

June 18, 1963

L. H. LOGUE
CENTRIFUGAL PUMPS

3,094,075

Filed June 8, 1960

4 Sheets-Sheet 1

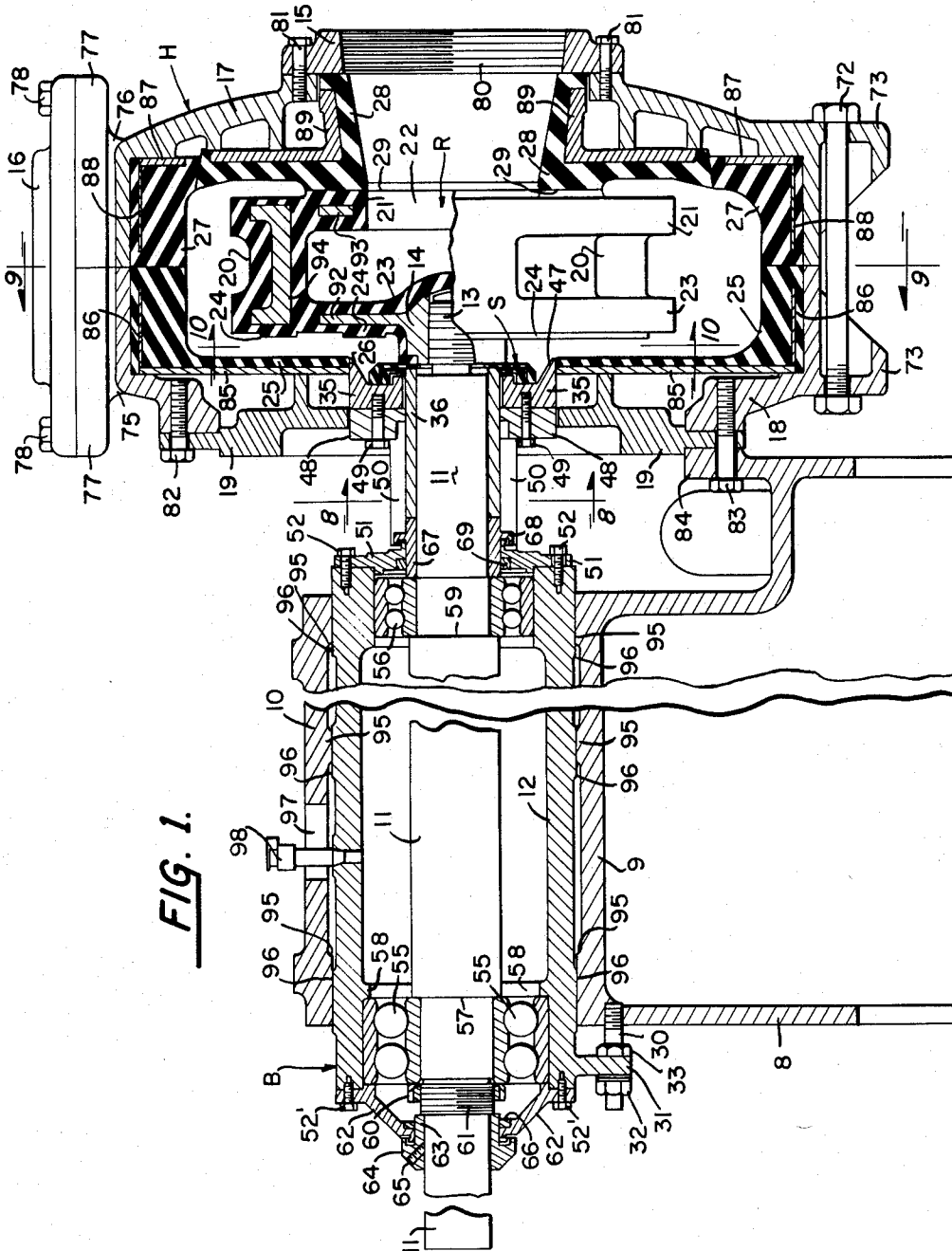


FIG. 1.

