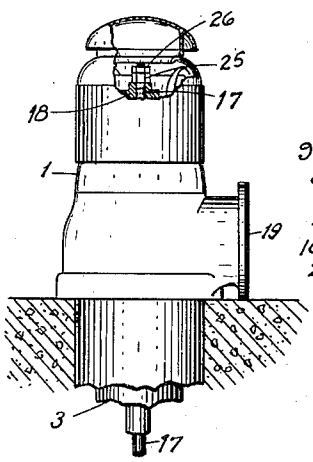
Jan. 31, 1939. J. M. HAIT 2,145,597

CENTRIFUGAL PUMP

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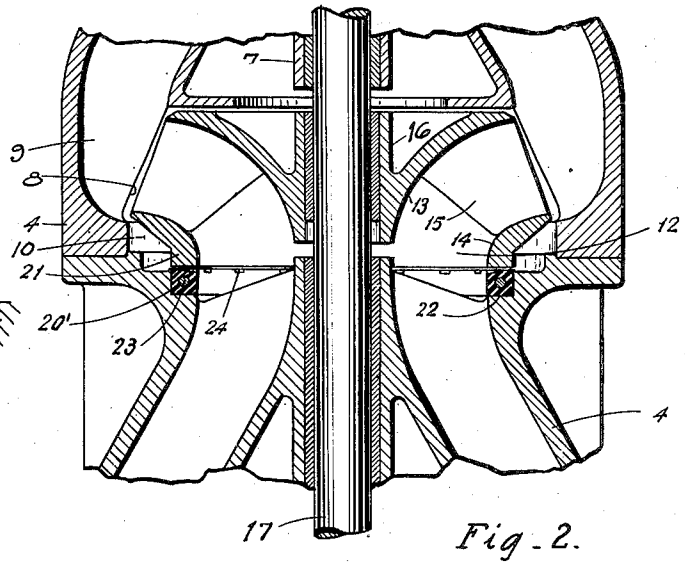


Fig. 2.

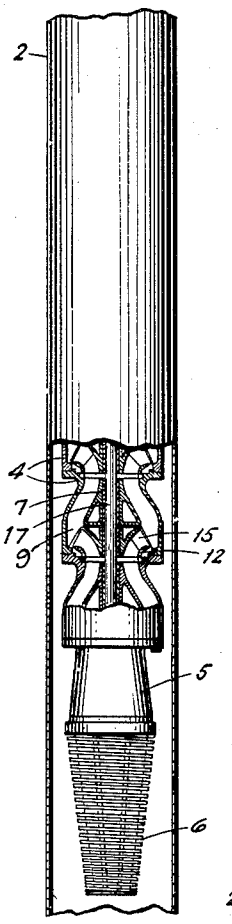


Fig. 1.

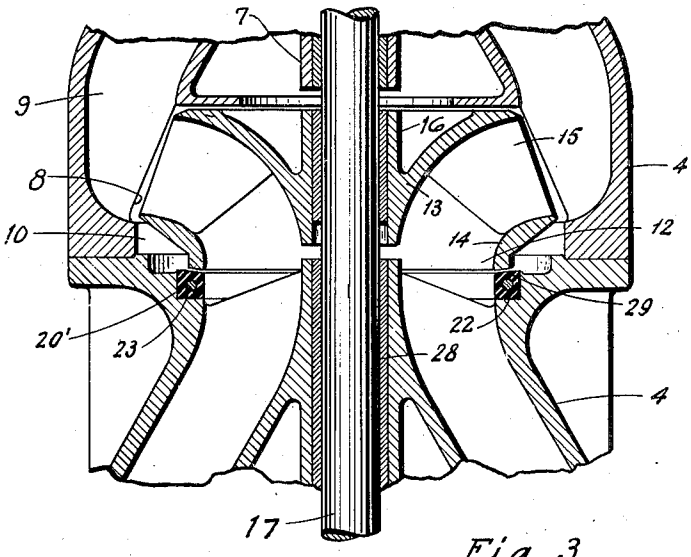


Fig. 3.

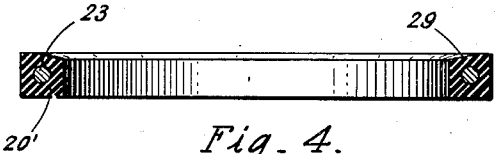


Fig. 4.

