operated motor positioned in said motor housing; a turbine pump adjacent and operatively connected to said motor; an outer shell around said motor housing and cooperating therewith in providing an annular space through which the fluid operating said motor may pass; and walls forming a space separated from said annular space for conducting the fluid pumped by said turbine pump.

11. In a fluid-operated deep-well pump, the combination of: a motor housing; a fluid-operated motor positioned in said motor housing; a turbine pump below and operatively connected to said motor; an outer shell around said motor housing and cooperating therewith in providing an annular space in communication with the lower end of said motor; means for supplying an operating fluid to said annular space, said fluid entering said motor and moving upward therethrough;

and walls forming a space conducting fluid from said turbine pump upward and around said fluid-operated motor.

12. In a fluid-operated deep-well pump, the combination of: a motor housing; a fluid-operated motor positioned in said motor housing; a turbine pump adjacent and operatively connected to said motor; an outer shell around said motor housing and cooperating therewith in providing an annular space in communication with the lower end of said motor; means for supplying an operating fluid to said annular space, said fluid entering said motor and moving upward therethrough; and walls defining ports communicating between said motor and the discharge of said turbine pump for exhausting said fluid discharge from said motor into said discharge.

13. In combination: a casing extending downward into a well; a pump unit positioned in said well and sealed in fluid-tight relationship with said casing; a fluid-operated motor adjacent said pump unit and operatively connected thereto, there being a space between said motor and said casing; a pump tubing extending downward in said well and dividing said space between said motor and said casing into inner and outer annular spaces, one of said spaces forming a passage through which passes the well fluid being pumped; and means for forcing the fluid operating said motor through the other of said annular spaces.

14. In a deep-well pumping unit, the combination of: a base member including a passageway therethrough; a turbine pump adjacent and secured to one end of said base member and discharging into said passageway; a motor shell secured to the opposite end of said base member; a fluid-motor in said motor shell; a motor housing surrounding said motor shell to define an annular space communicating with said passageway; and means for delivering operating fluid to said motor from the space around said motor housing.

15. In a fluid-operated deep well-pump, the combination of: a pump housing; a turbine pump secured to said pump housing; a motor housing in said pump housing; a fluid-operated motor situated in said motor housing and operatively connected to said turbine pump, there being a space between said motor housing and said pump housing through which the fluid operating said motor may pass; and a base member providing openings communicating between said space and the interior of said fluid-operated motor.

16. In a fluid-operated deep-well pump, the combination of: a pump housing providing a counterbore; a plurality of inserts positioned in said counterbore and providing pump impeller chambers; a base member above said inserts and extending into said counterbore; a fluid-operated motor secured to said base member; turbine wheels in said motor; a shaft extending between said turbine wheels and said inserts; impellers carried by said shaft in said pump impeller chambers; a head member above said motor, said head member journalling said shaft; and a bearing shell below said inserts and extending into said counterbore and compressed against said inserts, said bearing shell containing a thrust bearing adapted to take the net thrust of said impellers and said turbine wheels.

17. In a fluid-operated deep-well pump, the combination of: a pump unit positioned in a well; a pump tubing extending upward in said well to the upper end thereof; walls defining an annular space around said pump tubing; a fluid-operated motor operatively connected to said pump unit; means for delivering an operating fluid to said annular space; walls defining one or more openings for conducting said operating fluid from said annular space into said fluid-operated motor, said operating fluid moving through said motor to operate same; and walls defining one or more ports for mixing said operating fluid discharged from said motor into the fluid pumped by said pump unit.

18. In a deep-well turbine pump, the combination of: a casing extending downward in a well; a motor-pump sealed in fluid-tight relationship with said casing, said motor-pump including a motor element operatively connected to a turbine pump; a housing around said motor and separated therefrom by an annular space communicating with the discharge of said turbine pump; a pump tubing extending upward in said casing, there being an annular space therebetween; means for forcing an operating fluid into said annular space between said pump tubing and said casing; and a base member providing passageways therethrough conducting into said pump tubing the fluid discharged from said pump and flowing through said first-mentioned annular space, said base member providing one or more openings crossing over said passageways and conducting fluid from said annular space between said pump tubing and said casing into the intake end of said fluid-operated motor.

19. In a deep-well pump, the combination of: a motor-pump unit comprising a fluid-operated motor positioned above and operatively connected to a turbine pump, said motor including a motor shell; walls around said motor shell and spaced therefrom to form an annular space through which the fluid pumped by said turbine pump moves upward; and a base member providing one or more passageways through which the pumped fluid moving through said annular space passes, said base member providing openings crossing over said passageways for conducting operating fluid to the interior of said fluid-operated motor, said operating

fluid being discharged from said motor into the upward moving stream of fluid being pumped.

20. A combinatioin as defined in claim 19 including means for defining another annular space around said walls and communicating with said openings of said base member to supply said operating fluid to said fluid-operated motor.

21. A combination as defined in claim 19 in which said base member is positioned between said motor and said turbine pump whereby said operating fluid moves upwardly through said motor to set up a thrust counteracting the hydraulic thrust of said turbine pump.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 24th day of May, 1927.

GEORGE E. BIGELOW.