INVENTOR.
LELAND H. LOGUE
BY
Horace B. Van Veenburg
ATTORNEY

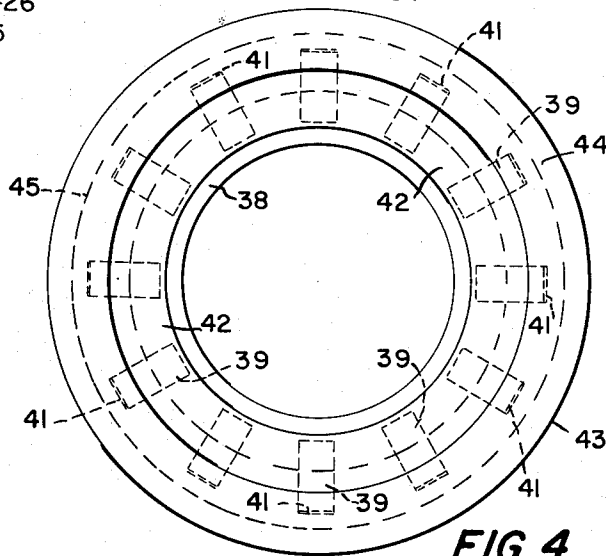
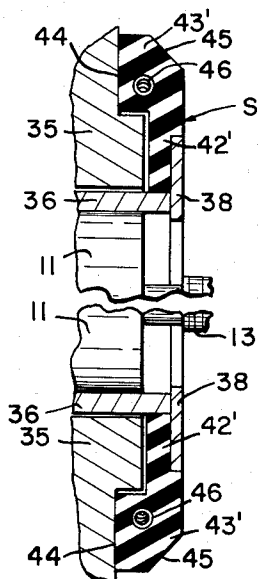
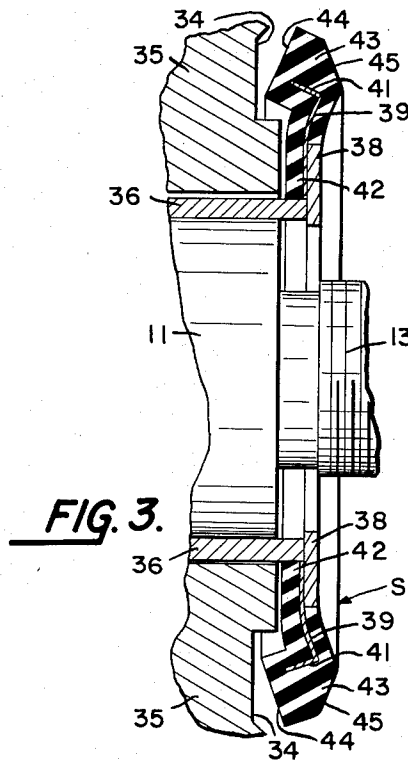
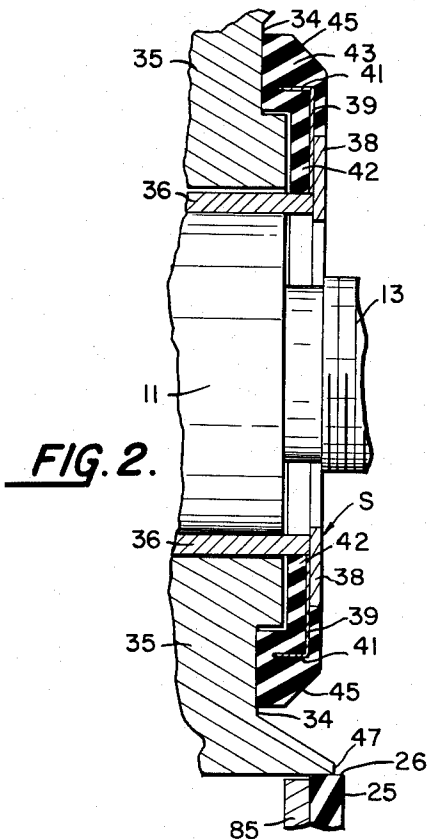
June 18, 1963