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CENTRIFUGAL PUMP

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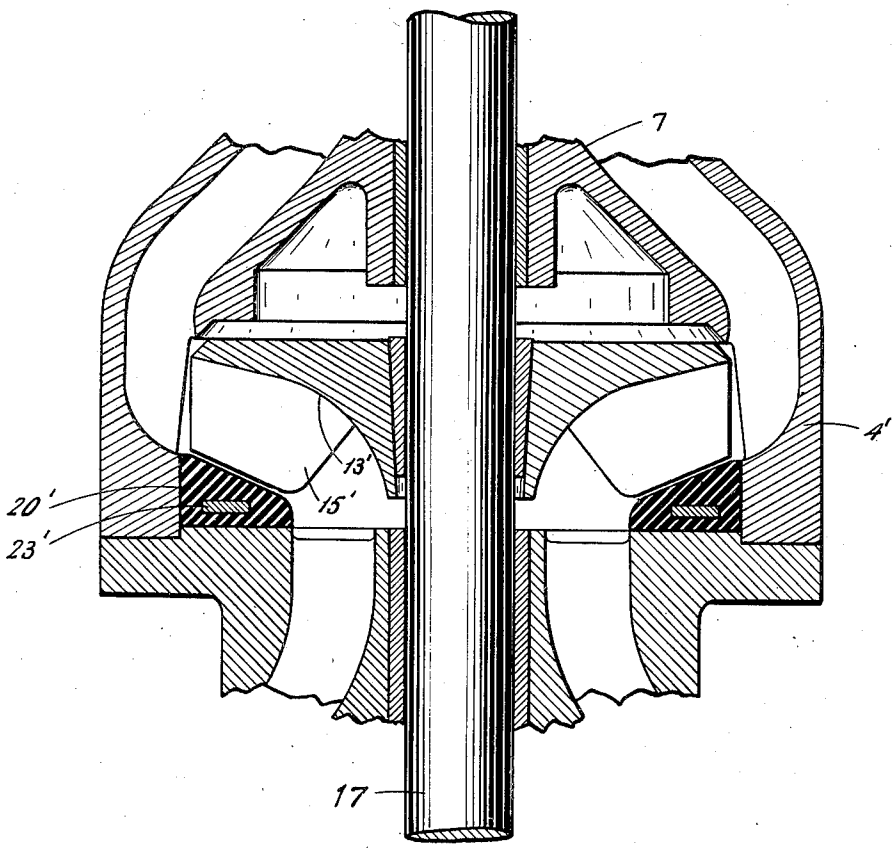


Fig. 5.

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UNITED STATES PATENT OFFICE

2,145,597

CENTRIFUGAL PUMP

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Application February 4, 1936, Serial No. 62,265

5 Claims. (Cl. 103—102)

This invention relates to centrifugal pumps, and is primarily concerned with the provision in pumps of this character, of improved sealing means for minimizing wear and limiting certain characteristic hydraulic losses.

It is well known that incident to the operation of centrifugal pumps, as for example when used for pumping water from wells, rapid and excessive wear on the impellers and their housings frequently results from the abrasive action of sand, gravel or other abrasive materials, which may be entrained in the water being pumped. This may be attributed to the fact that such pumps are necessarily designed to provide relatively close clearances between certain portions of the impellers and their housings, in order to minimize hydraulic losses, and the introduction of sand, gravel or the like into such clearances results in a grinding action upon the adjacent relatively moving surfaces, thereby causing them to be rapidly worn away. Such wear not only reduces the life of the pump, but also increases the clearances referred to, so as to reduce the efficiency of the pump by reason of the resulting increase in hydraulic losses.

It is the general object of my invention to minimize such wear and thereby provide a centrifugal pump which is long lived both in structure and efficient characteristics.

More specifically, it is an object of the invention to provide a centrifugal pump having improved sealing means, such as to effectively minimize wear caused by abrasive materials entrained in liquid being pumped, and to thereby limit increase of hydraulic losses.

Another object is to provide a centrifugal pump with sealing means of the character referred to, so arranged with respect to the impeller as to permit variation of the clearance between them by longitudinal adjustment of the impeller.

Further objects and advantages will best be understood by reference to the following description of preferred embodiments taken in connection with the accompanying drawings, in which:

Fig. 1 is a side elevation of a deep well pump embodying my invention, certain portions being broken away whereby to illustrate certain details of construction in section.

Fig. 2 is an enlarged sectional view of a portion of the pumping units shown in Fig. 1.

Fig. 3 is a similar view, illustrating a modified form of impeller and sealing ring.

Fig. 4 is a sectional view of a modified form of sealing ring, and

Fig. 5 is a fragmentary sectional view of a pump unit employing an impeller of the open or single shroud type, and embodying therein the principle of my invention.

