March 21, 1933. A. R. WEIS 1,902,431

DEEP WELL TURBINE LEAKPROOF AND SANDPROOF UPPER MAIN BEARING

Original Filed April 23, 1928

Fig. 1.

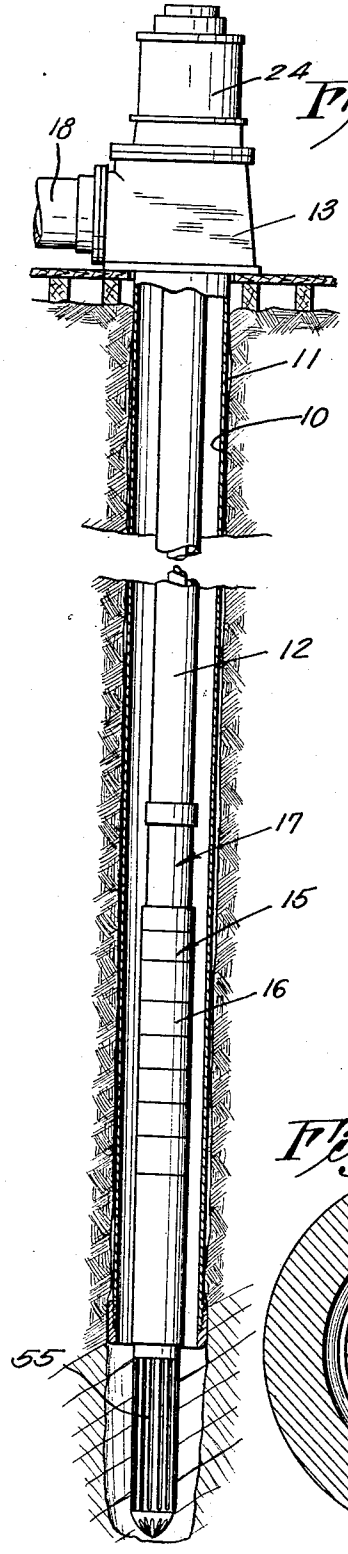


Fig. 2.

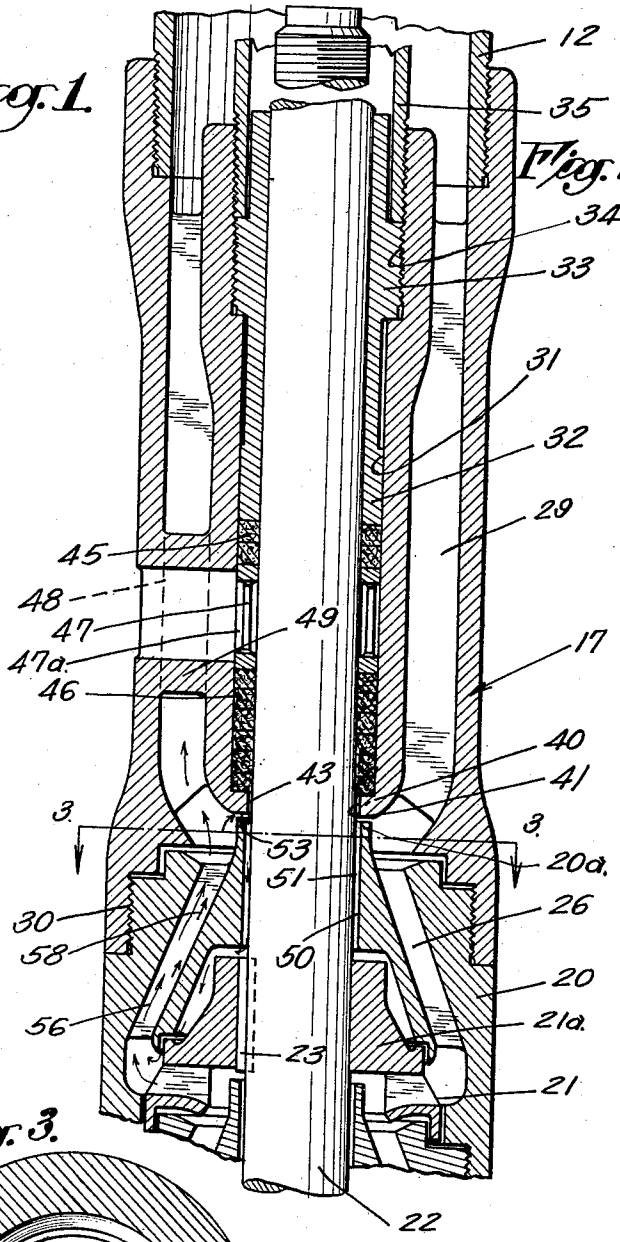
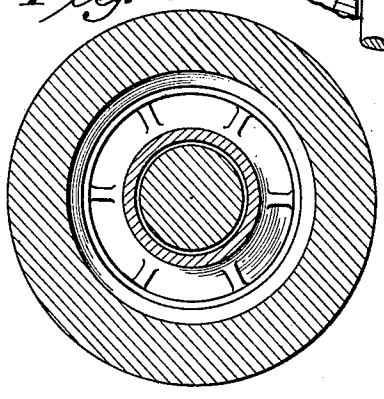


