Nov. 26, 1940. O. JACOBSEN 2,223,212

PUMP RUNNER ASSEMBLY

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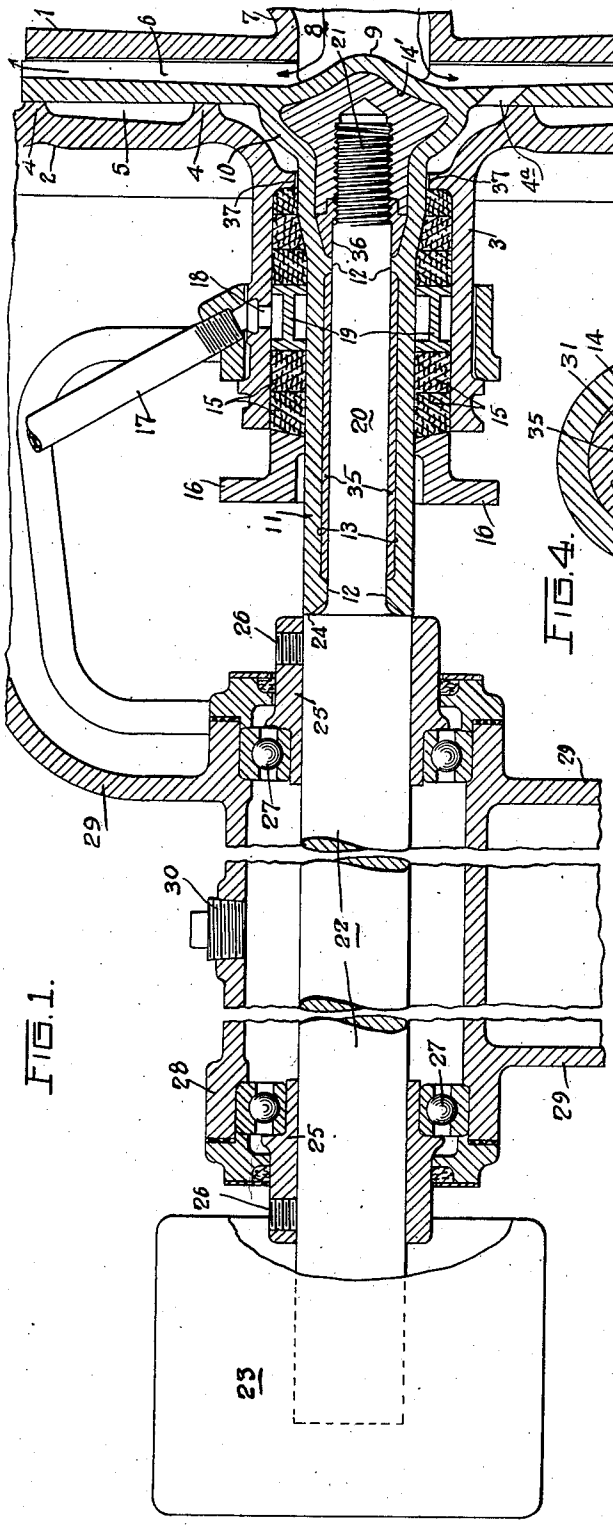


FIG. 1.

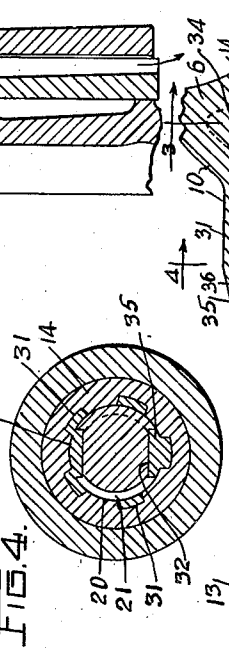


FIG. 4.

