

May 2, 1950

D. MURPHY

2,505,868

SEAL FOR CENTRIFUGAL PUMPS

Filed Oct. 20, 1945

3 Sheets-Sheet 1

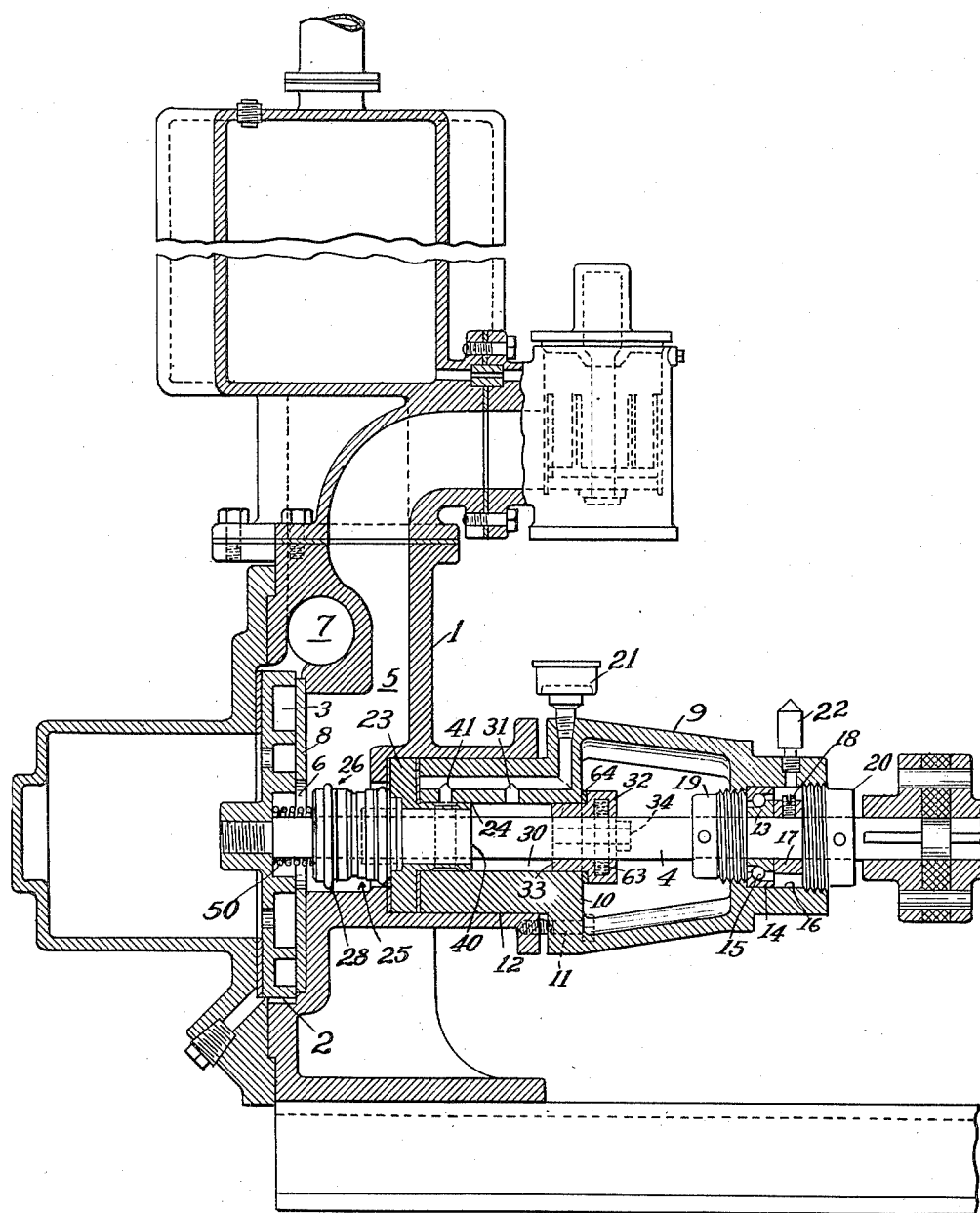


Fig. 1.