Fig. 3.



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UNITED STATES PATENT OFFICE

ARTHUR R. WEIS, OF HUNTINGTON PARK, CALIFORNIA, ASSIGNOR OF ONE-HALF TO PACIFIC PUMP WORKS, OF HUNTINGTON PARK, CALIFORNIA, A CORPORATION OF CALIFORNIA, AND ONE-FOURTH TO GEORGE E. BIGELOW, OF HUNTINGTON PARK, CALIFORNIA

DEEP-WELL TURBINE LEAKPROOF AND SANDPROOF UPPER MAIN BEARING

Application filed April 23, 1928, Serial No. 272,097. Renewed July 5, 1932.

My invention relates to the deep-well turbine pumping art, and more particularly to a construction for eliminating wear on a bearing thereof which may be caused by sand or other foreign particles carried by the well-fluid, this invention being an improvement over the device shown in my co-pending application filed December 27, 1927, Serial No. 242,907.

The well-known type of deep-well turbine pump includes a pump section disposed below the liquid level of the well, this pump section being supported by a discharge pipe extending upward to a pump head located at the top of the well. The pump section has one or more impellers therein, these impellers being secured to a line shaft which extends downward from the pump head through the discharge pipe. This line shaft is journalled at frequent intervals throughout its length in bearings supported by a shaft tubing.

This line shaft is journalled in an upper main bearing just above the uppermost impeller of the pump section. This bearing is of necessity located in a zone of high fluid pressure for the reason that the well-fluid is pumped directly therearound at a sufficient pressure to raise this fluid throughout the entire length of the discharge pipe.

The well-fluid ordinarily carries a considerable quantity of abrasive matter, such as sand, which, if it enters the main bearing, quickly destroys it. Much difficulty is experienced in keeping these abrasive particles out of the main bearing of the pump section.

It is an object of my invention to provide a pump structure in which the upper main bearing of the pump section is protected from abrasive matter carried by the fluid being pumped.

A further object of my invention is to provide a method of reducing the flow of a fluid between a stationary and a rotatable member.

There is ordinarily a large difference in pressure between the lower end of this bearing and the upper end thereof, this upper end being in communication with the interior of the shaft tubing. This difference in pressure tends to cause an upward flow of well-fluid through the main bearing. This flow is ordinarily checked by a stuffing box which has a by-passed portion in communication with the exterior of the pump to allow any leakage which occurs through the lower portion of the packing in the stuffing box to reach the exterior of the pump. This packing quickly wears away in the presence of any abrasive particles, due to the journalling action which takes place between the packing and the shaft. This wearing action quickly causes a large leakage which materially reduces the efficiency of the pump, especially on small installations where the leakage oftentimes becomes a large proportion of the capacity of the pump.

Furthermore, there is always a tendency for well-fluid to flow from the discharge passage of each pump section into the impeller chamber of that section, this short-circuiting flow taking place around the periphery of the shaft and thus wearing any bearing surface which may be between the pump bowl and the shaft. Various methods have been devised for eliminating or decreasing this short-circuiting flow, but I have found by properly directing this flow adjacent the opening which communicates with the upper bearing, that this short-circuiting flow decreases the pressure on the lower end of the main bearing, thus decreasing any tendency for the well-fluid to flow therethrough.