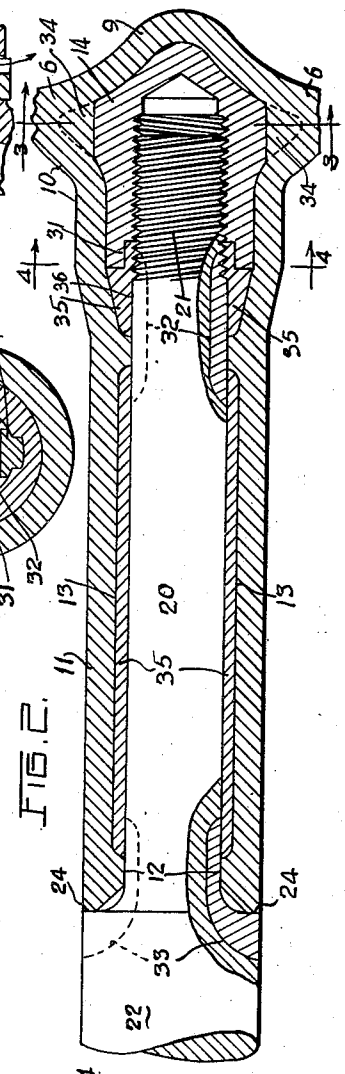


FIG. 2.

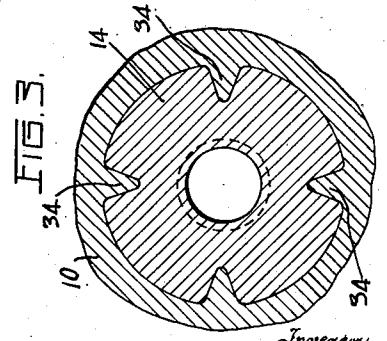


FIG. 3.

Inventor
OYSTEIN JACOBSEN,
By Paulmin & Paulmin
Attorneys

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PUMP RUNNER ASSEMBLY

Oystein Jacobsen, Montgomery County, Ohio, assignor to The Duriron Company, Inc., Dayton, Ohio, a corporation of New York

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3 Claims. (Cl. 287—53)

The present invention relates to a pump runner assembly of the type requiring corrosion-resisting material as a composition of the runner proper and sleeve which contact with the liquid handled by the pump and a drive shaft of stronger, tougher material.

When a centrifugal pump is designed to handle an acid or water containing acid, it is usual to fabricate the runner or impeller out of high silicon iron which has been found to resist corrosion. This metal is somewhat brittle and is extremely hard to machine, which facts introduce a severe problem in securing the shaft to the runner. The latter revolves at a high rate of speed, e. g., 1800 revolutions per minute, so that it is absolutely necessary that the shaft be rigidly affixed to the runner and to maintain this connection even when the pump is being subjected to variable loads. It is apparent that the slightest wear or tendency for the shaft to move with respect to the runner would soon result in considerable looseness due to the small lever distances through which the shaft exerts its rotative effort on the impeller.

The prior art has evolved certain modes of connection between the shaft and the impeller, which has withstood the severe strains exerted at the point where the shaft connects with the impeller, but such connections have not had a considerably long life, particularly when the pump was working under variable loads, variable heads and variable speeds, and more especially when the impeller was large, heavy and its inertia considerable. It will be understood that it is impossible to use bolts or other positive securing means, because the impeller material does not lend itself to machine working.

The primary object of the present invention is to provide an improved mechanical connection which is of simple and sturdy design and adapted to secure a steel shaft to a disk of corrosion-resisting material carried on the end of the shaft, thus providing an assembly which can be rotated at high speeds and under variable loads.

Another object is to provide a positive lock between the runner of a centrifugal pump and its shaft, permitting the assembly to be driven in either direction without slippage under the strains introduced at the time the impeller is being started and also preventing unscrewing of the shaft when the pump is started up backwards.

A still further object is to provide a bond between the impeller and shaft, not only as against rotation between members when the impeller is subjected to considerable inertias or momentums, but also as against relative longitudinal movement between the impeller and the shaft.