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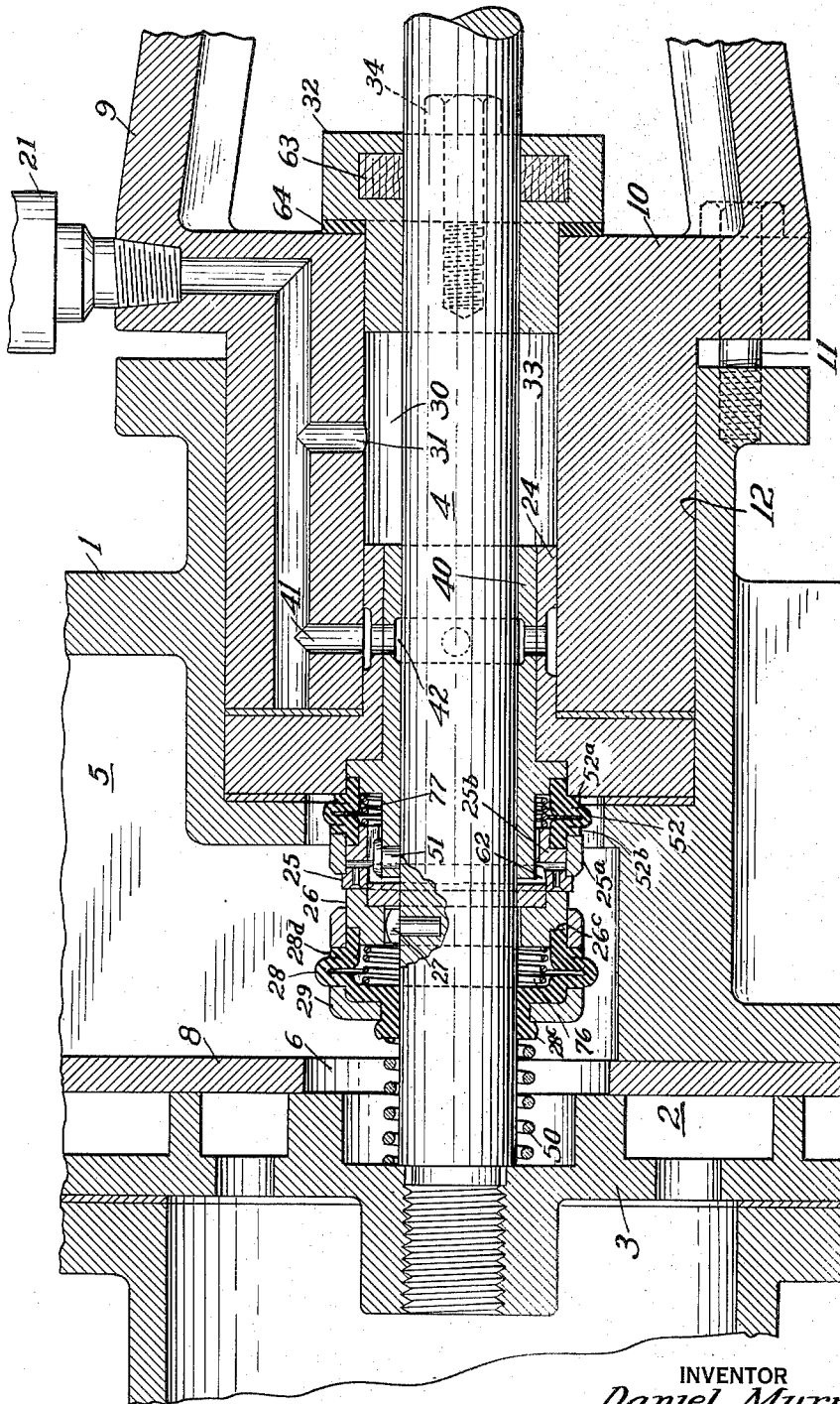
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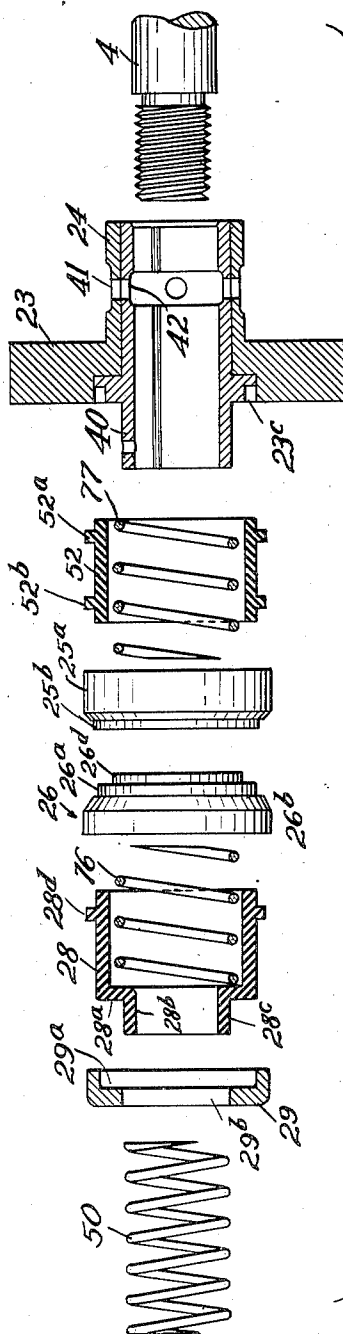
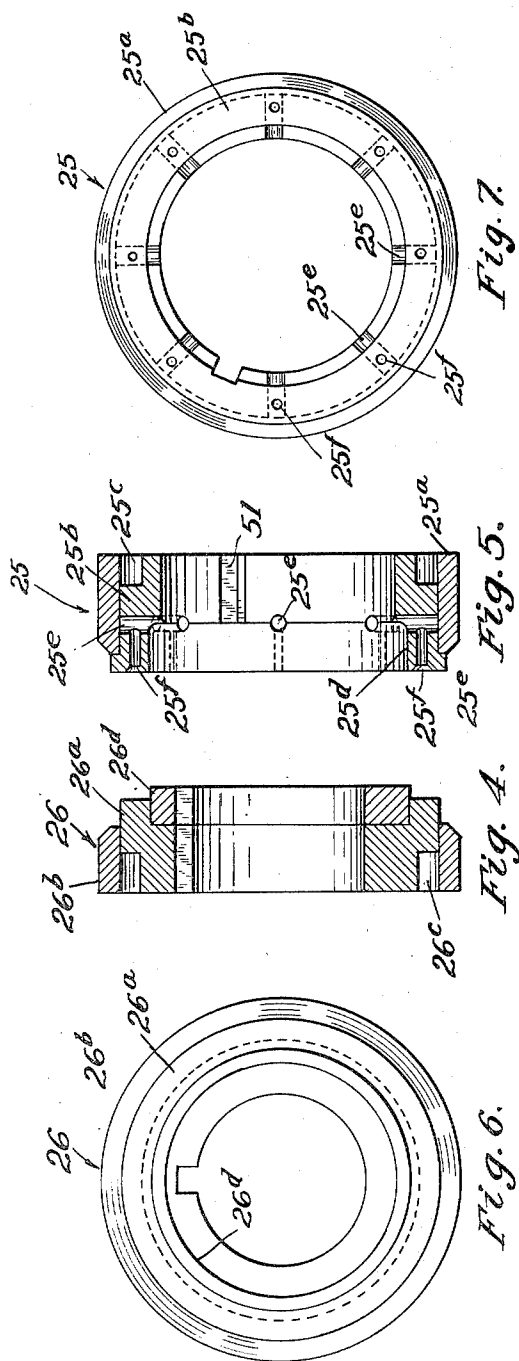
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SEAL FOR CENTRIFUGAL PUMPS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,505,868