Referring first to Figs. 1 to 4 of the drawings, the pump illustrated comprises a conventional pump head 1, arranged at the ground level and secured to the upper end of a well casing 2, which extends downwardly into the ground to form a soil retaining wall for the well. A discharge column 3 of usual construction depends from the pump head, and carries at its lower end, one or more pump bowls 4; an intake pipe 5 and a strainer 6.

Each of the pump bowls 4 is provided in its upper portion with a central bearing 7, joined to the bowl 4 by integrally formed vanes 8, to form an annular liquid passage 9, leading upwardly from an impeller chamber 10 beneath the bearing. A rotary impeller 12 is mounted in the chamber 10 of each bowl; the impellers illustrated being of the double shroud type, comprising an inner or upper shroud 13, and an outer or lower shroud 14, joined together in spaced apart relation by impeller vanes 15, so as to form a liquid passageway therebetween. The inner shrouds 13 are provided with hubs 16, secured to the vertical line shaft 17, which is journalled in the bearings 7 and driven by the rotor 18 of an electric motor housed within the pump head 1.

All of the foregoing described structure is conventional construction, well known in the art, so that further detailed description is believed unnecessary. It will be understood that the motor in the pump head drives the several impellers 12 through the medium of the line shaft 17, and the well water entering the strainer 6 and intake pipe 5, is lifted by the impellers through the bowl passages 9 and thence through the discharge column 3 to the pump head 1, from which it is discharged through the elbow 19.

In accordance with my invention, and referring now particularly to Fig. 2, a sealing ring 20 of resilient material, such as soft rubber, is mounted closely beneath the lower end of the impeller skirt, as by means of an annular recess 22 milled into the bore of the adjacent pump bowl, and forming a seat into which the ring may be pressed. The sealing ring is preferably reenforced in order to give it the necessary rigidity, to prevent collapse, by means of a rigid core, such as a metal hoop 23, which may be molded therein during manufacture. For a purpose shortly to be described, the upper face of the sealing ring may also be provided with a plurality of recesses, such as grooves 24.

It will be observed that the sealing ring cooperates with the end of the impleller skirt to form a hydraulic seal, and the importance of this construction and arrangement may best be understood by a consideration of certain structural and operating characteristics of pumps of the general type illustrated. In such pumps it is an essential requirement for satisfactory operation that frictional engagement between the impellers and the adjacent stationary parts of the bowls be avoided, since any dragging of the impellers on the bowls would obviously result not only in rapid wear, but the increased power required to run the pump would seriously reduce its efficiency.

A minimum, but adequate clearance between the impellers and the bowl is therefore required, and by reason of such clearance and the difference existing between the pressures at the intake and discharge ends of the impellers, a circulation of liquid takes place in operation, creating a back flow around the outside of the impellers, from the high pressure zones at the discharge ends of the impellers to the low pressure zones at the intake ends of the impellers. This back flow of liquid, commonly referred to as circulation loss, obviously decreases the efficiency of the pump, and to minimize such losses as far as possible, it is customary to so form the bowl that a portion of it closely fits around the impeller at some suitable point, so as to form a seal having just sufficient clearance to allow the impeller to run freely without dragging. Such clearance may ordinarily be approximately 1/64", which is about as small as it is practical to make it.

A serious difficulty arises however, where abrasive materials, such as sand or gravel, for example, happen to be present in the liquid being pumped, due to the back flow carrying such materials around the impellers, and introducing them into the small clearances between the impellers and the closely fitting seal portions of the bowl. Since the desirable clearance is insufficient to permit the free movement of sand or gravel therethrough, it will be apparent that when such materials are introduced thereinto, they are ground between the adjacent relatively moving surfaces of the impeller and the bowl, and this grinding action rapidly wears them away, with the result that the life of the pump is decreased, while its efficiency is simultaneously reduced in consequence of the increased circulation losses, attendant upon the increased clearances.

A similar effect is likewise occasioned by sand, gravel or the like, being introduced into the shaft bearings **7**, causing them to cut out, whereupon a laterally whipping of the line shaft takes place. Such whipping is frequently sufficient to move the impellers into engagement with closely fitting portions of the bowls, and consequently adds to the wear caused by the sand and gravel introduced into the clearances by the back flow previously described, and further contributes to the reduction in the life and efficiency of the pump.

