April 29, 1947. M. L. BETTCHER 2,419,623

SHAFT SEAL

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FIG. 1.

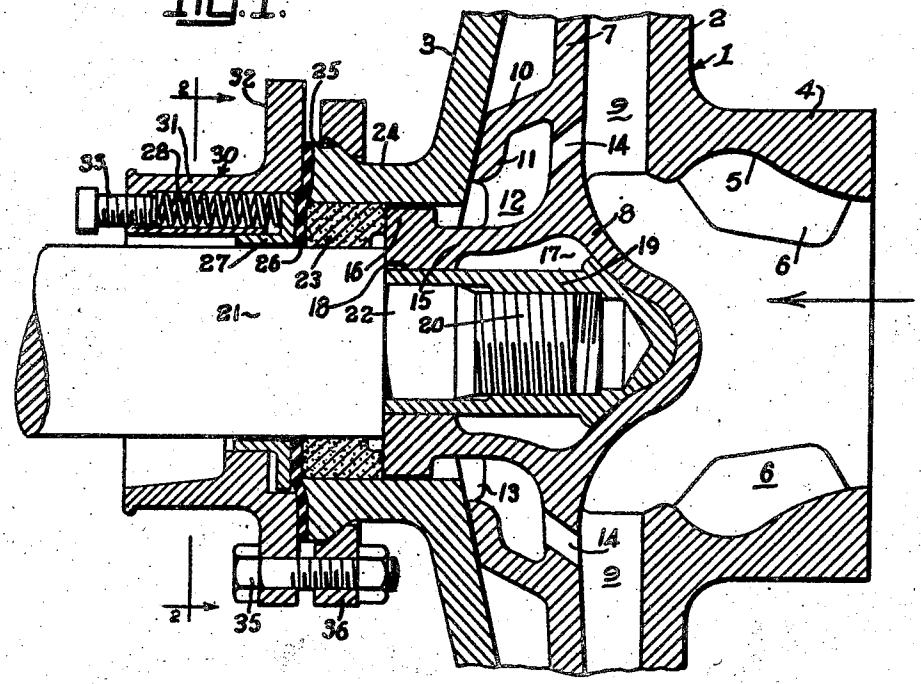
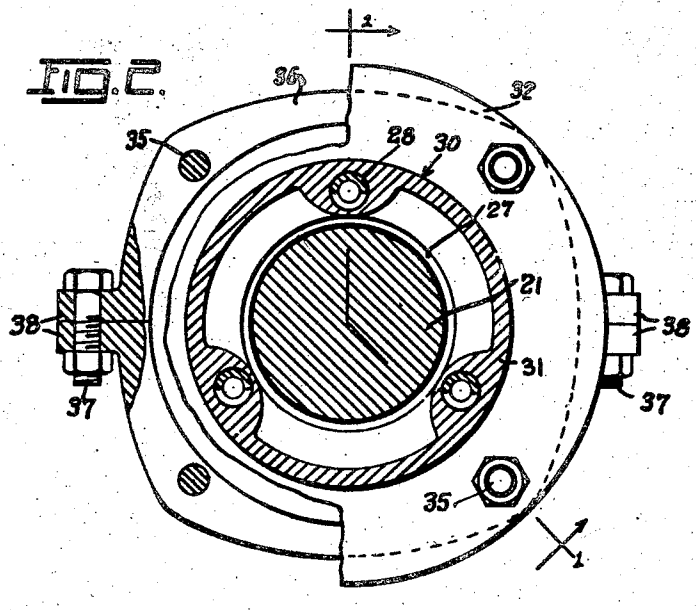


FIG. 2.



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SHAFT SEAL

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3 Claims. (Cl. 286—11)

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The present invention relates to shaft seals for centrifugal pumps which are designed to operate at considerable velocities and adapted to handle corrosive fluids.

In the case of pumps which handle acid-containing solutions and which involve an impeller secured to an overhanging shaft, it becomes necessary to prevent the creepage of the fluid from the position of the impeller along the surface of the shaft, because unless such creepage is blocked the acid-containing liquid might reach the bearings on which the shaft is journaled.

It will be understood that in pumps of this character those parts which come directly into contact with the liquid are made of a non-attackable metal such as silicon iron, but metal of this character is so hard that it is practically unmachinable. Those parts that require finishing to size are necessarily made of a machinable metal which is subject to attack by the acid and for that reason the contact of acid with those parts must be avoided.