SEAL FOR CENTRIFUGAL PUMPS

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Application October 20, 1945, Serial No. 623,568

6 Claims. (Cl. 286—11)

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My invention relates to rotary pumps, and consists in means for sealing such pumps against the escape or infiltration of fluid between the rotating shaft of the pump and the pump body portion or wall through which the shaft extends.

In Letters Patent of the United States, No. 2,251,020, granted to me August 8, 1944, I have disclosed a pump that has enjoyed success in pumping "slip" in the pottery industry, and in an application for Letters Patent Serial No. 521,771, filed February 10, 1944, now Patent No. 2,453,249, granted November 9, 1948, I have illustrated and described in association with such a pump a device for sealing the rotating pump shaft to the stationary walls of the pump through which the shaft extends. More particularly, my present invention consists in certain new and useful improvements in such sealing device, whereby the device becomes yet more efficient, as is desired in those installations in which the wear on the pump bearings is particularly severe.

The invention will be understood upon reference to the accompanying drawings, in which:

Fig. 1 is a view, partly in side elevation and partly in vertical section, of a pump in which a sealing device embodying the invention is organized;

Fig. 2 is a fragmentary view, showing partly in side elevation and partly in vertical section, the structure of an exemplary sealing device and adjacent parts of the pump to larger scale;

Fig. 3 is an "exploded" view, showing the several elements of the sealing device before assembly;

Figs. 4 and 5 are sectional views to larger scale of two ring or collar members included in the sealing device; and

Figs. 6 and 7 are views in elevation of the ring or collar members of Figs. 4 and 5, respectively, it being noted that Figs. 6 and 7 show the collar members as they appear from a point of view located between Figs. 5 and 6.