By the provision of the rubber sealing ring **20**, however, I have found that these difficulties may be largely overcome. This may be explained by the fact that the toughness and resiliency of the ring is such that it is not only highly resistant to abrasion or cutting, but it also eliminates the grinding action which has heretofore occurred. Apparently, when particles of sand, gravel or the like are caught between the cooperating sealing surfaces of the ring and impeller skirt, the ring body acts as a cushion and the resulting deformation of the rubber causes the particles to be rolled, rather than scraped between the relatively moving surfaces, thereby avoiding any gouging or grinding action, upon either the ring or the impeller skirt. As a result, neither the ring nor the impeller are subject to excessive wear from abrasive materials introduced therebetween.

The arrangement of the sealing ring in endwise relation to the impeller is also of considerable importance, for it will be noted that by such arrangement, any lateral whipping of the line shaft which may take place, will not bring the impeller into engagement with the ring, so that no wear is occasioned by this action. As shown in Fig. 3, the cooperating faces of the sealing ring **20'** and the impeller skirt, may be more or less beveled if desired, in order to permit gravity to assist the passage of abrasive materials therebetween, and yet allow for considerable lateral whipping of the line shaft, without causing the impeller to drag on the sealing ring.

A further advantage obtained by mounting the sealing rings beneath the impellers, is that such arrangement permits vertical adjustment of the impellers to vary the clearance between them and the sealing rings, either for the purpose of compensating for such wear as does take place, or to vary the output of the pump; such adjustment may be provided for by securing the line shaft **17** to the rotor **18** of the motor, by means of a nut **25**, and lock nut **26**. Thus by taking up these nuts, the line shaft may be lifted so as to increase the clearance between the impeller and the sealing ring, and thereby decrease the output of the pump by increasing the circulation losses. On the other hand, by loosening the nuts, the line shaft may be lowered to decrease the clearance as may be desired to compensate for wear.

I have found that a further and appreciable reduction in the rate of wear of the sealing surfaces may be obtained by suitably forming the sealing surface of the ring, as for example by the provision therein of the transverse channels or grooves **24**. Preferably these channels extend but partially across the upper surface of the seal and terminate short of the outer periphery thereof, so that the effective width of clearance between the cooperating faces of the sealing ring and impeller is not increased. These channels serve to interrupt the travel of sand or gravel particles around the ring by momentarily relieving them of pressure and allowing them to be flushed out from between the ring and the impeller skirt; thus the distance to which such particles may be carried around the ring and the wear occasioned thereby, is greatly reduced.

In the modified form of sealing ring illustrated in Fig. 4, the upper surface of the ring is slightly beveled across a portion of its width, as at **29**, and such a ring may be utilized, if desired, in connection with the form of impeller shown in Fig. 2. When so used, it will be apparent that the resultant clearance between the cooperating faces of the ring and impeller skirt is tapered, and as a result, abrasive particles are released as they work inwardly thereof to effect results similar to those obtained by the channels **24** of the sealing ring **20**.

Fig. 5 illustrates the application of my invention to a pump employing an impeller of the open or single shroud type. In this type of impeller only the upper shroud **13'** is employed, the lower edges of the impeller vanes **15'** being free.

In accordance with my invention, I provide a sealing ring 20', of resilient material such as soft rubber, mounted immediately beneath the impeller vanes and having its upper surface beveled to provide a conical surface adjacent the lower edges of the vanes for cooperation therewith. The ring may be provided with a suitable core 23' of metal, for the purpose of giving rigidity thereto, and may be secured in place in any suitable manner. In the construction illustrated, the ring is tightly pressed within the upper pump bowl 4', and is supported by the upper face of the lower bowl. It will be apparent that the fluid pressure acting upon the conical surface of the sealing ring insures a firm seating of the ring in the housing.

The employment of the resilient sealing ring in connection with impellers of the open or single shroud type as illustrated, is obviously productive of beneficial results similar to those obtained when employed in connection with impellers of the double shroud type, as heretofore described. For example, it will be apparent that in the operation of this type of pump, more or less of the liquid being pumped will leak or "slip" beneath the lower edges of the impeller vanes, the amount depending upon the degree of clearance between the vanes and the cooperating surface of the sealing ring. Such leakage, commonly referred to as "slippage loss", obviously detracts from the efficiency of the pump, and is therefore desirably to be minimized so far as possible.

In conventional pumps, employing single shroud impellers, such as illustrated in Fig. 5, the section occupied by the sealing ring 20' is ordinarily of metal, being formed as an integral part of the pump bowl, and consequently, it is necessary to maintain a clearance between it and the adjacent edges of the impeller vanes sufficient to prevent dragging and consequent wear and increased power consumption. The small clearance required, however, to minimize slippage losses, gives rise to problems similar to those heretofore pointed out in connection with the operation of double shroud impellers, in that where sand or gravel happens to be present in the liquid being pumped, it is introduced beneath the edges of the impeller vanes and ground between them and the adjacent cooperating surface of the bowl. As a result the adjacent faces of the impeller vanes and the bowl are rapidly worn away, thereby reducing the life of the pump, and at the same time reducing its efficiency, due to the increase in slippage losses, as the clearance is increased.