L. H. LOGUE
CENTRIFUGAL PUMPS

3,094,075

Filed June 8, 1960

4 Sheets-Sheet 2



INVENTOR.
LELAND H. LOGUE

BY

Horace B. Van Valkenburg

ATTORNEY

June 18, 1963

L. H. LOGUE
CENTRIFUGAL PUMPS

3,094,075

Filed June 8, 1960

4 Sheets-Sheet 3

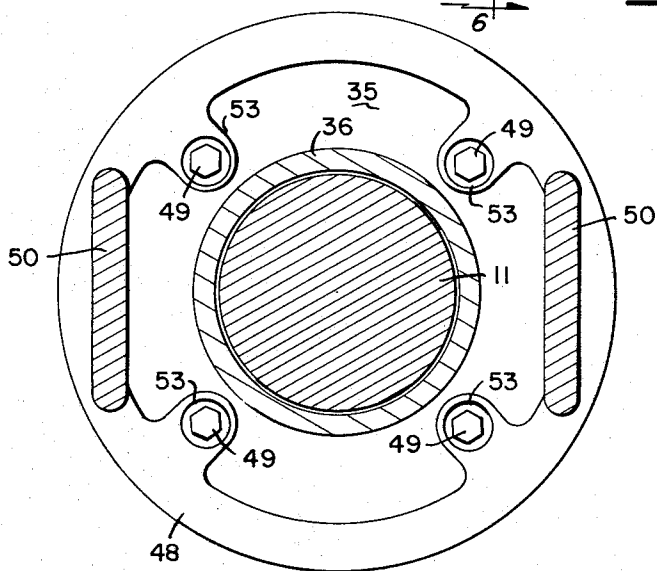
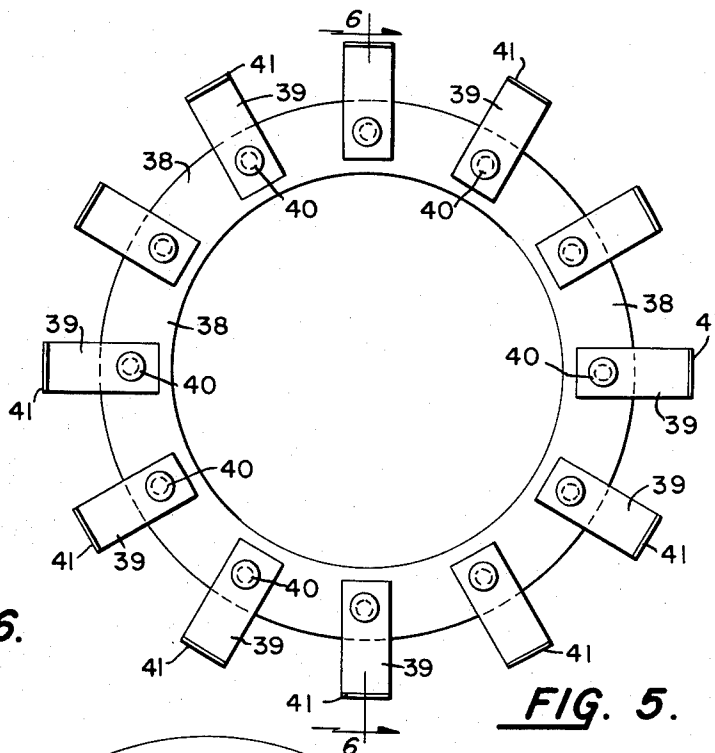
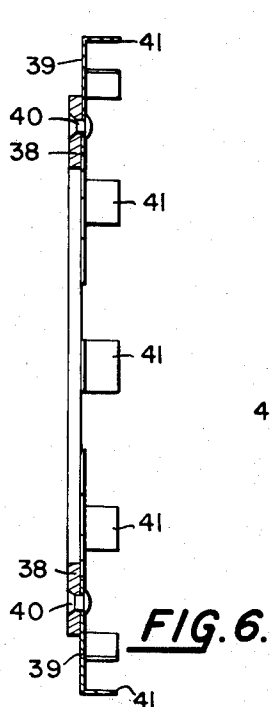


FIG. 8.

INVENTOR.
LELAND H. LOGUE
BY
Horace B. Van Vackenburg
ATTORNEY

June 18, 1963

L. H. LOGUE
CENTRIFUGAL PUMPS

3,094,075

Filed June 8, 1960

4 Sheets-Sheet 4

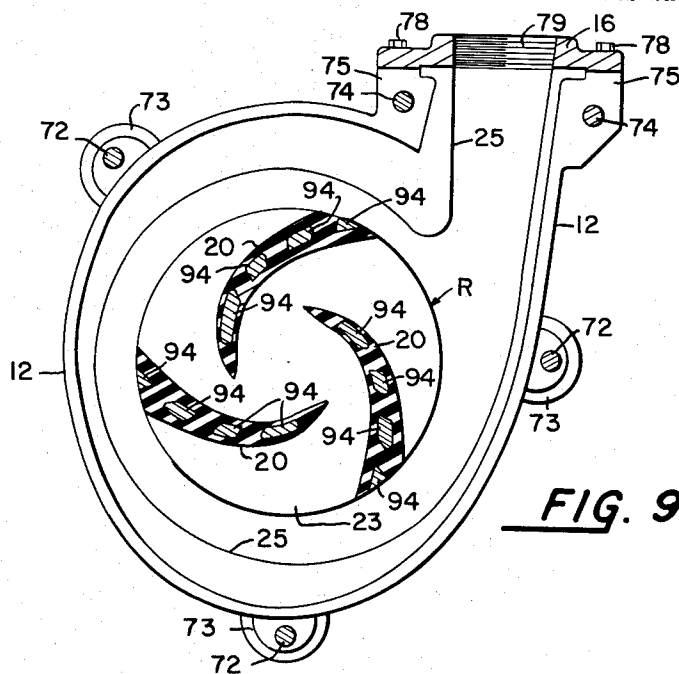


FIG. 9.