It is thus an object of my invention to provide a small short-circuiting flow of well-fluid from the discharge passage of a pump section into the impeller chamber thereof, this flow passing adjacent the lower end of the main bearing, or adjacent an opening communicating directly or indirectly with this bearing.

I prefer to place a packing below the main bearing, this packing having a lantern providing a space which is by-passed to the exterior of the pump, so that should any leakage occur through the lower portion of the packing, this leakage will pass outward instead of upward in a manner to reach the main bearing.

It is a further object of my invention to provide a packing below the main bearing of a turbine pump, one end of this packing be-

ing in communication with a short-circuiting flow of well-fluid and the other end of this packing being by-passed to the exterior of the pump.

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

Referring to the drawing, in which I illustrate one form of my invention, —

Fig. 1 is a utility view.

Fig. 2 is a medial sectional view illustrating the details of my invention.

Fig. 3 is a cross-sectional view taken on the line 3—3 of Fig. 2.

Referring particularly to Fig. 1, I illustrate a well 10 in which a well casing 11 has been set. Extending downward inside the well casing is a discharge pipe 12, this pipe being supported at the surface of the ground by a suitable pump head 13. This discharge pipe is adapted to carry a fluid forced upward therethrough by a pump unit 15 attached to the discharge pipe at its lower end, which pump unit is composed of pump sections 16 and an upper bearing structure 17. The well-fluid rising through the discharge pipe is directed from the pump head by a pipe 18.

Each pump section 16 has a body 20 in which an impeller chamber 21 is formed. An impeller 21ª is positioned in each impeller chamber 21, these impellers being secured to a line shaft 22 by any suitable means such as by keys 23, illustrated in Fig. 2. The shaft 22 extends upward through the column pipe and is adapted to be rotated by a motor 24 situated in the pump head 13. Each pump section 16 provides a discharge chamber 26 which converges upward to carry well-fluid from one impeller chamber 21 to the adjacent impeller chamber. When this fluid reaches the uppermost pump section 16 it is discharged into discharge passages 29 formed through the upper bearing structure 17, from whence it is conducted into the interior of the discharge pipe 12.

The upper bearing structure 17 and the body 20 of the uppermost pump section 16 cooperate to form a supporting structure for my invention. I have illustrated the upper bearing structure 17 and the uppermost body 20 as being threadedly secured together, as indicated at 30, but it should be understood that flanges or other attaching means might be substituted for this particular construction without departing from the spirit of my invention.

The upper bearing structure 17 has a bearing chamber 31 formed therein in which a bearing sleeve 32 is situated. This bearing sleeve journals the shaft 22 and has a hub portion 33 extending outward therefrom and fitting into a counterbored portion 34 of the bearing chamber 31. This counterbored portion is threaded so as to receive the lower end of a shaft tubing 35, this shaft tubing extending upward to the pump head and carrying bearings throughout its length which journal the shaft 22. As will be noted from Fig. 2, the lower end of the shaft tubing 35 is screwed into the counterbored portion 34 until this tubing contacts the hub portion 33 of the bearing sleeve 32, thus firmly clamping this bearing sleeve in place.

The lower end of the bearing chamber 31 is defined by a shoulder 40 having a hole 41 through which the shaft 22 passes, there being an annular passage 43 between the outer periphery of the shaft 22 and the sides of this hole. This annular passage 43 communicates with the lower end of the bearing chamber 31, and I prefer to place upper and lower packing members 45 and 46 in this lower portion of the bearing chamber which lies below the bearing sleeve 32, these packing members having surfaces in contact with the peripheral surface of the shaft. These packing members are separated by a lantern 47, this lantern providing a space 47ª between the periphery of the shaft and the interior of the bearing chamber 31. The space 47ª is by-passed to the exterior of the upper bearing structure 17 by means of openings 48 which are formed through webs 49 extending across the discharge passages 29.

The body 20 provides a bore 50 which is slightly larger in diameter than the shaft 22, thus providing a longitudinal leakage passage 51 therebetween. This leakage passage is, however, quite small, being in the neighborhood of five of ten thousandths of an inch in width and extending completely around the shaft 22. The longitudinal leakage passage 51 communicates with the impeller chamber 21, and with a radial leakage passage 53 which is formed between the lower edge of the shoulder 40 and the upper edge of a cylindrical projection 20ª of the body 20. This longitudinal leakage passage 51 also communicates with the annular passage 43.