By the provision of the resilient sealing ring 20' however, in accordance with my invention, it will be apparent that sand, gravel, or other abrasive materials which may be introduced beneath the impeller vanes are rolled rather than ground between the edges of the impeller vanes and the resilient surface of the sealing ring, as heretofore described. It will also be apparent that this construction permits longitudinal adjustment of the impellers as before, to effect variation in the pump capacity, or to compensate for wear. Moreover, it will be observed that the employment of the resilient sealing ring in connection with impellers of the single shroud type in the manner illustrated, affords an advantage over conventional pumps employing impellers of this type, in that any dragging of the impeller vanes over the seal, which may take place, due to lateral whipping of the line shaft, does not result in excessive wear or rupture of parts, due to the fact that the metal vanes may slip freely over the wet surface of the rubber, at the same time compressing it slightly so as to avoid any serious consequence.

Having now explained the principles of my invention and illustrated preferred embodiments thereof, it will be appreciated by those skilled in the art, that various modifications and variations may be resorted to without departing from the spirit of my invention. I desire to be understood, therefore, that I consider myself entitled to all such modifications and variations as fall within the scope of the claims appended hereto.

I claim as my invention:

1. In a deep well turbine pump having a vertical line shaft extending into a well, a series of impellers carried by the lower portion of said line shaft, a series of pump bowls cooperatively associated with said impellers, sealing means associated with said impellers and comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces having a rigid surface, a resilient sealing ring carried by the other of said faces and having an end face presented to and spaced from said rigid surface to provide a flow restrictive clearance space therebetween, and means for adjusting said line shaft vertically to vary the vertical position of said impellers with respect to said bowls, whereby to compensate for wear of said faces and to vary the vertical extent of said clearance spaces as desired.

2. In a deep well turbine pump having a vertical line shaft extending into a well, a series of impeller members carried by said line shaft adjacent the lower end thereof, a series of bowl members associated with the respective impeller members, a series of sealing members disposed between the respective lower ends of said impeller members and the associated upper ends of said bowl members to provide the only sealing restriction between adjacent pairs of said series of members, each sealing member comprising a resilient seal ring carried by one of the pair of members associated with the same and having a face presented to and spaced from a rigid end of the other of said pair of members to provide a flow restrictive clearance space therebetween, and means for adjusting said line shaft vertically to vary the vertical position of said impeller members with respect to said bowl members, whereby to compensate for wear of said members and to vary the vertical extent of said clearance spaces as desired.

3. In a deep well turbine pump having a vertical line shaft extending into a well, an impeller carried by said line shaft adjacent the lower end thereof, a bowl associated with said impeller, a sealing member between said bowl and the lower end of said impeller providing the only sealing restriction therebetween, said sealing member comprising a resilient sealing ring seated at the upper end of said bowl and having a face presented to and spaced from a rigid end of said impeller to provide a flow restrictive clearance space therebetween, and means for adjusting said line shaft vertically to vary the vertical position of said impeller with respect to said bowl and said sealing member, whereby to compensate for wear of said members and to vary the vertical extent of said clearance space as desired.

4. In a deep well turbine pump having a vertical line shaft for extension into a well, an impeller member carried by the lower portion of said line shaft, a bowl member cooperatively associated with said impeller member, one of said members having a rigid surface facing endwise

with respect to said impeller member, a resilient sealing ring carried by the other of said members and having a face presented to and normally spaced from said surface to provide a flow restrictive clearance therebetween, and means for adjusting said line shaft vertically to vary the vertical position of said impeller member with respect to said bowl member, whereby to compensate for wear on the face of said sealing ring and said surface to which it is presented, and to vary the vertical extent of said clearance as desired.

5. In a deep well turbine pump having a vertical line shaft for extension into a well, an impeller member carried by the lower portion of said line shaft, a bowl member cooperatively associated with said impeller member, one of said members having a rigid surface inclined with respect to the axis of said line shaft, a resilient sealing ring carried by the other of said members and having a face presented to and normally spaced from said surface to provide a flow restrictive clearance therebetween, and means for adjusting said line shaft vertically to vary the vertical position of said impeller member with respect to said bowl member, whereby to compensate for wear on the face of said sealing ring and said surface to which it is presented, and to vary the vertical extent of said clearance as desired.

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