The pump shown in the drawings comprises a body 1, within which is formed the usual impeller chamber 2, and within the chamber a vaned impeller 3 is borne upon a rotary shaft 4. Under the influence of the rotating impeller, liquid is drawn from an intake passage 5 through the eye 6 of the pump, and is delivered at the periphery of chamber 2 to a discharge passage 7. When the pump is in operation, the pressure exerted upon the rotating impeller, holds the impeller in abutment upon the side wall on the right (as seen in Fig. 1) of the pump chamber 2. This side wall is advantageously formed as a removable and replaceable plate 8.

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The body 1 of the pump carries rigidly mounted upon it a housing 9; and within the housing two bearings are formed, which carry rotatably the shaft 4 of the impeller. The shaft 4 at its outer end (to the right, Fig. 1) is adapted to be coupled to or otherwise brought into power-transmitting connection with a suitable motor; and the mounting of the shaft in said two spaced-apart bearings is effective to prevent whipping of the shaft when the pump is in operation.

One of the bearings includes an annular block 10, conveniently made in one piece with the housing 9; and the block 10, together with the integral housing, is secured by set-screws 11 in a cylindrical seat 12, formed exteriorly upon the body 1 of the pump. The other bearing consists of concentric rings 13 and 14 with rolling members, here shown to be balls 15, arranged in the face formed for them by and between the rings. The inner ring 13 fits snugly upon the shaft 4; the outer ring 14 fits snugly within, and is adapted to slide longitudinally within, a bore 16 formed in the housing 9. The bearing 13, 14, 15 abuts laterally upon a ring 17, which, by means of a set-screw 18, is secured to the shaft 4. The assembly of bearing and ring is held between two nuts 19 and 20, that, encircling the shaft 4 and movable freely along shaft 4, make screwthread engagement with the bore 16. The housing 9 is made in the form of a cage, as shown, to afford access to the inner nut 19, for adjusting it.

Means are provided for lubricating the two bearings, and conventional means are here shown, consisting of lubricant cups 21 and 22, with ducts leading to the bearing surfaces.

It will be seen that in the second bearing (the bearing to the right), and particularly in the ring 17 and the co-operating nuts 19 and 20, means are found for adjusting the shaft 4 longitudinally, in compensation for wear of the impeller 3 upon the plate 8.

It is requisite that provision be made against withdrawal of lubricant from the bearings by the suction of the operating pump, and against ingress to the bearings (when the pump is at rest) of the liquid that is pumped, a supply of which remains standing in passageway 5. In the means to such end, and in the structural organization of such means with associate parts, the improvements of my present invention are found.

In the seating of the bearing block 10 in the body 1 of the pump an annular shaft-encircling plate 23 is, by the screws 11, clamped to place at the left-hand end (Fig. 1) of the cylindrical seat 12. This annular plate is provided with a

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sleeve-like extension 24. The extension is in this case integral with the plate itself. The plate 23 with its sleeve-like extension 24, when clamped to place, constitutes within block 10 the bearing member proper. The extension 24 carries interiorly a bronze bushing 40, within which the shaft turns. Lubricant ducts are indicated at 41, 42, (cf. Fig. 2). The annular plate is clamped with sealing effect to the wall of the pump casing, and its integral sleeve-like extension is the immediate bearing member for the shaft; and, accordingly, I term the member 23, with its shaft-encompassing portion 24, the inner bearing and sealing member.

In the assembly the plate 23 with its sleeve-like extension 24 snugly encircles the shaft. The fit is, however, not so snug as to exert any restraint upon the free turning of the shaft within the sleeve. The central bore through the bearing block 10 is of sufficiently larger diameter to form a packing gland for the shaft in its bearing block 10. In the cylindrical space formed by and between the shaft and the block 10, are closed to the left by the plate 23 with its extension 24, is a chamber 30, that normally is filled with a supply of lubricating grease from passage 31. The chamber 30 is at its outer end and closed by a block 32 having a sleeve-like extension 33 that is adjustably anchored in the bearing block 10 by set-screws 34. The block 32 includes within its outer end a channel in which a felt packing 63 is contained, and between the block and the body 10 of the bearing a rubber gasket 64 is clamped, thus preventing the escape of grease outward from chamber 30.

A sealing device cooperates with the shaft-encompassing member 23 to prevent liquid from being sucked into the pump from the bearing structure when the pump is in operation, and to prevent liquid from draining from the pump into the bearing structure when the pump is at rest. The sealing device comprises a seal member in the form of a collar portion 26 keyed, as at 27, to the shaft 4. The collar portion is thus made to rotate with the shaft, while being adapted to slide on the shaft to maintain, as presently will appear, snug contact with a second seal member in the form of a non-rotating annular wearing member 25.