While a number of seals to prevent creepage of liquid have been proposed in the art, many of them are unsatisfactory for different reasons, mainly due to the fact that they begin to wear after a short period of time and unless immediately adjusted or repaired allow small but important amounts of fluid to get past the seal and damage the shaft, bearings, or other attackable parts. Still other types of seals are of complicated construction, hard to assemble, and difficult to adjust and to replace.

The fact that the pumps which handle acid-containing liquids usually involve fairly heavy impellers and are operated at considerable velocities, also enhances the difficulties of affording complete obstruction to creepage liquid without entailing undue friction or excessive wear.

The primary object of the invention is to provide an improved form of seal structure and particularly one which employs only relatively simple parts and wherein adjustments to take up wear may be readily effected.

Still another object is to provide a seal structure which is particularly adaptable to high pressure pumps involving impellers which travel at considerable speeds and in which even the slightest amount of liquid being delivered by the pump is prevented from creeping along the shaft from the impeller casing.

These objects are attained in brief by employing a graphite seal member for providing the obstruction of radial flow of liquid and replacing the usual type of packing ring by a flat diaphragm which serves to prevent longitudinal flow or creepage of the liquid.

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The invention will be better understood when reference is made to the following description and the accompanying drawings, in which:

Figure 1 represents a fragmentary longitudinal sectional view of the improved seal as applied to a typical form of pump. This view is taken approximately along the line 1—1 in Figure 2 and looking in the direction of the arrows but somewhat enlarged;

Figure 2 is a transverse sectional view of the structure shown in Figure 1 taken along line 2—2 and looking in the direction of the arrows.

Referring more particularly to Figure 1, reference character 1 generally designates the casing of a centrifugal pump of the double walled type, the walls being indicated at 2 and 3 respectively. The casing terminates at its periphery in a volute chamber to which the outlet conduit (not shown) is connected. A large cylindrical portion 4 which communicates with the interior of the casing serves as the inlet conduit, as indicated by the arrow.

The central opening through the cylindrical portion 4 may have a curvilinear surface as indicated at 5 and there is secured to this surface a plurality of equidistantly disposed longitudinally extending guide ribs or lugs 6 which serve to prevent swirling or eddy current motion in the fluid as it enters the casing.

The front wall 2 of the casing has a flat inner surface against which the blades of the impeller have a running clearance, while the other or rear wall 3 of the casing takes on a conical shape which provides a bearing surface for the rear side of the impeller. The latter may include a centrally disposed radially extending web element 7 positioned approximately midway between the walls 2 and 3, the web being carried on a central hub 8.

A plurality of equidistantly disposed vanes or blades 9 are secured edgewise to the front side of the web 7. These blades usually take a curvilinear shape and have a running clearance against the inner face of the front wall 2. Extending rearwardly from the web 7, there is an overhanging flange or lip portion 10, this portion terminating in an annular extension 11 which together with the hub 5 forms an annular recess 12. There are a plurality of blades 13 secured to the web and equidistantly positioned about the recess 12 the purpose of these blades being to provide a suction effect at the rear of the impeller. A number of openings 14 are

cored through the web 7 in order that the leakage fluid which reaches the recess 12 and is placed under pressure by the blades 13 may pass up through the openings and join the main body of liquid which is being forced out of the pump by the main blades 6.

The web 7 extends to the left in the form of a cylinder 15 and the cylinder terminates at its left hand end in an enlarged or flange portion 16 which forms one of the sealing surfaces.

The hub 8 and the cylinder 15 are cored to leave a relatively large recess 17 in order to lighten the weight of the impeller and also to provide a structure by which the impeller is secured to its shaft.

The flange portion 16 is provided with a centrally disposed opening 18 for tightly receiving a liner 19. This liner is hollow and the right hand end thereof has a configuration such as snugly to fit the inner surface of the spherical hub portion 8. The liner 19 is threaded over a portion of its length to receive the threaded end 20 of the driving shaft 21. The latter is provided with a shouldered portion 22 which fits tightly within the liner or sleeve 19 as shown on the drawings.