The invention will be better understood when reference is made to the following description and the accompanying drawing.

Figure 1 is a longitudinal section of a pump assembly, partly broken away, and showing the drive pulley and shaft in elevation.

Figure 2 is an enlarged section of a portion of the impeller and shaft showing the improved manner in which these elements are secured together.

Figure 3 is a cross section taken along line 3—3 of Figure 2 and looking in the direction of the arrows.

Figure 4 is a cross section taken along line 4—4 in Figure 2 and looking in the direction of the arrows.

Referring to the drawing in detail, numerals 1 and 2 designate the front and back plates respectively of a pump housing containing an impeller of the open runner type. The back plate 2 terminates in a horizontal sleeve 3 which extends away from the plate and takes on a cylindrical configuration to form a housing for packing material. The plate 2 is provided with a pair of sealing rings 4 against which the solid or plate portion 5 of the impeller bears. An opening 4a is provided to drain off the fluid which gets by these rings. There is a plurality of vanes or blades 6, either of arcuate or straight configuration, secured to the front side of the impeller plate 5. These vanes are shown in elevation in Figure 1, because the line of section does not pass therethrough. As will be noted from Figure 1, the front plate 1 of the housing terminates in a cylindrical member 7 provided with an opening 8 which serves as the eye or the inlet passage for the impeller.

The plate 5 of the impeller is provided with a nose or humped portion 9 which extends into the opening 8 and serves to direct the liquid which passes through the opening into the passages (not shown) between the vanes 6. There are projecting from the other side of the plate 5 a number of cylinders or hubs of different diameters and indicated at 10, which finally extend into a long sleeve portion 11 which has a pair of annular bearing surfaces 12 normally separated by a cutaway annular space indicated at 13. The cylinders 10 and the nose portion 9 of the impeller are cored out to leave a compartment indicated at 14' which, as will be explained hereinafter, contains a machinable metal, such as bronze, white metal or the like, positioned by a

casting operation. Between the sleeve 11 and the housing 3, there is a quantity of packing material 15 which preferably takes the form of rings so as to accommodate themselves to the cylinders of different sizes and these rings are clamped together in any suitable manner, for example, by a flanged plate 16 which slides along the sleeve 11 and is adapted to exert longitudinal pressure against the packing.

By moving the plate 16 to the right, it is obvious that the packing 15 will press downwardly on the sleeve 11 to form a liquid-tight joint. The pores of the packing are filled with grease in any suitable manner and, as illustrated, there is provided a nozzle 17 leading to an adjustable grease cup which is adapted to force grease under pressure through the opening 18 in the housing 3 and through openings in the partition member 19 to the packing.

The shaft for rotating the impeller is indicated at 20 and is provided at one end with a screw portion 21 and at the other end a portion 22 of larger diameter, to which a pulley 23 is keyed. This shaft is made preferably of machinable steel designed to carry heavy rotating loads at considerable speed. There is thus a shoulder indicated at 24 formed between the portion 22 and the portion 20. As will be noted, this shoulder abuts the outer end of the sleeve 11.

The shaft is provided with sleeves 25 secured thereto by a headless set screw 26 and is adapted to rotate in the ball bearings 27 which are secured to a housing 28. The latter is supported from the frame 29 of the machine and is provided at a position intermediate the ball bearings with an opening containing a plug 30. The interior diameter of the housing is considerably greater than the portion 22 of the shaft to leave an annular compartment which receives grease or other lubricant through the opening in the housing 28 when the plug 30 is removed.