Organized with the collar portion or member 26 is a tubular member 28 formed of flexible and elastic material that is resistant to deterioration under the effects of both the liquid being pumped and the lubricant used in the bearing structure. A synthetic rubber known on the market as "Neoprene" has been found to be a suitable material of which to form the member 28, but it will be understood that the invention is not predicated upon the selection of the particular material which may be used. Important characteristics of the member 28 are that it is mounted in shaft-encircling position; that at one end of its tubular or ring-like body it is secured in sealed union to the collar portion 26, and at opposite end is secured in sealed union to the shaft, or to a portion that is united to the shaft in such way that the effect is the same; that it (still referring to the member 28) is adapted to rotate in unison with the shaft and the collar portion 26; and that it is adapted to permit axial movement of the said collar portion on the shaft without breaking the sealed unions mentioned. Preferably, if not essentially, the elastic body of the member 28 is so organized

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in the assembly that it operates to press and maintain the collar portion 26, in snug "running" contact with the face of the wearing member 25, whereby a sealed engagement of the relatively rotatable portions 25 and 26 is maintained both when the pump is in operation and when it is idle. The member 28, by virtue of its physical nature, is adapted to maintain such sealed engagement even though a slight misalignment exists between the relatively rotatable parts.

The member 28 may take the form of a cylindrical sleeve, shown in Fig. 3, and the substantially inelastic seal or collar member 26, herein shown to be formed of a steel portion 28a and two annular brass portions 28b and 28d united in drift fits, includes a circular slot 28c that in assembly receives the right-hand edge of the sleeve member 28. At its left-hand end the sleeve member is provided with a wall 28a having a circular opening 28b through which the impeller shaft 4 extends. Cooperating with the left-hand end of the sleeve is a collar member or disk 29 that is recessed, as at 29a, to receive and support the left-hand end of the sleeve member. The disk member 29 includes an orifice 29b that peripherally engages a flange portion 28c formed integrally at the edge of the opening 28b in the sleeve member, and this flange, when the parts are assembled on the shaft 4, extends through the orifice in the disk member 29, and is engaged by a compressed helical spring 50, although a rigid sleeve may be used in lieu of the spring as shown in my copending application Ser. No. 521,771. The proportions and dimensions of the several elements of the sealing device are such that, when the elements are assembled in service positions, the body of the impeller, screwed into place on the threaded end of the shaft, compresses the spring 50; under the pressure of the spring 50 against the flange portion 28c on the shaft-encircling sleeve member 28, the flange portion is caused to bulge outward over the edge of the orifice in disk member 29 and form a fluid-tight seal between such member and the shaft. Under the urging of the spring 50, the disk member 29 moves to the right, effecting the outward bulging of the elastic, cylindrical body of the member 28. As the impeller reaches fully screwed-on position, the parts are arranged as they are shown in Fig. 2. The outward bulging of the cylindrical body of the member 28 causes such body to press tightly against and to envelop the outer edge of the circular slot 28c formed in collar member 26, whereby a fluid-tight seal between the member 26 and the right-hand end of the member 28 is provided. In elaboration the elastic sleeve member 28 may be provided with an annular shoulder 28d that bears against the end of collar portion 26b and improves the sealing effect.

The spring 50, disk member 29, flexible member 28, and collar member 26 all rotate in unison with the impeller shaft. A helical spring 76 may be provided within the member 28 on the shaft 4, and compressed between members 26 and 29, to assist the inherent resilience or elasticity of the axially compressed body of the sleeve member 28 in providing adequate thrust to press and hold the collar member 26 in fluid-tight engagement with the face of the shaft-encompassing wearing member 25. There is a slight clearance between the collar member 26 and the shaft 4, so that the collar may wobble

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in the event that there is any misalignment of the rotating parts, and by such wobbling to maintain tight surface-to-surface contact with the wearing member 25. However, if there is substantial wear of the bearings, or if the bearings as originally provided have a running tolerance substantially more than one thousandth of an inch, the lateral play of the shaft may in time result in unequal wear between the collar member and the wearing member, with the result that leakage will develop. It is in contravention of this undesirable consequence that the wearing member 25 is formed separately from the bearing portion 23, and, while sealed to such bearing portion, is adapted to wobble sympathetically with the collar member 26 and thereby maintain the desired fluid-tight engagement in spite of any misalignment of the rotating parts.