While the structure described up to this point operates quite effectively as a pump when the shaft 21 is rotated by an electric motor (not shown), it has been found that notwithstanding the presence of the vanes 13 slight amounts of the fluid being handled by the pump inevitably finds its way by creepage over the shaft. In order to avoid this creepage it has been proposed to employ a graphite sealing ring which bears against the left hand surface of the flange 16 to take care of the fluid which tends to flow in the radial direction, and in addition packing rings have been proposed to block any part of the creepage fluid that tends to flow in the longitudinal direction. While such a structure is completely satisfactory in operation the arrangement is somewhat complicated, particularly as regards the use and adjustment of the packing rings.

In accordance with the present invention I propose to discard the packing rings entirely and to use in their place a washer of packing material and to secure the washer at its peripheral edge, leaving the inner annular portion thereof to serve as a seal. It has been found in practice that the washer is not only less expensive than the use of two or more packing rings, but in addition is more effective in providing an absolute blocking effect for the fluid which tends to move lengthwise between the various parts of the seal at the rear of the impeller.

Thus, the shaft 21 and all other parts which are subject to attack by the acid-containing fluid which is being forced into the volute chamber by the impeller are completely protected from such fluid. Directly adjacent the flange portion 16 of the impeller there is a sealing ring 23 of a self-lubricating material such as graphite which loosely surrounds the shaft and has a diameter substantially equal to the diameter of the flange portion 16.

The conically shaped rear wall 3 of the casing is extended in the longitudinal direction to form a cylindrical member 24 which terminates in an enlarged or humped portion 25. The cylinder 24 has an interior diameter such as to receive the sealing member 23. The left hand surface of the enlarged portion 25 is not directly

in line with the left hand surface of the sealing element 23 but as shown on the drawings, the bearing member projects slightly more to the left and the purpose of this is to accommodate wear as the pump is being used.

Directly adjacent the left hand surface of the enlarged portion 25 and the sealing member 23, there is a packing washer 26 which may be made of several thicknesses of rubberized cloth. This washer has an inner diameter somewhat larger than the shaft and an outer diameter of approximately the same size as the enlarged portion 25. The washer 26 may be cemented or otherwise secured to the sealing ring 23.

In order to apply longitudinal pressure against the inner annular portion of the washer 26 thereby forcing the sealing ring 23 to the right, a flanged metal ring 27 which fits loosely over the shaft 21 may be provided. This ring has a flat annular surface which bears against the washer 26. Pressure is applied to the ring 27 by means of a plurality of springs indicated at 28.

There is a fairly thick ring generally designated by 30 surrounding the shaft 21 but spaced therefrom, this ring having longitudinally and radially extending portions 31 and 32 respectively. The horizontal portion is provided with three or more openings equidistantly spaced about the periphery and counter-bored from the right hand face in order to accommodate the compression springs 28. The right hand end of these springs bears against the flat surface of the ring member 27 so as to force the said member against the washer 26, which in turn applies pressure between the sealing ring 23 and the sealing surface of the flange 16. The force exerted by these springs may be adjusted by means of a plurality of set screws 33 which are threaded into the left hand end of the ring 30. The springs 28 together with the adjustable set screws 33 serve to provide a yieldable contact between the packing washer and the sealing ring. This, in turn, causes the sealing ring 23 to yieldingly contact the flange portion 16.

The member 30 may be secured in place by being bolted as indicated at 35 or in any other manner attached to a split ring 36. This split ring has an interior configuration such as to fit over the hump portion 25 of the casing, and the two halves of the ring may be secured together by a pair of oppositely disposed clamp bolts 37 which pass through lugs 38.

It is apparent that when the set screws 33 have been given proper adjustment the ring 27 is caused to move to the right to compress the packing ring 26 and to move the sealing ring 23 more tightly against the flange 16. Consequently, by regulating these various adjustments it is apparent that as much or as little contact pressure can be exercised as desired at the junction between the sealing ring and the flange. Thus, any liquid that tends to flow to the rear of the impeller and is not sucked upwardly by the blades 13 into the openings 14 is immediately blocked from passing radially downwardly between the sealing ring 23 and the flange 16 and is also blocked from creeping longitudinally along the outer periphery of the sealing ring 23 because the packing ring 26 constitutes an effective barrier at this point.