As stated hereinbefore, the present invention is concerned more especially with the difficult problem of obtaining a positive locking or securing means between the screwed end of the shaft and the impeller. The manner in which the improved locking arrangement is effected is best shown in Figures 2, 3 and 4. The inner or lefthand end of the bronze member 14 is provided with a number of milled slots 31, five as shown in Figure 4, these slots having a depth along the axis of the shaft of approximately ¼'' and a width of about the same dimension. The slots 31 are preferably equidistantly spaced around the bronze member and each slot is presented to the threaded opening in the member. The shaft 20 is provided with a pair of oppositely positioned, elongated keyways 32 of considerably greater width than the width of each slot 31, and extending on each side of the righthand bearing surface 12. As will be noted in Figure 2, the milling of the keyways begins at a position considerably to the left of the bearing surface 12 and terminates at a position near the deeper surface of the slots 31. As will also be noted in Figure 2, there is an annular space left between the lefthand end of the bronze member 14 and the righthand edge of the shoulder formed by the bearing portion 12.

Keyways 33, similar to keyway 32, are also provided at a position determined by the shoulder 24 so that part of the keyway 33 is cut in the large diameter portion 22 of the shaft and the remainder of the keyway is cut in the small diameter portion 20 of the shaft. The purpose of these keyways will be explained presently.

In order to assure that the bronze member 14 does not turn within the cored hub member 10, I provide four or more ribs 34 which project inwardly toward the shaft and are made integral, as by casting, with the hub member.

In the assembly of the shaft and impeller, and assuming that the compartment within the hub 10 contains the integral ribs 34, the first thing done is to cast the bronze member 14 in place. This is accomplished by holding the impeller in a horizontal position so that the sleeve 11 remains upright and then pouring the bronze or other fusible metal through the opening in the sleeve until it collects in the cored compartment within the hub 10. The molten metal will obviously fill up all the spaces between the ribs 34, as indicated in Figure 3. When sufficient metal has thus been introduced, the latter is permitted to solidify and a hole is bored into the metal and threaded to receive the threaded end of the shaft 20. However, before the threads are actually cut, the keyways 31 are provided by an end miller and shaper, the lefthand end of the bronze member 14 being also milled to the proper length at the same time. During this machining operation, the bearing surfaces 12 are ground very carefully so as snugly to receive the shaft portion 20.

Assuming that the keyways 32 and 33 have been cut in the shaft, the latter is then introduced into the sleeve 11 and the end of the shaft is screwed into the threaded opening provided in the bronze member 14. The shaft is threaded into this opening to such a depth that the shoulder on the shaft 22 firmly abuts the lefthand end of the sleeve 11.

Molten metal, for example, lead or Babbitt, is then introduced into the keyways 31 and 32 to prevent the shaft from turning with respect to the bronze member and thus lock the shaft in position. This metal is indicated at its various positions by the reference character 35. For pouring the locking metal, the assembly is held with the shaft in vertical position and is heated to insure against freezing of the metal during the pouring operation. One of the keyways 33 adjacent the shoulder 24 is utilized as the inlet in pouring, a suitable funnel gate being applied to facilitate the operation. The metal, thus supplied, flows downward between the shaft and the sleeve 11, filling all of the spaces therebetween, including the annular space between the bearing surfaces 12, the keyways 31, 32 and also the annular space immediately to the left of the keyways. The keyway 33 at the shoulder 24 which lies in opposition to the one through which pouring occurs, merely acts as an escape passage for air or gases during the pouring operation, thus facilitating the free inflow of the metal.

When the assembly cools, the locking metal solidifies, and any unscrewing action of the shaft with respect to the bronze member 14 is positively prevented due to the locking effect of the metal in the two sets of keyways 31, 32, the one lying in the bronze member 14 and the other in the shaft 20. The arrangement also gives assurance that the keyways 31 which are overlapped by the keyway 32 will be filled with fusible metal, since the combined depth of the two keyways permits a much more ready flow of the molten metal than is the case with those of the keyways 31 whose sole source of supply is the

annular recess indicated at 36. These latter keyways constitute narrow pockets closed at their inner ends, and into which it is somewhat difficult to flow molten metal because of the air trapped therein.

