

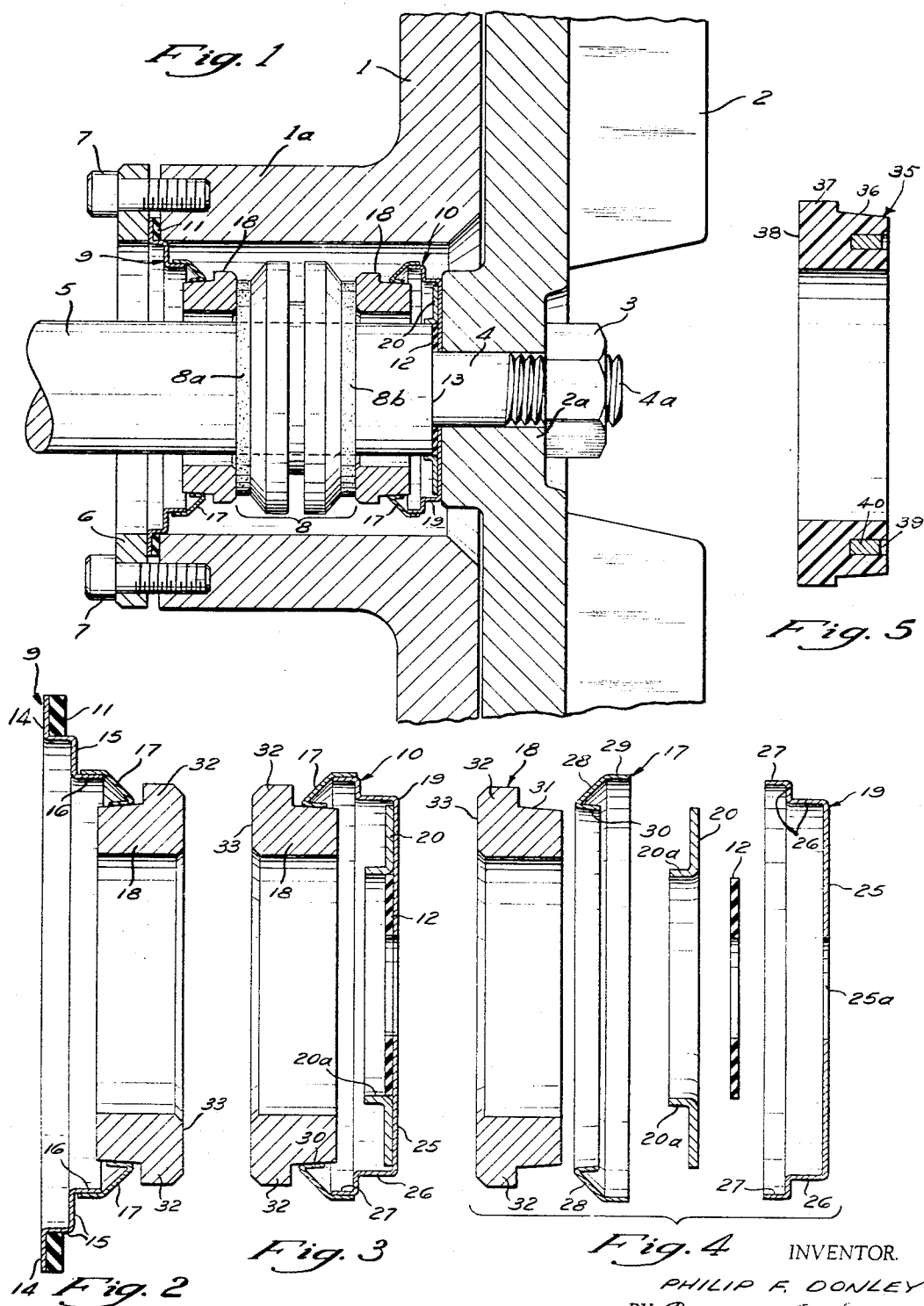
July 9, 1968

P. F. DONLEY

3,391,941

SHAFT-SEALING SYSTEM

Filed Oct. 16, 1963



INVENTOR.
 PHILIP F. DONLEY
 BY *Bosworth, Sessions,
 Herstrom & Knowles*
 ATTORNEYS

1

3,391,941

SHAFT-SEALING SYSTEM

Philip F. Donley, Shaker Heights, Ohio, assignor to Donley Products, Inc., Cleveland, Ohio, a corporation of Ohio

Filed Oct. 16, 1963, Ser. No. 316,617

3 Claims. (Cl. 277-63)

This invention relates to a shaft-sealing system, particularly a shaft-sealing system for a pump or other machine characterized by a housing, a shaft extending through one of the walls of the housing, a rotatable member carried by the shaft, and a stationary member spaced from the rotatable member.