Thus, all possible passageways for the leakage liquid to pass from the rear side of the impeller to the bearings in which the shaft 21 is journaled are completely stopped by the combination of the packing washer 26 and the sealing ring 23.

In fact, the use of the packing washer 26 is quite as effective in preventing longitudinal creepage of the liquid as is the use of packing rings, which are not only more expensive to make but also require a more expensive structure to accommodate the rings. It will be understood in this connection that the packing rings usually necessitate annular recesses of proper dimensions and suitable positions, but no such expense is incurred by the use of a packing washer because the outer edge of the washer is entirely free from contacting the metal and the washer is securely held by compression between the ring 30 and the flange 25. It is also apparent that the use of the packing washer provides a construction which is not only simple to fabricate but in addition is easy to install, dismantle, and reassemble.

It will be understood that all of these parts of the structure shown in Figure 1 which come directly into contact with the acid-containing fluid being pumped at the impeller are made of a non-attackable material such as silicon iron. The remaining parts, which constitute the seal, may be made of ordinary steel or iron since by reason of the improved combination of parts, including the packing washer and the sealing ring, positively none of the acid-containing fluid can ever reach those parts made of a workable and therefore attackable material.

While the apparatus herein disclosed and described constitutes a preferred form of the invention, yet it is to be understood that the apparatus is capable of mechanical alteration without departing from the spirit of the invention and that all such modifications as follow within the scope of the appended claims are intended to be included herein.

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

1. A seal including a casing, a shaft, said seal comprising a sealing ring surrounding the shaft and having a side adapted to bear against a part mounted on the shaft, said casing having a cylindrical member surrounding said sealing ring, said member having an enlarged end portion, a thick ring surrounding said shaft having longitudinally and radially extending portions, a flexible washer surrounding said shaft, means engaging said radially extending portion and said enlarged end portion for clamping said washer between the enlarged end portion of said member and the radially extending portion of said thick ring, the radially inner portion of said washer engaging said sealing ring, said longitudinally extending portion of said ring having a plurality of openings facing said washer, springs in said openings acting to force said washer and said sealing ring along said shaft to cause engagement of the sealing ring with said part, the other end of said sealing ring normally extending beyond the enlarged end of said member and in the direction of said thick ring whereby to initially cause deformation or bending of said washer to offset the radially inner part of said washer from the outer clamped portion in a direction away from said shaft part.

2. A seal including a casing, a shaft, said seal comprising a sealing ring surrounding the shaft and having a side adapted to bear against a part mounted on the shaft, said casing having a cylindrical member surrounding said sealing ring, said member having an enlarged end portion, a thick ring surrounding said shaft having longitudinally and radially extending portions, a flexible washer surrounding said shaft, means engaging said radially extending portion and said enlarged end portion for clamping said washer between the enlarged end portion of said member and the radially extending portion of said thick ring, the radially inner portion of said washer engaging said sealing ring, said longitudinally extending portion of said ring having a plurality of openings facing said washer, springs in said openings acting to force said washer and said sealing ring along said shaft to cause engagement of the sealing ring with said part, the other end of said sealing ring normally extending beyond the enlarged end of said member and in the direction of said thick ring whereby to initially cause deformation or bending of said washer to offset the radially inner part of said washer from the outer clamped portion in a direction away from said shaft part, and a flanged ring surrounding said shaft and interposed between the ends of said springs and said washer.

3. A seal including a casing, a shaft, said seal comprising a graphite sealing ring surrounding the shaft and having a side adapted to bear against a part mounted on the shaft, said casing having a cylindrical member surrounding said sealing ring, said member having an enlarged end portion, a thick ring surrounding said shaft having longitudinally and radially extending portions, a flexible washer surrounding said shaft, means engaging said radially extending portion and said enlarged end portion for clamping said washer between the enlarged end portion of said member and the radially extending portion of said thick ring, the radially inner portion of said washer engaging said sealing ring, said longitudinally extending portion of said ring having a plurality of openings facing said washer, springs in said openings acting to force said washer and said sealing ring along said shaft to cause engagement of the sealing ring with said part, the other end of said sealing ring normally extending beyond the enlarged end of said member and in the direction of said thick ring whereby to initially cause deformation or bending of said washer to offset the radially inner part of said washer from the outer clamped portion in a direction toward said springs, and means for individually adjusting said springs.

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