As shown in the drawings, the seal member 25 comprises a two-piece structure; that is, a brass ring 25a within which is secured a ring 25b of bearing material, in this case cast iron and to the extent that brass and cast iron are inelastic the body of the seal member 25 may be understood to be substantially inelastic. The ring 25b at its left-hand end extends from the ring portion 25a and provides a face against which the collar member 26 bears. The bushing 40 is extended from the stationary bearing portion 23 to receive the wearing member 25 in a loose fit, and a slot-and-key device 51 secures the wearing member against rotation, while permitting to required degree axial and angular movements of the wearing member relatively to the stationary bearing portion. The wearing member is sealed to the stationary bearing portion by means of a sealing element 52 of the same general sort as the sealing element 28 already described, with the following qualifications: Whereas the element 28 is cup shaped, the element 52 is here shown as a plain cylindrical tube which is adapted at its two circumferential edges to be inserted in annular grooves 23c and 23c formed respectively in the wearing or seal member 25 and the bearing portion 23, and whereas the sleeve element 28 is provided with a single annular shoulder 28d, the element 52 is provided with two annular shoulders 52a and 52b that overlie the outer edges of the grooves 23c and 23c in the assembled structure. When the seal-forming parts are assembled upon the impeller shaft in the order in which they are shown in Fig. 3, and the impeller 3 is screwed on the threaded end of the shaft, the parts are yieldingly urged into the assembled position shown in Fig. 2. Not only is the sealing element 28 axially compressed as described above, but the sealing element 52 is similarly compressed, causing its body to be outwardly bulged between the members 25 and 23 and the shoulders 32b and 52a to envelop the outer edges of the grooves 23c and 23c with fluid-tight engagement. The elastic body of the compressed and outwardly bulged element 52 exerts a thrust between the stationary bearing 23 and the wearing member 25, and this thrust may be augmented by a spring 77 within element 52, to oppose the thrust of springs 50 and 76, and maintain the elements 25 and 26 in the desired fluid-tight contact.

Provision is made for lubricating the contacting faces of the members 25 and 26. Advantageously, the bore of the member 25 is enlarged for a part of its extent as indicated at 25d in Fig. 5, to provide when assembly has been made, Fig. 2, a chamber 62 for a supply of lubricating grease.

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Within the body of the inner ring 25b of the wearing member, a plurality of pockets 25e is formed, the pockets extending radially from the enlarged bore portion 25d and being located at points spaced apart circumferentially of the member 25. And from each of said bores 25e a small passage 25f leads to the face of the wearing member that makes contact with the collar 26. The pockets 25e are in this case $\frac{1}{8}$ inch in diameter—the passages $\frac{1}{16}$ inch, and the mouth of each passage is countersunk to eliminate sharp edges on the face that receives the face of the rotating collar member 26.

When making assembly of the sealing device, the chamber 62 and the bores and passages 25e and 25f are packed with lubricating grease, and when the pump is in operation this grease works its way to the meeting faces of the relatively rotating members 25 and 26 and lubricates them.

The lubricant supplied through the passages 31 and 41 may be forced, under pressure applied by manipulation of the grease cup 21, between the shaft 4 and the bushing 40 and into the chamber 62, to replenish the supply of lubricant as needed. In fact, not only is the chamber 62 thus charged, but the spaces within the sealing members 28 and 52 may be also filled, to serve as reservoirs of lubricant.

The bores and passages 25e and 25f have a second utility. They function to augment the dissipation of the heat generated by the friction between the faces of the rotating collar member 26 and the non-rotating member 25. But for the heat dissipation thus obtained, the effective life of the seal would be impaired; that is, no matter how efficient the lubrication is, substantial heat tends to develop and endanger the life of the rubber sealing members 28 and 52. The augmented dissipation of heat provided by the feature described eliminates this danger.

The structure described affords an exemplary embodiment of my invention. The spring 50 yieldingly maintains the axially aligned series of seal-forming members in cooperative relation, and within the series the resilience of the compressed sealing elements 28 and 52, and the springs 76 and 77 enclosed thereby, are effective to the same end. In fact, the resilience of the compressed sealing elements alone may in many cases be adequate, so that the spring 50 may be replaced by a tubular sleeve, as already noted. It will further be understood that the sealing element 28 may be of the same general cylindrical form as the element 52, and cooperating members 26 and 29 appropriately modified in structure, as is also illustrated and described in my copending application, Ser. No. 521,771.

It will be perceived that I have sealed the passage of the pump shaft through the wall of the pump against leakage, by means of a simple organization, and that I have provided bearing for the pump shaft that is easily assembled and separated. As in course of operation the wearing plate 8 and the impeller 3 are worn away, they may readily be removed and replaced, and that as operation continues the adjustment nuts 19 and 20 constitute means for compensating for the wear.