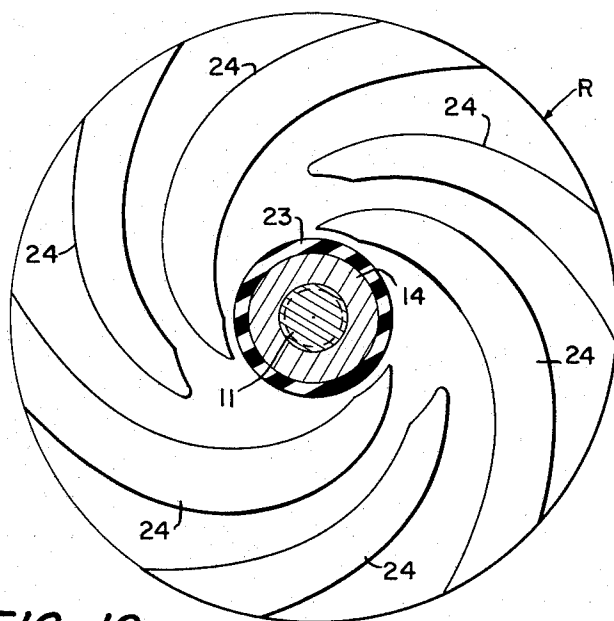


FIG. 10.

INVENTOR.
LELAND H. LOGUE
BY
Horace B. Van Vackenburg
ATTORNEY

1

3,094,075

CENTRIFUGAL PUMPS

Leland H. Logue, Denver, Colo., assignor to Denver Equipment Company, Denver, Colo., a corporation of Colorado

Filed June 8, 1960, Ser. No. 34,787

8 Claims. (Cl. 103-103)

This invention relates to centrifugal pumps and more particularly to improvements in pumps for handling slurries and the like, such as divided solids carried by a liquid.

A serious problem, in the construction of centrifugal pumps for handling slurries and the like, lies in providing an adequate seal around the drive shaft. The disadvantages of a friction seal, i.e., packing rings, is that these wear out very quickly due to the friction between the packing rings and the drive shaft, while the amount of power used in overcoming this friction unduly increases operating costs. When sand or other gritty materials are being pumped in a slurry, the sand or the like tends to enter the packing, thereby causing the packing to wear out quickly. Thus, the problem is to provide a seal which will provide a minimum of friction during the time that the pump is operating, but will prevent leakage of fluid from within the pump during the time the pump is not in operation. Several attempts have been made to overcome this problem, one being the use of a water seal. In this type of seal, water is directed under pressure through an opening around the shaft, adjacent to the packing, at a greater pressure than the pressure of the fluid or slurry within the pump. This type of seal prevents the liquid and the solids within the pump from passing through the opening, as well as preventing the solids from entering the packing, but has the disadvantage of allowing the water from the water seal to enter the slurry or solution within the pump, thus diluting the same and in many instances making it necessary later to remove this excess water. This is particularly true when the amount of water in the slurry or solution is critical. Also, the power necessary to overcome the friction created by the packing rings used to prevent leakage of water from the water seal, to the exterior of the pump, again increases operating costs.

Among the objects of this invention are to provide a novel centrifugal pump; to provide a seal for a centrifugal pump which positively prevents leakage of the slurry or solution within the pump, through the shaft opening, when the pump is stopped; to provide such a seal which produces a minimum of friction during operation of the pump, such as to allow vanes on the rear side of the impeller or runner to prevent leakage while the pump is running, by driving the slurry or solution away from the opening around the shaft; to provide such a seal which requires a minimum of maintenance; and to provide such a pump and seal therefor which are readily constructed and which are efficient in operation.

Additional objects and the novel features of this invention will become apparent from the description which follows, taken in connection with the accompanying drawings, in which:

FIG. 1 is a condensed longitudinal section of a centrifugal pump embodying the principles of this invention, with the impeller or runner in partial section;

FIG. 2 is an enlarged, fragmentary vertical section showing a centrifugal seal of the pump of FIG. 1 in the position it assumes when the pump is not in operation;

FIG. 3 is an enlarged fragmentary vertical section, similar to FIG. 2, but showing the position which the centrifugal seal assumes when the pump is in operation;

FIG. 4 is an enlarged rear elevation of the seal of FIG. 2;

2

FIG. 5 is an enlarged rear elevation of a metal skeleton of the seal of FIG. 4;

FIG. 6 is a vertical section taken along line 6-6 of FIG. 5;

FIG. 7 is a condensed fragmentary vertical section, similar to FIG. 2 but showing an alternative form of centrifugal seal;

FIG. 8 is an enlarged cross section, showing particularly a section of a support for a blind plate at the end of the drive shaft, taken along line 8-8 of FIG. 1;

FIG. 9 is a cross section of the pump and impeller, on a reduced scale, taken along line 9-9 of FIG. 1 and showing particularly the vanes in the interior of the impeller; and

FIG. 10 is a fragmentary cross section, on an enlarged scale, taken along line 10-10 of FIG. 1 and showing particularly the vanes on the rear side of the impeller or runner which prevent fluid from escaping through the drive shaft opening when the sealing ring is in the position shown in FIG. 3.

