

Aug. 29, 1933.

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1,924,203

SAND PROTECTED BY-PASS SEAL

Filed Dec. 13, 1929

2 Sheets-Sheet 1

Fig. 1.

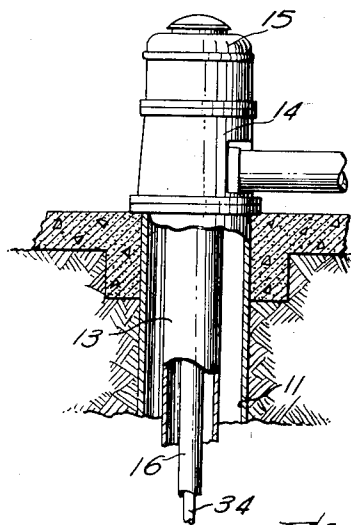


Fig. 3.

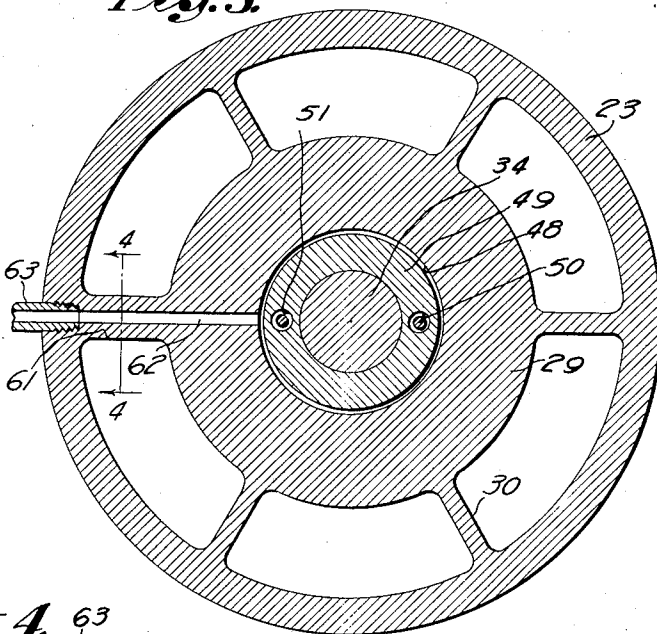


Fig. 4.

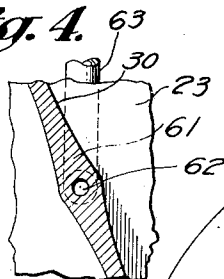
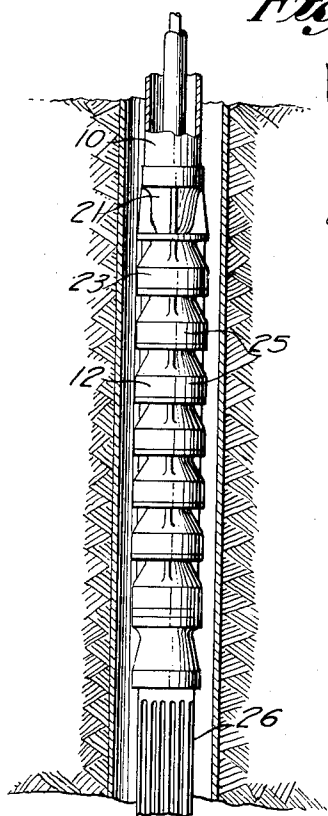
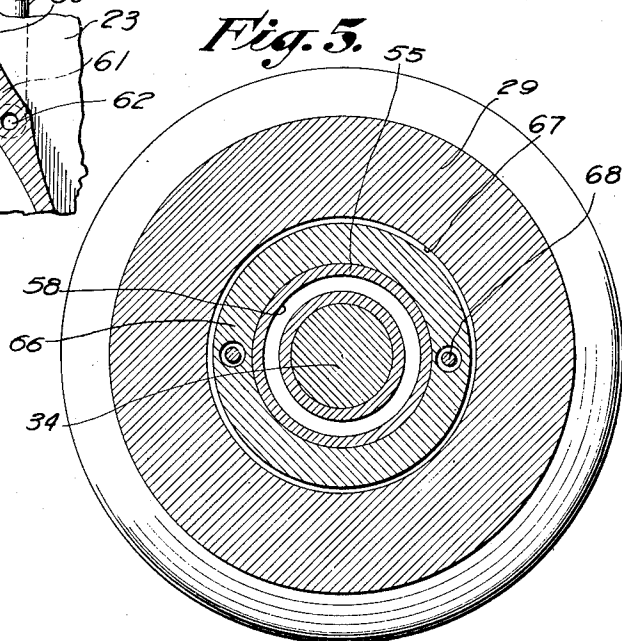