It is to be remarked of the sealing device described that the wearing member 25 is mounted independently of the shaft 4 on the stationary extension of the bushing or sleeve 40 that carries the shaft load within the bearing member 23, and, while being secured by key 51 against rotation, the member 25 is assembled with a loose

fit, whereby it is free to "float" and to wobble in all directions required to obtain self-alignment with the associated rotating parts. The bushing 40 extends from the bearing member 23 a sufficient distance to provide ample support for the floating wearing and sealing member 25, and it will be noted that the flexible bellows-like organization of the member 52 allows the member 25 to move away from the member 23 to maintain contact with collar 26 without breaking the seal. At the same time the flexible bellows-like member 28 with equal pressure urges the floating collar 26 into self-aligning contact with member 25. Thus, the rotating members 29, 28 and 26, and the non-rotating members 25 and 52 comprise a "floating" seal that is yieldingly held in assembly between the stationary member 23 and the spring 50 that rotates with the shaft 4. The engagement of the edge of member 28 in groove 26c seals the member 28 to the outer edge of the collar 26, whereby maximum flexibility and self-aligning activity of the parts are obtained, it being manifest that the keyed union 27 of the collar 26 to the shaft relieves the bellows-like member 28 from torque, just as the keyed union of member 25 to bushing 4 safeguards the elastic member 52 from torque. These features of the sealing device are of particular value in rotary pumps in which end play usually develops in the impeller shaft, and the bearings sooner or later wear out of true with the shaft. It will be understood that if both sealing members 25 and 26 were mounted immediately on the shaft 4, with one member held against rotation and the other rotating with the shaft, the desired effect would not be obtained, for if the bearing ran out of true by as much as three thousandths of an inch the two contacting seal members 25 and 26 in relative rotation would chatter or repeatedly hit at two points spaced 180° apart with respect to the axis of the shaft, and thus would form an opening between such members that would destroy the seal and cause leakage. This I have discovered by experience, and the objection is eliminated in the structure of my present invention.

Another important feature of the invention is to be noted. I have discovered that, while the individual floating or wobbling mounting of the rotating and non-rotating seal members 25 and 26, respectively, tends to maintain the bearing faces of the two seal members in the desired fluid-tight running contact, there is a relative lateral play or oscillation between the seal members. It is a play or oscillation that is effective to produce a wiping action between the snugly contacting and relatively rotating faces of the two members—a rubbing action that is effective, back and forth, on lines that extend radially of the axis of the shaft 4, an action that is caused by one member (25 or 26) being eccentric relatively to the other even though their meeting faces may be maintained in snug surface-to-surface contact. This rubbing action tends to produce a condition that sucks the lubricant out of the reservoir 62, causing the engaged and relatively rotating faces of the members 25 and 26 to run dry, with the effect that the fluid-tight seal is impaired, and particles of abrasive are admitted from the pump chamber or passage 5 into the seal structure, thereby destroying its effectiveness.

In the provision of means for elimination of this situation, a very essential and valuable improvement has been made. Such means com-

prises an annular shoulder that extends from the bearing face of one of the seal members (25, 26) into a recess in the other seal member. In this case the ring 26 is provided with a drift-fitted brass ring 26d that extends from the annular bearing face of the ring portion 26a, and in the assembly (Fig. 2) extends into the bore portion 25d of the ring 25, but such extension of the portion 26d into the bore portion 25d does not so completely fill such bore portion as to impair the bore portion's function as a reservoir for lubricant. The fit of the shoulder formed by the extending body of ring portion 26d in the bore of ring 25 does not inhibit the wobbling of the two rings in the manner required to maintain a snug running contact between the engaged bearing faces of the two rings, but the fit is effective to prevent the relative oscillating or side shimming of the two seal members 25 and 26.

After a prolonged and adequate period of service, it may develop, as in any piece of machinery whose parts are subject to wear, that the seal members will require renewal. In my structure this may be accomplished without tearing down the pump. It is necessary only to disconnect the coupling of the shaft 4 to its driving motor, and then remove the housing 9 from the shaft and the pump body 1. Access to the sealing device is thereby afforded. And in case a leak should develop in the sealing device at a time when it is inconvenient to make immediate repair, the block 32 may be removed, and packing placed in the chamber 30. Then the block may be reassembled and tightened against the packing. In this fashion the pump may be operated until such time as the sealing device can be renewed.

The sealing device described will prove useful in many apparatus, other than pumps, in which it is desirable to seal a rotating shaft against the escape of fluid, and within the scope of the appended claims such varied utility of the sealing device, as well as many variations and modifications in the structure of the device, are held in contemplation.