The pump of this invention is particularly adapted to be used to pump various types of concentrates, sands, slimes, waste disposal, and any other liquid having solids suspended therein or carried thereby. The pump, as in FIG. 1, includes a housing H supported by a bearing pedestal 8 having a semi-cylindrical portion 9 provided with a semi-cylindrical cap 10, together forming a cylinder in which a bearing assembly B is received for adjustment longitudinally thereof. The pump is driven by a motor or engine (not shown), connected to a drive shaft 11 in a conventional manner, such as including a coupling which permits longitudinal adjustment of shaft 11. Bearing assembly B includes a bearing cylinder 12 which houses drive shaft 11 and the bearings therefor, the drive shaft 11 extending through the bearing cylinder and having one end projecting inside the housing H and having threads 13 for attachment to a hub 14 of an impeller or runner R. The other end is connected to the motor, by direct drive or more conveniently by belt drive. The pump housing H has a central inlet 15 at one end and an outlet 16 at the top, the housing H conveniently being divided into an outer half 17 and an inner half 18, the latter being attached to a casing ring 19 with the casing ring and inner half being mounted on pedestal 8. The housing H and runner R may be constructed in any suitable manner, the details of one suitable construction being described later. In general, the runner R is provided with interior vanes 20 adapted to move the slurry outwardly from the center and extending between a front wall 21, having a central inlet opening 22, and a rear wall 23, provided on its rear side with vanes 24 adapted to move the slurry outwardly from the rear of hub 14 and particularly away from any opening around the drive shaft 11. The vanes 20 and 24 and front and rear walls 21 and 23 are conveniently formed of rubber or other material, suitable to resist abrasion of the particles in the slurry and molded on a reinforcing skeleton, as described later. As will be evident, vanes 24 permit an opening around shaft 11 while the pump is operating, to reduce friction and operating costs; but as soon as the pump is stopped, the slurry in the housing will flood outwardly through such an opening. This constitutes a problem which the seal of this invention overcomes.

The inner half 18 of housing H is provided with a liner 25, formed of rubber or other suitable material which resists abrasion by any abrasive materials in the slurry being pumped and prevents wearing of the metal of the inner half, is reinforced in a manner described later, and is provided with a central circular opening 26. The outer half 17 is provided with a similar rubber lining, conveniently including a liner 27 formed of rubber and rein-

forced in a manner described later. Both liner 25 and liner 27 extend to the outlet 16, as shown for liner 25 in FIG. 9, while liner 27 interfits with an angularly cylindrical liner 28 which extends to inlet 15 and is formed of rubber and reinforced in a manner described later.

Another factor involved is that produced by the necessity for adjustment of the longitudinal position of the runner. As will be evident, the space at line 29, at the area over which the front face of front wall 21 of the impeller, which is rotating, is close to the rear face of liner 28, which is stationary, should be controlled to produce a balance, on the one hand, between the wear of the liner and the impeller, which would be unduly great if these surfaces rubbed, as well as requiring additional power and increasing the cost of operation, and, on the other hand, the tendency for the slurry to flow inwardly through this space, as a result of the greater pressure at the outlet than at the inlet, with a resultant decrease in the efficiency of the pump. The optimum balance is normally obtained by adjusting the clearance along line 29 so that it is only a few thousandths of an inch, to prevent actual contact of the surfaces but to minimize the inflow. However, particles in the slurry will tend to enter the space and rub against these surfaces, so that a slight amount of wear will normally take place, requiring periodic adjustment of the longitudinal position of the impeller. Since the impeller R itself cannot readily be adjusted on the shaft 11 without disassembly of the pump housing, the most convenient method of adjustment is to adjust bearing assembly B and shaft 11, with the impeller, as a unit. This is conveniently accomplished through an adjustment stud 30 which extends through a hole in a flange 31 on the lower portion of bearing cylinder 12 and into a tapped hole in pedestal 8, in FIG. 1, with nuts 32 and 33 to lock flange 31 in adjustment position. As will be evident, by adjusting flange 31, the shaft, impeller, and bearing cylinder may be adjusted longitudinally of the pedestal, to adjust the spacing 29 between the front face of the front wall 21 of the impeller and the liner 28.