Fig. 5.



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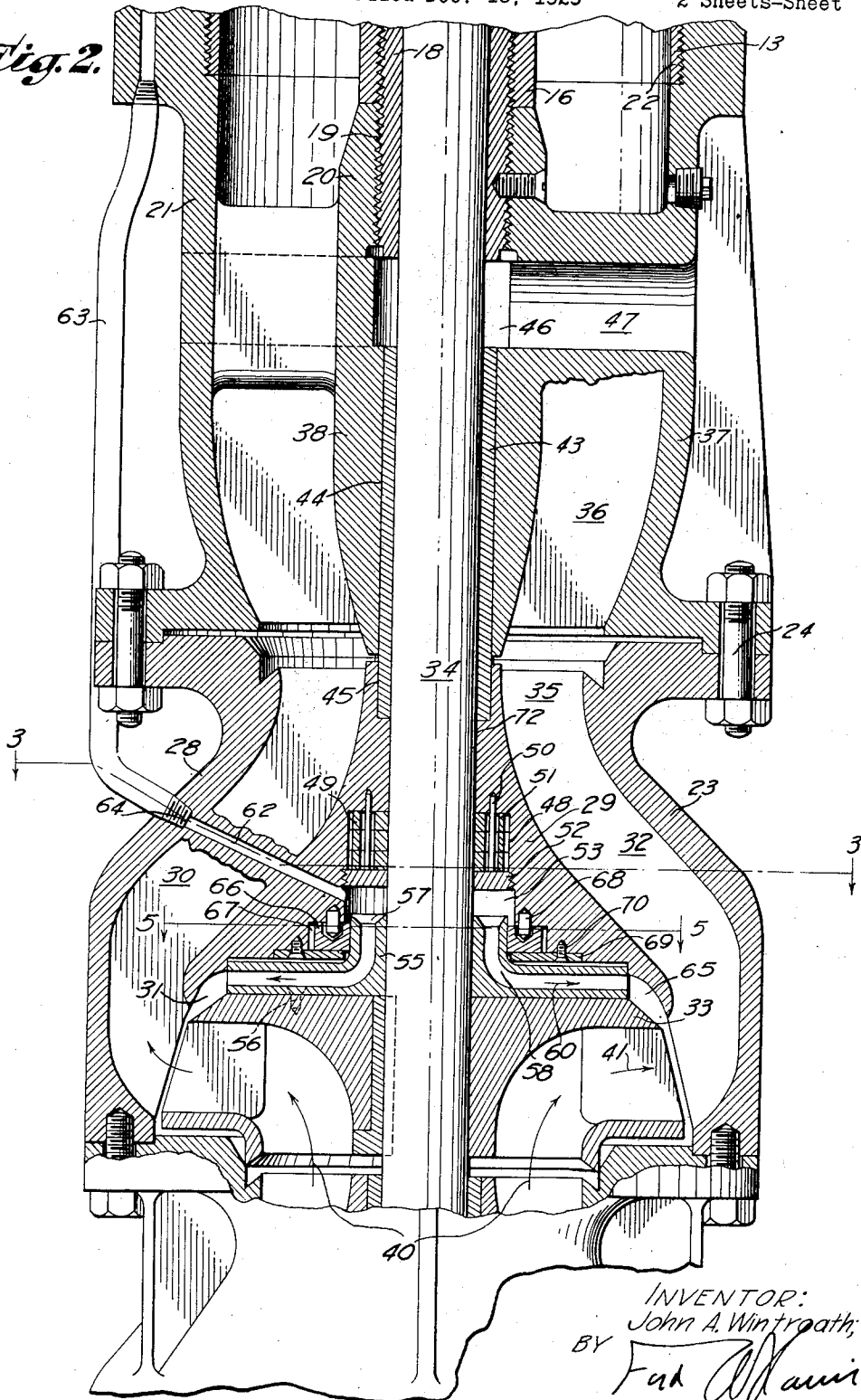
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2 Sheets-Sheet 2