The application for this patent comprises a continuation-in-part of application Serial No. 555,925, filed September 27, 1944, now Patent No. 2,479,178, granted August 16, 1949.

I claim:

1. In a pump comprising a pump body, a rotary shaft extending into said body, and a pump impeller in said body mounted on said shaft; the invention herein described in means for sealing the pump against the flow of fluid between the shaft and the pump body comprising a stationary shaft-encompassing sleeve portion carried by the pump body, two shaft-encompassing seal members having substantially inelastic bodies yieldingly held in abutment axially of said shaft, one of said members being secured on said sleeve portion against rotation but being arranged for wobbling movement and being bodily movable axially of the shaft and an elastic shaft-encompassing sleeve sealing such member to said body, the other of said members being secured to said shaft for rotation therewith and being arranged for wobbling movement, means including an elastic shaft-encompassing sleeve sealing such member to the shaft, and means for securing said relatively rotating seal members against lateral oscillation while admitting of said wobbling movement.

2. A seal for a rotary shaft extending through a stationary body, a stationary sleeve projecting from said body through which said shaft extends,

two shaft-encompassing seal members having substantially inelastic bodies and means for urging such members axially of the shaft into yielding contact with each other, one member being secured against rotation on said sleeve and the other member being secured to said shaft for rotation therewith, both of said members being bodily movable axially of the shaft and both members being arranged for wobbling motion to maintain a sealing contact with each other during their relative rotation, means for securing said relatively rotating seal members against lateral oscillation while admitting of said wobbling motion and a lubricant reservoir formed between said seal members and said shaft and the sleeve thereon.

3. A seal for a rotary shaft extending through a stationary body, two shaft-encompassing seal members and means for urging such members axially of the shaft into yielding contact with each other, one member being secured against rotation to said body and the other member being secured to said shaft for rotation therewith, at least one of said seal members being movable axially of the shaft and arranged for wobbling motion to maintain a sealing contact with the other member, and means for securing said relatively rotating seal members against lateral oscillation while admitting of said wobbling motion, one of said seal members being formed of two telescopically united ring portions, and including at least one lubricant passage that extends from the bore which receives said shaft and opens through the surface thereof which is contacted by the other seal member, said passage comprising a radially extending pocket whose outer end is closed by one of said ring portions, and a passageway extending from said pocket to the face of the seal member engaged by the other seal member.

4. A seal member for a rotary shaft comprising two ring members telescopically united, said seal member formed of a plurality of rings and including a bore through which said shaft may extend and having an annular wearing face that encircles the shaft, said bore being provided with an annular enlargement for a store of lubricant, and a system of passages extending from said enlargement and opening through said wearing face, each of said passages comprising a radially extending pocket formed in one of said rings and closed at its outer end by another of said rings, said system of passages providing for the supply of lubricant to said face and serving to enhance the dissipation of heat, substantially as described.

5. A seal for a rotary shaft comprising a tubular seal member adapted to encompass the shaft and forming an annular bearing surface, said seal

member including in structure two telescopically assembled rings, and a lubricant passage extending radially inward from the outer face of one ring and opening into the bore of the tubular seal member, the outer end of said passage being closed by the other of said ring members, and a passageway extending laterally from said radial passage and opening through said annular bearing surface.

6. In a pump comprising a pump body, a rotary shaft extending into said body, and a pump impeller in said body mounted on said shaft; the invention herein described in means for sealing the pump against the flow of fluid between the shaft and the pump body comprising a stationary sleeve projecting from said pump body, through which sleeve said shaft extends, two shaft-encompassing seal members having substantially inelastic bodies yieldingly held in abutment axially of the said shaft, one of said members being secured against rotation on said stationary sleeve and being bodily movable axially of the shaft while being free for wobbling movement thereon and an elastic shaft-encompassing sleeve for sealing such member to said stationary body, the other of said members being secured to said shaft for rotation therewith and being arranged for wobbling movement, means including an elastic shaft-encompassing sleeve sealing such member to the shaft, and a shoulder on one of said seal members extending into the bore of the other member for securing said relatively rotating seal members against lateral oscillation relatively to each other while admitting of said wobbling movement and a common lateral movement of the interengaged seal members laterally of the shaft.

DANIEL MURPHY.

REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Country	Date
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833,527	France	of 1938

Certificate of Correction

Patent No. 2,505,868

May 2, 1950

DANIEL MURPHY

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 24, for the words "are closed" read *and closed*; line 28, after "end" strike out *and*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of July, A. D. 1950.

[SEAL]

JOE E. DANIELS,

Assistant Commissioner of Patents.