It is important to my invention that the radial leakage passage 53 be of a smaller fluid-carrying capacity than is the longitudinal leakage passage 51; in other words, the distance across the radial passage 53 should be smaller than the distance across the longitudinal passage 51. Furthermore, I prefer to form the annular passage 43 of smaller size than either the radial leakage passage 53 or the longitudinal leakage passage 51.

The operation of my invention is as follows:

When the motor 24 is energized, and the shaft 22 rotated, the impellers 21ª are rotated, thus drawing fluid from the lower end of the well through a strainer 55. This well-fluid passes upward through each of the pump sections16, each of the impellers therein imparting to this fluid a higher velocity and pressure head as the fluid passes there-

through. Thus, when this well-fluid reaches the uppermost pump section 16, the fluid therein is already at a high pressure. The impeller in this upper section forces the well-fluid outward into the discharge chamber 26.

The main body of this well-fluid passes through the discharge chamber as indicated by large arrows 56 in Fig. 2, thus reaching the discharge passages 29 and travelling upward therethrough, reaching the top of the well through the annular space between the shaft tubing 35 and the discharge pipe 12.

As this well-fluid leaves the impeller, its energy is mainly in the form of velocity, but during the time that it passes upward through the discharge chamber, this velocity energy is transformed into pressure energy. Thus, the pressure of this well-fluid will be greater adjacent the radial leakage passage 53 than it was at the instant of leaving the impeller. This fact, together with the fact that as the impeller rotates any fluid in the upper portion of the impeller chamber is thrown outward due to centrifugal force, acts to cause a difference in pressure between the upper end of the impeller chamber 21 and the discharge chamber 26 adjacent the radial leakage passage 53. This difference in pressure causes a short-circuiting flow of well-fluid in a direction indicated by small arrows 58 of Fig. 2. This fluid enters the radial leakage passage 53, and passes downward through the longitudinal leakage passage 51, thus reaching the impeller chamber 21 after which it is again discharged outward into the main body of well-fluid passing from the impellers. This short-circuiting flow thus passes adjacent the annular passage 43 and is communicable with the contacting surfaces of the packing members and the shaft.

This well-fluid often carries sand or other abrasive particles. The radial leakage passage 53 acts to screen the larger particles of abrasive matter to keep these particles from entering this passage. The smaller abrasive particles may enter this passage and are carried downward by the flow of well-fluid through the longitudinal leakage passage 51, being again discharged into the main stream of well-fluid as previously described. Due to the fact that the radial leakage passage 53 is smaller than the longitudinal leakage passage 51, any abrasive particles which may pass through the former passage will easily be transmitted through the latter passage. There will thus be no wearing action between the shaft 22 and the bore 50.

Furthermore, as this short-circuiting flow passes adjacent the mouth of the annular passage 43, the pressure against this annular passage is materially lowered, due to the high velocity head and low pressure head of the fluid passing through this short-circuiting path. If the longitudinal leakage passage 51 were to be entirely closed, a relatively high pressure would be built up in the annular passage 43, and this pressure would tend to force well-fluid and its associated abrasive particles upward between the shaft 22 and the packing 46 due to the fact that the pressure on the annular passage 43 would be greater than the pressure above the packing members.

The reduction in pressure, due to the high velocity head as the fluid passes through this short-circuiting path, reduces the pressure in this annular passage 43, thus reducing any tendency for well-fluid to flow through the packing member 46. Even should any slight amount of fluid pass therethrough after the packing has become worn through long use, this slight amount of fluid will be discharged through the openings 48 and into the space surrounding the upper main bearing structure 17 before reaching the bearing sleeve 32.

It is important to my invention that the shoulder 40 and the upper end of the body 20 are stationary relative to each other. Thus, the radial leakage passage 53 is formed of two stationary members, and there is no tendency for wear therebetween. The particular construction shown is extremely efficient, and easily assembled. No extra sleeves or other structure is needed, and the cost of a pump such as is illustrated in Fig. 2 is very reasonable.

The invention is not limited to use on the particular bearing shown, but may be used in conjunction with similar bearings in different positions or on other designs of bearings. By the term "bearing" I do not necessarily mean metal bearings, but I refer to any device surrounding a member which is rotatable relative thereto.