The impeller is operated by rotating the pulley 23 in any suitable manner, for example, by a belt drive (not shown). The acid or water containing acid is drawn from a suitable reservoir (not shown) and is caused to flow through the opening 8 and up through the spaces between the blades 6, as indicated by the arrows, and emerges from the periphery of the blades to be delivered to a volute chamber which communicates with an air or separation chamber (not shown).

During operation, it is apparent that heat is developed at the various surfaces which contact with the impeller, such as the sealing rings 4 and to some extent at the packing 15 which is compressed against the sleeve 11 in order to constitute a water-tight joint. Friction may also be produced at the bearing surfaces on the member 13 and at the surface 37 which forms part of annular ledge against which the packing is compressed. Since the impeller revolves at a high rate of speed, the temperature of the immediate parts may become greatly elevated, and thus facility for the transference of this heat to cool the metal parts must be provided. This heat unless quickly dissipated may cause the sleeve 11 to bulge in the middle, i. e., due to the longitudinal stress introduced by the shoulder 24, and this bulging effect might cause additional heat to be developed at the packing and at other bearing surfaces.

It has been found that the poured metal which fills the elongated annular space between the bearing surfaces 12 acts as an excellent medium to transfer heat from the sleeve 11 to the large metal mass of the shaft which is at a considerably lower temperature. It will be understood that this annular space must be provided in order that the entire inner surface of the sleeve need not be ground to fit the shaft—a laborious and very expensive job. Consequently, unless this space were filled with the metal 35, there would be a cylindrical body of air positioned between the shaft and the sleeve which would preclude in considerable degree the ready transference of heat between the sleeve and the shaft. Thus, the poured metal not only provides a locking means between the shaft and the bronze member 14, but in addition furnishes an all-metal path for heat which might otherwise accumulate in the sleeve 11 to be distributed and readily dissipated by the shaft.

It has been pointed out that the shaft is positively locked in the member 14. It is also apparent that, by reason of the ribs 34 and the fact that the bronze member 14 is cast around these ribs, the member 14 is securely locked within the cored hubs 10.

From the foregoing, it is evident that I have provided an improved construction by which a shaft of steel is firmly secured to an impeller made of an acid-resisting metal and which is not readily machinable. The locking arrangement is obtained solely by successive casting operations and is so effective that, regardless of the direction in which the heavy impeller is started, the shaft positively cannot turn with respect to the member 14 and the latter is firmly secured to the impeller.

While I have shown only four ribs 34 projecting into the member 14, it is obvious that any number of ribs may be employed and having any desired shape. These ribs may be cast within the hub member 10 by the same coring operation which provides the compartment.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In combination, a fluid impeller of acid-resisting, hard-to-machine metal and a steel shaft, said impeller having a hollow hub containing solidified fusible material, a shaft screwed into said fusible material, means for preventing the unscrewing of the shaft in said material, and means for preventing rotation of the fusible material with respect to said impeller whereby said shaft is prevented from rotating and moving longitudinally with respect to said impeller.

2. In combination, a fluid impeller of acid-resisting, hard-to-machine metal and a steel shaft, said impeller having a hollow hub of cylindrical configuration and containing cast metal, a shaft screwed into said cast metal, means for preventing the unscrewing of the shaft in said cast metal, and means for preventing rotation of the cast metal with respect to said impeller whereby said shaft is prevented from rotating and moving longitudinally with respect to said impeller, said last-mentioned means comprising interlocking projections which extend radially inwardly and outwardly from said hub and said cast metal respectively.

3. In combination, a rotatable member and a shaft adapted to be secured thereto, said member having a hollow hub containing fusible material solidified in situ and bored for receiving the end of the shaft, means for anchoring said shaft to said fusible material, and internal ribs on said hub for preventing rotation of the fusible material with respect to said member whereby the shaft is prevented from rotating and moving longitudinally with respect to said member.

OYSTEIN JACOBSEN.