Fig. 2.



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UNITED STATES PATENT OFFICE

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SAND PROTECTED BY-PASS SEAL

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2 Claims. (Cl. 103—102)

This invention relates to rotary deep well pumps and relates particularly to that type of deep well pump in which a by-pass is employed for the purpose of relieving the shaft tubing of such pumps from pressure which would tend to force water and its entrained sand into the lower end of the shaft tubing.

In rotary deep well pumps it is customary to employ a continuous shaft tubing for protecting the pump or impeller shaft from water and sand and for holding shaft bearings which guide the shaft throughout its extension from the pump bowl assembly to the power source situated at the top of the pump discharge head.

In the original form of shaft tubing construction the shaft is entirely enclosed from a point adjacent to the upper face of the uppermost pump impeller to the top wall of the discharge casing or outlet fitting of the pump. When such a pump is operated, a pressure exists in the space surrounding the uppermost impeller, this pressure being greater than a column of water having a height equal to the distance the water must be raised by the pump. This pressure existing around the uppermost impeller of the pump is exerted on the lower end of the shaft tubing through the space existing between the shaft and the bearing structure placed adjacent to the upper face of the uppermost impeller. Therefore, in order to prevent an upward flow of water and sand within the shaft tubing, this tubing was sometimes filled with oil and a packing device was placed between the upper end of the shaft tubing and the shaft portion extending there-through to prevent this oil being forced out through the upper end of the shaft tubing by the water pressure exerted at the lower end of the shaft tubing due to the pressure head exerted thereat when the pump is in operation.

This previous form of construction has been replaced by a new construction in which a by-pass opening is extended from communication with the shaft at a point near the lower end of the shaft tubing to the exterior of the pump, and a sealing device is placed around the shaft between the uppermost impeller and the by-pass to maintain at a minimum the flow of water from the pump passages, through the sealing means, and out through the by-pass into the well. By the adoption of this by-pass construction the interior of the shaft tubing is relieved from pump pressure, lubrication of the bearings within the shaft tubing by the drip feed method is made possible, and the interior of the shaft tubing is kept free from the entry of water and sand due to the

presence of a body of oil in the lower end of the shaft tubing, this body of oil having a static head equivalent to the static head in the water of the well outside the pump.

The sealing means employed around the shaft in a position between the uppermost impeller of the pump and the by-pass operates very satisfactorily over an extended period of time where the water being pumped from the well carries no sand or a very small amount of sand; but where the sand content of the water is quite large, such an amount of sand is carried into and through the by-pass sealing means as to produce a very rapid wear therein, with the result that the sealing means becomes inefficient in that it allows a large escape of water from the pump passages through the by-pass and into the well space surrounding the pump. This loss of water materially reduces the efficiency of the pump, especially when the pump is of small capacity.

It is an object of this invention to provide in a pump having a by-pass, a means for preventing entry of water from the pump passages into the sealing means employed for controlling the flow of water out through the by-pass into the well. By preventing entry of water into the sealing means from the passages of the pump, the entry of sand or other abrasive substances into the sealing means is likewise prevented, and therefore the sealing means is maintained in operation under conditions which are conducive to minimum wear between the cooperating parts thereof, with the result that by use of my invention in a pump employed to pump sandy water, as long and as efficient operation may be had as where the ordinary by-pass seal is employed in a pump used to lift clean water which is entirely free from sand.