Certain features of the present invention are shown and claimed in my co-pending application filed December 27, 1927, Serial No. 242,907, entitled "Main bearing construction for turbine pump".

I claim as my invention:

1. In a deep-well turbine pump, the combination of: a supporting structure having a discharge chamber, and a bearing chamber therein; a bearing in said bearing chamber; and a shaft journalled in said bearing and passing through a bore in said supporting structure, there being a longitudinal leakage passage between said shaft and the walls of said bore, said longitudinal leakage passage being communicable with said bearing chamber, said supporting structure also providing a radial leakage passage opening on said longitudinal leakage passage and on said discharge chamber, said radial leakage passage being narrower than said longitudinal leakage passage.

2. In a deep-well turbine pump, the combination of: a body having an impeller chamber and a discharge chamber; a shaft extending through a bore of said body, there being

a longitudinal leakage passage between said shaft and the walls of said bore, said longitudinal leakage passage communicating with said impeller chamber; an impeller adapted to force a fluid through said discharge chamber; and means forming a radial leakage passage communicating with said discharge chamber and opening on said longitudinal passage, said radial leakage passage being narrower than said longitudinal passage.

3. In a deep-well turbine pump, the combination of: a body, there being an impeller chamber, a discharge chamber and a bore formed therein, said bore communicating with said impeller chamber; a bearing structure secured to said body and having a bearing chamber therein; a shoulder on said bearing structure defining the lower end of said bearing chamber and extending adjacent a portion of said body in a manner to form a radial leakage passage therebetween, said shoulder having a hole therethrough; a shaft extending through said bore and said hole and into said impeller and bearing chambers, said shaft cooperating with the walls of said hole to define an annular passage communicating with said bearing chamber and with a longitudinal leakage passage, said longitudinal leakage passage communicating with said impeller chamber, said radial leakage passage opening on said longitudinal leakage passage; and a bearing in said bearing chamber and journalling said shaft.

4. In a deep-well turbine pump, the combination of: a body, there being an impeller chamber, a discharge chamber and a bore formed therein, said bore communicating with said impeller chamber; a bearing structure secured to said body and having a bearing chamber therein; a shoulder on said bearing structure defining the lower end of said bearing chamber and extending adjacent a portion of said body in a manner to form a radial leakage passage therebetween, said shoulder having a hole therethrough; a shaft extending through said bore and said hole and into said impeller and bearing chambers, said shaft cooperating with the walls of said hole to define an annular passage communicating with said bearing chamber and with a longitudinal leakage passage, said longitudinal leakage passage communicating with said impeller chamber, said radial leakage passage opening on said longitudinal leakage passage; a bearing in the upper end of said bearing chamber and adapted to journal said shaft; and a packing means compressed in said bearing chamber between said bearing and said shoulder.

5. In a deep-well turbine pump, the combination of: a body having an impeller chamber, a discharge chamber and a bore therein, said bore communicating with said impeller chamber; a bearing structure secured to said body and having a bearing chamber therein; a shoulder on said bearing structure defining the lower end of said bearing chamber; a shaft extending through said bore and said bearing chamber, there being an annular passage between said shaft and the sides of a hole through said shoulder, and a longitudinal leakage passage between said shaft and the sides of said bore, said longitudinal leakage passage communicating with said discharge chamber through a radial leakage passage formed between said body and said shoulder, said radial leakage passage having a smaller fluid carrying capacity than said longitudinal leakage passage; and a bearing in said bearing chamber journalling said shaft.

6. In a deep-well turbine pump, the combination of: a body having an impeller chamber, a discharge chamber and a bore therein, said bore communicating with said impeller chamber; a bearing structure secured to said body and having a bearing chamber therein; a shoulder on said bearing structure defining the lower end of said bearing chamber; a shaft extending through said bore and said bearing chamber, there being an annular passage between said shaft and the sides of a hole through said shoulder, and a longitudinal leakage passage between said shaft and the sides of said bore, said longitudinal leakage passage communicating with said discharge chamber through a radial leakage passage formed between said body and said shoulder, said radial leakage passage having a smaller fluid carrying capacity than said longitudinal leakage passage and a larger fluid carrying capacity than said annular passage; and a bearing in said bearing chamber journalling said shaft.

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

ARTHUR R. WEIS.