For convenience, the invention will be described as applied to pumps of the impeller type. Pumps of this kind are often used under conditions in which the pumpage takes the form of a liquid such as petroleum which, because of the presence of grit, is hard on the sealing system. However, grit is not always to be found in pumpage; for instance, the pumpage may take the form of a clear liquid such as a petroleum distillate, carbon tetrachloride, carbon bi-sulphide, an industrial alcohol or the like. All of the latter and a good many other liquids commonly moved by impeller pumps can be troublesome for various reasons; viz., a tendency to corrode metal, a tendency to leak past sealing surfaces, a tendency to develop escape routes by-passing the sealing surfaces, etc. In many cases, moreover, it is important to preclude contamination of the pumpage by shaft lubricants that may tend to work their way into the pumpage by capillary action. These and similar factors have heretofore made almost impossibly difficult demands on a great many conventional shaft-sealing systems, particularly those employing mechanical sealing units.

However, in the recent past highly efficient mechanical sealing units have reached the commercial market, illustrative examples being the floating sealing units shown and described in U.S. Patent 3,028,163 to A. H. Heinrich and in the pending patent application of Philip F. Donley identified as Ser. No. 180,612 (now U.S. Patent No. 3,218,086). Efficient though they are, such sealing units do not provide the whole answer to the problem for the reason that they constitute only a part of the sealing system as a whole. Thus their performance can be and is influenced by such factors as the design, construction and composition of the seating elements and/or the manner of their incorporation in the organization. For example, a seating element of metal that has been inaccurately machined, a seating element of carbon that has been mechanically distorted, or a seating element of any kind that is not properly installed will provide an environment that can prevent even a highly efficient sealing unit from delivering maximum performance.

One of the principal objects of the present invention is to provide improved sealing systems in which the seating element or elements can cooperate with the sealing unit in such manner as to make it possible to take better advantage of the potentialities of the latter.

Other objects, advantages and features of the invention will be apparent from the description which follows and from the accompanying drawings, in which:

FIGURE 1 is a fragmentary section with parts in elevation through a pump incorporating an improved sealing system within the purview of the present invention.

FIGURES 2 and 3 are enlarged central sections through sub-assemblies which in FIGURE 1 flank the sealing unit on its left and right-hand sides, respectively.

FIGURE 4 is an exploded view of the components going to make up the sub-assembly shown in FIGURE 3.

FIGURE 5 is a central section through a modified form of seating element provided with an oversize stay ring.

2

In FIGURE 1 is shown a portion of a pump of the impeller type one of the walls of which has a cylindrical extension 1a provided with a longitudinally extending opening of the nature of a chamber for the reception of the several components described hereinafter. Impeller 2, which comprises and may be described as a rotatable end member, is held in place at the inboard end of the extension 1a by a tapped nut 3 that normally seats against the hub 2a of impeller 2. Nut 3 cooperates with and is screwed into place on the threaded portion 4a of the reduced end 4 of pump shaft 5.

At the outboard end of extension 1a is a stationary end member 6 of the nature of a clamping ring held in place by bolts 7. In the chamber intervening between the proximate faces of impeller hub 2a and stationary end member 6 is the entire sealing system of the instant invention, the same incorporating as a part thereof a floating sealing unit of the type illustrated in U.S. Patent 3,028,163. Sealing unit 8 is supported by and rides with a running fit on pump shaft 5. Seen as in FIGURE 1 of the drawings forming part of the present application, sealing unit 8 is flanked by two generally similar but not identical sub-assemblies 9 and 10, the former being stationary and bearing against carbon sealing ring 8a and the latter being rotatable with impeller 2 and pump shaft 5 and bearing against carbon sealing ring 8b. Sealing rings 8a and 8b form part of and rotate with sealing unit 8.

When stationary sub-assembly 9 is about to be installed in the pump, it is first provided with a snugly fitting resilient gasket 11 of annular shape: see FIGURES 1 and 2. Such gasket, which may be of leather, rubber, synthetic resin or the like, closely engages the adjoining portions of sub-assembly 9; i.e., those portions that are to be clamped in place by stationary end member 6. On the opposite end of the sealing system, rotatable sub-assembly 10 intervenes between sealing unit 8 and impeller hub 2a. An annular gasket 12, likewise of leather, rubber or synthetic resin, is interposed between the portions of the sub-assembly farthest removed from sealing unit 8 and the shoulder 13 on shaft 5. When impeller 2 is in position, gasket 12 is compressed between shoulder 13 and sub-assembly 10.

Thus both ends of the sealing system of the present invention are supported in liquid-tight fashion within the limits of cylindrical extension 1a, the outboard end bearing against stationary end member 6 and the inboard end engaging hub 2a of impeller 2.