Such a pump, in accordance with this invention, is provided with the seal S of FIG. 1, which is shown in greater detail in FIGS. 2 to 6, inclusive. Seal S requires no packing and provides an opening around shaft 11 while the pump is operating, as in FIG. 3, to reduce friction and consequent power loss, but engages the annular surface 34 of a recess in a blind plate 35 when the pump is stopped, as in FIG. 2, to prevent flooding out of the slurry in the pump. Seal S rotates with shaft 11, when turning, and is conveniently clamped between the impeller hub and the end of a sleeve 36 which surrounds shaft 11, as in FIG. 1. Seal S comprises a skeleton or frame, onto which rubber or other suitable material, such as resilient plastic, is molded. As in FIGS. 5 and 6, the skeleton for seal S consists of a ring 38 of relatively inflexible metal, to which a plurality of circumferentially spaced, resilient fingers 39 are attached, as by rivets 40. Each finger 39 terminates in an outer, axially extending flange 41 which, when the seal is installed, faces toward the blind plate 35. The mold for forming the seal has a configuration such that the front face and the inner edge of ring 38 are exposed, so that the ring will engage sleeve 36 on one side and the impeller hub on the other, with the rubber extending down to ring 38 on one side and a rubber leg 24 extending inwardly along the ring 38 on the opposite side. The flanges 41 of the fingers are embedded in an annular block 34 having a sealing face 44, adapted to engage the surface 34 of blind plate 35, and an opposite beveled edge 45. The center of gravity of block 43 is thus offset from the radial legs of fingers 39, in the direction of blind plate 35. The flanges 41 stiffen the overhanging mass of block 43, while fingers 39 resist tension stresses on the rubber due to centrifugal force and thereby increase the useful life of the rubber,

which would otherwise become flabby and lose its desired shape due to fatigue.

When the pump is motionless, the seal will assume the position shown in FIG. 2, i.e., the surface 44 of block 43 will bear against the surface 34 of blind plate 35, urged by resilient fingers 39 and the pressure of the slurry within the pump, thereby providing a tight seal, so that the slurry within the pump cannot discharge around the shaft, between blind plate 35 and the shaft. As the pump motor is first started and the shaft begins to rotate, the surface 44 of the seal will rub against the surface of blind plate 35, but as the speed increases, since the center of gravity of block 43 is offset, the block will move outwardly, losing contact with blind plate 35, until the center of gravity of the block is more nearly in alignment with the plane of the fingers 39, as in FIG. 3. However, there may be a very short period, such as a few seconds, of leakage of slurry before the shaft reaches a speed at which the rotation of the impeller will be sufficient to permit vanes 24 to drive all the slurry away from the opening around the shaft, as the surface 44 begins to pull away from blind plate 35. However, before the pump reaches operating speed, the vanes 24 should drive all of the slurry away from the space between block 43 and the blind plate. Upon stopping of the pump, the reverse action will take place, i.e., the block 43 will gradually return to its normal position, under the biasing influence of the spring fingers 39, until surface 44 again contacts surface 34 of blind plate 35, forming a positive seal which prevents leakage of slurry within the pump. Again, as the pump slows down, there may be a short period of leakage when vanes 24 of the impeller are not moving at a sufficient speed to prevent some of the slurry within the pump from reaching the opening between surface 44 and blind plate 35. As will be evident, each condition of leakage is momentary and will soon cease as the pump comes up to speed or comes to rest, and any loss of slurry is negligible. Thus, it can be seen that no type of packing or water seal is necessary, and that the centrifugal seal will operate accurately and positively each time the pump is turned on and off.

The alternative centrifugal seal S' of FIG. 7 includes a metal ring 38, the inner portion of which is clamped between the hub of runner R and sleeve 36, as in the case of seal S. Seal S' also includes rubber or other suitable material molded onto ring 38, with a leg 42' extending inwardly along ring 38 and an outer, annular block 43' offset toward blind plate 35 and having a blind plate engaging surface 44 on one side and a beveled edge 45 on the opposite side. Thus, the seal S' may be molded in a mold similar to the mold for seal S, except that a coil spring 46 is embedded in block 43', conveniently at approximately the center of gravity of the block. As will be evident, coil spring 46 will stiffen the overhanging mass of block 43' and will also resist tension stresses on the rubber to increase the useful life thereof. Seal S' operates in a manner similar to seal S, thus assuming the position of FIG. 7 when the pump is not operating and assuming a position corresponding to FIG. 3 when the pump is operating, it being noted that the clearance between surface 34 of blind plate 35 and the surface 44 of block 43 of seal S or block 43' of seal S' may be less than that indicated by FIG. 3, since a clearance of about one sixteenth of an inch may usually be found to be satisfactory.