A further object of the invention is to provide in a pump of this character a by-pass seal for limiting or throttling the flow of by-pass water, and means for introducing a continuous flow of clean fluid, such as clear water, at the entrance of such by-pass seal so that the flow of fluid through the by-pass seal will consist of such clean liquid and will displace and prevent from entry into the by-pass seal any liquid from the passages of the pump, which liquid ordinarily carries sand or other abrasive substances.

It is a further object of the invention to provide in a pump of this character an entrance chamber at the entrance end of the by-pass seal, to feed clean water to such entrance chamber, and to provide a means for causing a small flow of such clean water from the entrance chamber

into the pump passages, thus insuring against any entrance of water and sand from the pump passages into the entrance chamber.

A further object of the invention is to provide in a pump of the above character a pumping device which is preferably in the form of a small pump impeller, for producing a pressure, in opposition to the pressure in the pump passages, sufficient to produce a desired flow of clean water from the entrance of the sealing means toward and into the passages of the pump.

A further object of the invention is to provide a simple and efficient construction of cooperating parts whereby the hereinbefore mentioned objects of the invention are attained.

Further objects and additional advantages of the invention will be pointed out in the following part of the specification.

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

Figure 1 is a simple diagrammatic elevational view showing a rotary deep well pump with which the use of my invention is especially valuable.

Fig. 2 is an enlarged vertical cross section through that portion of the pump of Fig. 1 in which my invention is incorporated.

Fig. 3 is a horizontal cross sectional view, to reduced scale, taken as indicated by the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary section on a plane represented by the line 4—4 of Fig. 3.

Fig. 5 is a cross section, to reduced scale, on a plane represented by the line 5—5 of Fig. 2.

For the purpose of illustrating the utility of a single embodiment of my invention I have in Fig. 1 shown a deep well centrifugal turbine pump 10 supported in a well casing 11 and consisting of a pump bowl assembly or pump proper 12, a discharge column 13, and an outlet member or discharge head 14 on which a motor 15 for operating the pump is secured. In this type of pump a shaft tubing 16 extends from the discharge head 14 down through the interior of the discharge column 13 and, as shown in Fig. 2, threads onto a bearing sleeve 18 which is screwed at 19 into the upper end of the central body portion 20 of a by-pass and main bearing casting 21 with which the lower end of the discharge column 13 makes threaded engagement, as indicated at 22. To the lower end of the by-pass casting 21 a top or uppermost bowl casting 23 is secured by suitable means, such as represented by bolts 24. As indicated in Fig. 1, other bowls 25, similar to the bowl 23 illustrated in detail in Fig. 2, are successively secured together to form the pump bowl assembly or pump proper 12, the number of bowls employed in the pump bowl assembly 12 being proportioned in accordance with the characteristics of the bowls and impellers and the height or head against which the water must be pumped. A perforated inlet member or screen 26 is generally placed at the lower end of the bowl assembly to prevent entry of gravel or other objects into the pump with the water drawn from the well.

Referring particularly to Fig. 2, the bowl casting 23 includes an outer wall 28, an inner conical body 29 supported from the outer wall 28 by vanes or webs 30, an impeller chamber 31, and water passages 32 through which water is directed under pressure by an impeller 33 which is supported and rotated within the impeller chamber 31 by a shaft 34. The upper ends 35 of the water passages 32 lead into water passages

36 formed between an outer wall 37 and a central body portion or boss 38 of the by-pass casting 21. When the impeller 33 is rotated at operating speed, it takes in water, as indicated by the arrows 40, and by its centrifugal action discharges such water, as indicated by arrows 41, into the lower ends of the water passages 32 at a pressure higher than the pressure at which the water has entered the lower opening or inlet of the impeller.