An annular spacer of stepped configuration constitutes the outermost component of stationary sub-assembly 9. Best seen in FIGURE 2, it is characterized by a flat, annular washer-like portion 14 extending normally to the longitudinal axis of the sealing system, by an intermediate shoulder 15, and by an inwardly directed flange-like lip 16 of circular shape. Preferably formed from a moderately heavy sheet of stainless steel, this spacer is substantially rigid, having only a limited amount of flexibility. Lip 16 serves to support a trapeziform annular carrier 17, likewise of stainless steel, formed after the fashion of a circular channel with an inclined bottom wall. Of the two side walls of carrier 17, the one of greater diameter receives lip 16, which fits snugly therein. The telescoping parts are held together in liquid-tight fashion by a metallic bond of the type developed by continuous resistance welding.

The construction of the carrier 17 employed in sub-assembly 9, shown in FIGURE 2, and the construction of the carrier 17 employed in sub-assembly 10, shown in FIGURE 3, are the same. Thus these components are interchangeable with each other. The same is true as regards the stationary seating element 18 employed in sub-assembly 9 of FIGURE 2 and the rotatable seating element 18 forming part of sub-assembly 10 of FIGURE 3.

3

The precise manner in which carriers 17 support seating elements 18 and maintain them in the desired relation to sealing unit 8 will be apparent from the detailed description of sub-assembly 10 and the exploded view making up FIGURE 4.

As appears from FIGURE 4, sub-assembly 10 is comprised, rotatable apart from gasket 12, of carrier 17, seating element 18, a stepped spacer 19 of annular shape, and an annular retainer 20, of which the two last mentioned components will be described first. Notwithstanding the fact that stepped spacer 19 and retainer 20 appear as separate elements in FIGURE 4, in practise they form a unitary structure, being spot welded together in the relationship shown in FIGURE 3. In this structure, retainer 20 serves several purposes: (a) it acts to stiffen spacer 19; (b) it locates it in the desired relation to reduced portion 4 of shaft 5, this mainly by virtue of the presence of circular flange 20a; and (c) it helps retain gasket 12 in position.

The portion of spacer 19 appearing at the extreme right in FIGURE 4 comprises a flat, annular washer-like portion 25 with a central opening 25a of slightly greater diameter than the diameter of the reduced portion 4 of shaft 5. The shoulder 26 imparting the stepped appearance to spacer 19 intervenes between washer-like portion 25 and a flange-like lip 27 of circular configuration on the opposite side of spacer 19. From FIGURE 3 it will be noted that lip 27 is received within carrier 17. Being preferably formed from moderately heavy stainless steel sheet, these parts can advantageously be welded together by continuous resistance welding to provide a liquid-tight joint. The resulting structure is largely rigid but not without a moderate amount of flexibility, more particularly in carrier 17.

Bottom wall 28 of carrier 17 is inclined at an angle of approximately 45° to the longitudinal axis of the sealing system. The two side walls are so constructed that side wall 29 makes an obtuse angle and side wall 30 makes an acute angle with bottom wall 28. Preferably, side wall 29 parallels the longitudinal axis of the sealing system while side wall 30 deviates from parallelism therewith by a very small angle, normally about 3° and less in any event than about 7½°. Forming side wall 30 in this way makes it possible to attach seating element 18 to carrier 17 in particularly tenacious fashion. By providing them with complementary surfaces, the two can be made to adhere so tenaciously as to require the use of a tool to separate them.

From FIGURE 4 it may be observed that holding face 31 has a taper complementing the taper of side wall 30 of carrier 17; that is to say, the angle by which holding face 31 departs from parallelism with the longitudinal axis of the sealing system is a matter of only a few degrees, usually about 3° and not more as a rule than about 7½°. If desired, some other method of attaching carrier 17 to seating element 18 may be used, but the method described above and illustrated in FIGURES 1 to 4 of the drawings is a particularly satisfactory one, more especially for the reason that it admits, when necessary, of limited relative movement as between carrier 17 and seating element 18 in a direction paralleling the longitudinal axis of the sealing system.

As appears from FIGURES 3 and 4, seating element 18 is provided with a circumferential flange 32 extending beyond holding face 31 in a radial direction. On the side thereof away from stepped spacer 19, seating element 18 has a highly finished sealing face 33, preferably one that has been machined and lapped with an accuracy within a few light bands. By virtue of flange 32, sealing face 33 of seating element 18 can be relatively broad, permitting of the development of considerable relative movement in a transverse direction between seating element 18 and the adjacent sealing ring (8a or 8b) forming part of sealing unit 8: see FIGURE 1. It will be noted that in relation to the other components of the sub-assemblies of which they form part, seating elements 18 are of massive size.