In accordance with this invention, the blind plate 35 and particularly the support therefor is adjusted with the runner. Thus, the blind plate 35 is provided with an annular lip 47, the outer surface of which engages the central, circular aperture 26 in liner 25, as in FIG. 2, to form a seal therewith to prevent the egress of fluid or slurry around the blind plate. Since liner 25 is preferably formed of rubber or the like, the liner will resiliently engage the blind plate, while permitting longitudinal adjustment of the blind plate. The blind plate support in-

5

cludes a flange 48 to which the blind plate is attached, as by cap screws 49, while a pair of ribs 50, which are spaced laterally, as in FIG. 8, extend from flange 48 to an opposite flange 51 which provides an end cap for bearing cylinder 12 and is attached thereto by cap screws 52, flange 48 being provided with a series of bosses 53, to facilitate access to the cap screws 49. As will be evident, blind plate 35 will move with bearing cylinder 12 and also shaft 11, to maintain the correct relationship between the seal S and the blind plate 35, but will remain in sealing engagement with the inner edge 26 of liner 25.

The shaft 11 is rotatably supported in a thrust bearing 55 and a bearing 56, located at opposite ends of the bearing cylinder, with bearing 55 abutting a shoulder 57 on the shaft and also abuts a circumferential rib 58 in the bearing cylinder and bearing 56 abutting a shoulder 59 on shaft 11. Thrust bearing 55 is held in place on the shaft by a lock nut 60 which engages threads 61 on the shaft, and held in place in the end of the bearing cylinder, by an end cap 62, which is held in place by a plurality of cap screws 52'. A neck 63 of a water slinging ring 64, mounted on shaft 11, as by a set screw 65, extends within end cap 62, which is also provided with a groove to receive an oil seal 66 which engages neck 63. The purpose of the water slinging ring is to prevent extraneous water in the area, as from condensation on pipes or seeping walls, from entering the shaft bearings. Since the water slinging ring rotates with the shaft, it will throw off any water which drips onto it. Bearing 56 is held in place on the shaft by a neck 67 of a water slinging ring 68, which abuts sleeve 36, while flange 51 is provided with a groove receiving an oil seal 69, which also engages neck 67.

The outer half 17 and inner half 18 of housing H are secured together by bolts 72 extending through flanges 73 of the respective halves, spaced therearound, as in FIG. 9. Although three bolts and corresponding pairs of flanges have been shown, it will be understood that any number may be provided, as desired. Also, additional bolts 74 may extend through a neck 75 of the inner half, as in FIG. 9, and a corresponding neck 76 of the outer half, shown in FIG. 1. Each neck 75 and 76 terminates in a semi-circular flange 77, as in FIG. 1, to which outlet 16, conveniently formed as a companion flange, is attached, as by a plurality of circumferentially spaced cap screws 78. Outlet 16 is provided with internal threads 79, as in FIG. 9, for receiving a discharge pipe. Inlet 15 may comprise a companion flange provided with internal threads 80, for attachment to an inlet pipe, and attached to housing half 17 by a plurality of circumferentially spaced cap screws 81. Casing ring 19 is attached to the inner half 18, as by circumferentially spaced cap screws 82 and 83, the latter of which extend through an arcuate flange 84 of pedestal 8 for mounting the pump housing on the pedestal.

Liner 25 of the inner half 18 of housing H conveniently has a longitudinal configuration as in FIG. 1 and a lateral configuration as in FIG. 9, the liner being conveniently formed of rubber and reinforced, as in FIG. 1, by a circular steel plate 85 at the rear, provided with an axially extending plate 86 embedded in the rubber, with plates 85 and 86 conveniently being provided with holes through which the rubber flows. Liner 27 may similarly be reinforced by a circular steel plate 87 at the front, provided with an axially extending plate 88, similarly provided with holes and embedded in the rubber, while liner 28 is conveniently reinforced by a steel, flanged ring 89 molded thereto. The liners 25, 27 and 28 are conveniently bolted to the housing, as by studs (not shown) extending at appropriate positions from plates 85 and 87 and ring 89.

The impeller R, which is shown as being of the closed type but may be an open type runner, is conveniently formed of rubber molded onto a reinforcing metal skeleton carrier by hub 14, as indicated previously. The metal

6

skeleton for the runner includes an inner radial flange 92, connected to hub 14 and having holes therein through which the rubber extends, an outer radial flange 93 also having holes therein, and a series of ribs 94 connecting the inner and outer radial flanges. Ribs 94, as in FIG. 9, extend through each of the series of vanes 20, which force the slurry from the central inlet outwardly, then around the runner and through the outlet. As in FIG. 10, vanes 24 are molded and curved outwardly, similarly to vanes 20, to pump outwardly in the space between the rear of the impeller and rear liner 25, to prevent the slurry from running out along the drive shaft when the pump is operating.