When a number of bowls or pump stages are employed, as indicated by the assembly 12 in Fig. 1, water from the well is drawn into the pump through the strainer 26, and as it is carried upwardly through the successive stages its pressure is increased each time it passes through a bowl so that when the water reaches and is discharged by the impeller 33, Fig. 2, into the passages 32 of the uppermost pump bowl 23 it will be under sufficient pressure to overcome the static head or the height to which it must be pumped and the frictional head of the discharge column 13 through which it passes from the pump proper to the discharge fitting 14.

Therefore, it will be seen that as water is to be discharged from the discharge head 14 the pressure existing within the passages 32 of the uppermost bowl 23 must be greater than the static pressure exerted by a column of water having a height equal to the length of the discharge column 13; otherwise there would be no flow of water from the pump. The shaft 34 extends through the sleeve 18 and through a sleeve 43 which is held partly in a bore 44 of the body 38 provided by the by-pass casting 21 and partly by a counterbore 45 in the upper end of the central body 29, this bearing sleeve 43 fitting tightly into the bore 44 and the counterbore 45 so as to prevent leakage of water under pressure from the upper ends 35 of the water passages 32 into the space surrounding the shaft 34. The sleeve 43 connects the body 29 with the body 38 in such a manner as to provide a continuous wall structure surrounding the shaft from a point adjacent to the impeller 33 to a circular by-pass chamber 46 which has radial by-pass passages 47 extending outwardly therefrom.

During the operation of the pump, there is a small flow of water out through the by-pass passages 47 into the interior of the well owing to the pressure on the exterior of the pump being considerably less than the pressure on the interior of the pump.

Above the impeller 33 the body 29 is counter-bored, as indicated at 48, to receive a set of sealing rings 49 which are of such internal diameter as to fit closely about the shaft but are smaller in external diameter than the counterbore 48, with the result that the axial position of each of the rings of the set 49 is controlled by its engagement with the exterior of the shaft 34 and not by the engagement with the cylindrical wall of the counterbore 48. To prevent rotation of the set of rings 49, pins 50 are extended through holes 51 in the rings, which holes 51 are larger than the pins, thus permitting a degree of lateral movement of the rings relative to the pins. An externally threaded ring nut 52 is employed to hold the set of sealing rings 49 in the upper portion of the recess or counterbore 48. The lower portion of the counterbore 48 forms what shall be termed an entrance chamber 53, or in other words, a space or chamber through which any fluid must pass before it can reach and pass through the sealing means formed by the set of rings 49.

A small auxiliary impeller 55 is secured to the upper face of the impeller 33 by means such as indicated by screw 56, the barrel or throat portion 57 of this impeller projecting into the lower portion of the entrance chamber 53, and such impeller 55 having passages 58 so formed that a discharge pressure will be exerted radially outwardly in the direction indicated by the arrows 60.

Through one of the webs 30 which has been enlarged, as indicated at 61 in Figs. 3 and 4, a hole 62 is drilled from the exterior of the bowl 23 to communication with the entrance chamber 53, and from the surface of the ground piping 63 extends down the exterior of the pump structure and connects at 64 with the outer end of the passage 62, making it possible to feed clean fluid, such as water, into the entrance chamber 53. Owing to the fact that the point at which water is fed into the piping 63 is at substantially the same level as the upper end of the discharge column 13 of the pump, the static pressure of the clean water where it enters the entrance chamber 53 is nearly as great as the pressure existing within the pump passages 32 when the pump is in operation. To overcome the excess pressure existing in the passages 32 and also in the space 65 and to cause a small flow of clean fluid downwardly and outwardly from the chamber 53 through the space 65, the static pressure of the clean water entering the chamber 53 through the passages 62 is reinforced or added to by the impeller 55 which exerts an outward force in its passages 58, as indicated by the arrows 60. The outward pressure in the outer ends of the passages 58 of the impeller 55 is the sum of the static pressure head within the chamber 53 due to the height or length of the piping 63 and the pressure incurred or exerted by the centrifugal action of the impeller 55, and owing to the fact that this pressure in the outer ends of the passages 58 is slightly greater than the pressure in the pump passages 32, there will be a continuous outflow of clean water from the entrance chamber 53 through the impeller 55, and into the space 65 which communicates with the passages 32.