4

In many cases, seating elements 18 can to excellent advantage be of stainless steel. In the drawings, they are cross hatched to indicate that they are of metal. They may, however, be of any other suitable material, including ceramic materials, comminuted compressed carbon, hard rubber, nylon polytetrafluoroethylene ("Teflon") and the like. Although FIGURE 1 shows sealing rings 8a and 8b as stippled to indicate that they are of comminuted compressed carbon, they may, if desired, be of ceramic material, hard rubber, nylon, "Teflon," or any other suitable substance. Normally, sealing rings 8a and 8b on one hand and seating elements 18 on the other should not be of the same material.

FIGURE 5 shows a seating element 35 of "Teflon" in which a stainless steel stay ring has been incorporated. Holding face 36, circumferential flange 37 and sealing face 38 closely resemble the analogous portions of seating element 18 (FIGURE 4). However, seating element 35 is provided, on the side of the seating element away from sealing face 38, with an annular recess 39 for stay ring 40. The latter acts to stabilize seating element 35 against creep under load such as is so often encountered with components of "Teflon," whether filled or unfilled.

By constructing sub-assemblies 9 and 10 in the manner described above, each develops a fairly high degree of rigidity. Within the sealing system as a whole, there can nevertheless be a good deal of yieldability, both lengthwise and transversely, more especially within sealing unit 8. As a result, endwise movement of shaft 5 and even lateral movement of the shaft in a direction transverse to its own axis can be tolerated within comparatively wide limits, up to and above .050" in each case. Where there is such movement, sealing unit 8 tends to center itself in relation to the shaft, which is particularly advantageous.

In installing sub-assemblies 9 and 10, it is difficult and in fact virtually impossible for the installer to distort the seating elements. The latter result is one that sometimes comes about when seating elements of kinds commonly used in conventional sealing systems are drawn up too tightly by the mechanic by whom the installation is being made. Distortion of the seating element, if it occurs, tends to keep the sealing unit from operating at maximum efficiency. In sealing systems incorporating the present invention, this is not a problem.

It is intended that the patent shall cover, by summarization in appended claims, all features of patentable novelty residing in the invention.

What is claimed is:

1. In a machine having a housing, a shaft extending through an opening in the housing, and first and second end members encompassing the shaft in spaced relation to each other, the combination of a sealing unit floating on the shaft and, between said sealing unit and said first and second end members, two generally similar sub-assemblies each of which comprises (a) an annular seating element in sealing engagement with the sealing unit, (b) a moderately flexible carrier formed after the fashion of a circular channel, said carrier supporting the seating element in such sealing engagement, and (c) a substantially rigid spacer supporting the carrier in telescopic fashion and extending in a generally axial direction from the carrier to the adjacent end member.

2. In a machine having a housing, a shaft extending through an opening in one of the walls of the housing, a rotatable end member mounted on the shaft, and a stationary end member spaced from the rotatable end member, the combination of a shaft-supported sealing unit of the "floating" type and, in the space between the rotatable end member and the proximate face of the sealing unit, a sub-assembly comprising (a) a generally annular seating element in sealing engagement with the proximate face of the sealing unit, (b) a moderately flexible channel-shaped annulus engaging and serving as a carrier for said seating element, and (c) a substantially rigid spacer of generally annular shape supporting said channel-shaped annulus and

5

extending thence into engagement with the rotatable end member wherein the spacer is rigidly coupled to the rotatable end member.

3. In a machine having a housing, a shaft extending through an opening in one of the walls of the housing, a rotatable end member mounted on the shaft, and a stationary end member spaced from the rotatable end member, the combination of a shaft-supported sealing unit of the "floating" type and, in the space between the rotatable end member and the proximate face of the sealing unit, a sub-assembly comprising (a) a generally annular seating element in sealing engagement with the proximate face of the sealing unit, (b) a moderately flexible channel-shaped annulus engaging and serving as a carrier for said seating element, and (c) a substantially rigid spacer of generally annular shape supporting said channel-shaped annulus and extending thence into engagement with the rotatable end

6

member wherein the spacer is clamped between the rotatable end member and a shoulder on the shaft.

References Cited

UNITED STATES PATENTS

3,079,605	2/1963	Thomas et al.	277—27
3,028,163	4/1962	Heinrich	277—63
1,820,100	8/1931	Thompson	277—86
1,759,029	5/1930	Wishart	277—65
3,104,884	9/1963	Kerlin	277—235 X
3,058,718	10/1962	Johnson	277—235
2,646,001	7/1953	Ray	277—61

15 LAVERNE D. GEIGER, *Primary Examiner*.

J. S. MEDNICK, *Assistant Examiner*.