To hold the leakage in reverse direction from the space 65 and around the upper portion of the impeller 55 into the chamber 53, a sealing ring 66 is placed in an annular recess 67, this sealing ring 66 fitting closely the exterior of the barrel or throat 57 of the impeller 55, being held from rotation by pins 68 and being held in the recess 67 by an annular plate 69 which is secured in place by screws 70. Owing to the fact that there is a continuous discharge of clean water into the space 65, such water as may leak back around the exterior of the impeller 55 and through the sealing means 66 into the chamber 53 will be free from sand and abrasive substances.

The pressure of the water within the entrance chamber 53 being greater than the static pressure exerted on the by-pass passages 57 by the water in the well results in a small flow of clean water from the entrance chamber 53 upwardly around the exterior of the shaft 34, through the sealing means represented by the set of rings 49, through the bore 72 of the body 29 and the bore of the sleeve 43, and into the annular chamber and radial passages 47 forming part of the by-pass structure. This by-pass flow is desirable as it serves to lubricate the bearing formed by the sleeve 43 and also operates to keep such bearing cool.

By use of the structure previously described,

the following valuable results have been accomplished: Sand or abrasives are prevented from entering the space between the sealing means for the by-pass and the shaft, thereby reducing wear on the sealing means, the shaft, and the bearings to a minimum and thus assuring a maximum useful life of these operating parts. A constant flow of clean liquid is fed into the entrance of the by-pass structure, particularly the entrance to the by-pass sealing means, thereby assuring that all flow of liquid outward through the by-pass structure will be confined to this clean liquid. The running alignment of the rotary parts including the shaft and impellers attached thereto is maintained for a maximum period of time by keeping the main pump bearing free from excessive wear.

I have herein shown my invention in simple and practical form, but it is recognized that certain parts or elements thereof are representative of other parts, elements, or mechanisms which may be employed in substantially the same manner to accomplish substantially the same results; therefore, it is to be understood that the invention shall not be limited to the details disclosed herein but shall have the scope set forth in the following claims.

I claim as my invention:

1. A pump of the character described, including: an impeller shaft; an impeller secured to and rotated by said shaft; a casing structure surrounding said shaft and said impeller, said casing structure comprising an inner wall having a bore receiving said shaft above said impeller, an outer wall forming pump passages exterior of said inner wall, and a by-pass passage having communication at its inner end with said bore of said inner wall above said impeller and having communication at the outer end with the exterior of said casing, there being a recess at the lower end of said inner wall forming an entrance chamber leading into said bore; impeller means on the upper end of said impeller for producing a flow of liquid from said entrance chamber toward said pump passages; and sealing means operative to prevent a reverse flow of liquid from said pump passages and around said impeller means into said entrance chamber.

2. A pump of the character described, including: an impeller shaft; an impeller secured to and rotated by said shaft; a casing structure surrounding said shaft and said impeller, said casing structure comprising an inner wall having a bore receiving said shaft above said impeller, an outer wall forming pump passages exterior of said inner wall, and a by-pass passage having communication at its inner end with said bore of said inner wall above said impeller and having communication at its outer end with the exterior of said casing, there being a recess at the lower end of said inner wall forming an entrance chamber leading into said bore; means for delivering a fluid from an external position to said entrance chamber; sealing means operative around said shaft to restrict the flow of liquid through said bore; impeller means on the upper end of said impeller for producing a flow of liquid from said entrance chamber toward said pump passages; and sealing means operative to prevent a reverse flow of liquid from said pump passages and around said impeller means into said entrance chamber.

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