Movement of bearing assembly B relative to the pedestal is facilitated by inwardly extending lands 95 of pedestal cylinder 9 and cap 10, and corresponding outwardly extending lands 96 of bearing cylinder 12. For adjustment, cap 10 may be loosened, bearing cylinder 12 adjusted by nuts 32 and 33 on stud 30, then cap 10 retightened. Pedestal cap 10 may also be provided with a longitudinal slot 97 to allow relative movement of an oil filling fitting 98 during adjustment, the latter being mounted on bearing cylinder 12 and communicating with the interior thereof for adding oil for bearings 55 and 56.

From the foregoing, it will be evident that a pump constructed in accordance with this invention fulfills to a marked degree the requirements and objects hereinbefore set forth. It is apparent that the invention provides a centrifugal pump in which no packing seals or water seals are needed. A sealing surface of the centrifugal seal of the invention positively engages a blind plate to prevent leakage from within the pump, around the shaft, when the pump is not in operation. During operation, centrifugal force causes the offset block of the seal to move outwardly and pivot away from the blind plate, so that there is no friction through engagement with the blind plate and the vanes on the rear side of the impeller can prevent liquid or slurry from discharging through the shaft opening. Through the provision of a blind plate which is movable with the shaft and bearing, but sealingly engages a stationary portion of the housing, conveniently a liner formed of resilient material, the shaft may be adjusted in position to maintain the desired clearance between the front wall of the impeller and the front liner of the housing, without adversely affecting the operation of the centrifugal seal.

Although a preferred embodiment of this invention has been illustrated and described, it will be understood other embodiments may exist and various changes and variations made, without departing from the spirit and scope of this invention.

What is claimed is:

1. In a pump having a base, a housing mounted on said base and having an axial inlet, a tangential outlet and an opening opposite said inlet, a rotatable shaft extending through said opening in said housing opposite said inlet, an impeller mounted on the end of said shaft within said housing and adapted to pump liquid from said inlet to said outlet and having means for driving fluid away from said shaft opening when said shaft is rotating, the improvement which comprises a blind plate forming the peripheral face of said opening and having a sealing surface thereon; sealing means operative to engage said sealing surface to prevent leakage of fluid within said housing through said shaft opening when said shaft and said impeller are motionless, but which is disengaged from said sealing surface during rotation of said shaft; means for causing said sealing means to engage said housing when said shaft is motionless and to be disengaged from said housing upon rotation of said shaft; and means for longitudinally adjusting said shaft, said impeller, said blind plate and said sealing means to adjust the clearance between said impeller and said inlet.

2. In a pump as set forth in claim 1, in which said means for adjusting said shaft, said impeller, said blind

plate and said sealing means includes bearing means rotatably supporting said shaft outwardly from said housing, said bearing means being movable longitudinally of said base; means interconnecting said bearing means and said blind plate; and means for adjusting said bearing means longitudinally of said base, thereby causing said shaft, said impeller, said blind stop and said sealing means to be adjusted as a unit.

3. In a pump as set forth in claim 1, in which said sealing means is located within said housing and is provided with a sealing face offset away from said impeller and toward said blind plate.

4. In a pump having a base, a housing mounted on said base and having an axial inlet, a tangential outlet, and an opening opposite said inlet, a rotatable shaft extending through said opening in said housing opposite said inlet, and an impeller mounted on the end of said shaft within said housing adapted to pump liquid from said inlet to said outlet, the improvement which comprises a generally annular, yieldable disk having an offset portion and rotatably mounted on said shaft adjacent said shaft opening and operative to engage said housing to prevent leakage of fluid within said housing through said shaft opening when said shaft and said impeller are motionless; a circular metal ring mounted on said shaft adjacent said impeller for rotation therewith; and a plurality of spaced, resilient fingers extending outwardly from the circumference of the ring and embedded in said disk for normally urging the face of said offset portion of said disk against said housing around said opening to prevent leakage of fluid said offset portion being offset from the plane of said disk towards said opening, so that said face of said offset portion is thrown out of contact with said housing and around said opening by centrifugal force when said shaft is rotating.

5. In a pump as set forth in claim 4, wherein said fingers are provided with flanges extending into said offset portion of said disc.

6. In a pump as set forth in claim 4, including a sleeve

mounted upon and fixedly attached to said shaft so as to rotate therewith; a hub on said impeller, the end of said shaft being threadably received in said hub; and said ring of said sealing means being received between said other end of said sleeve within said housing and said face of said hub so that said sealing means will rotate therewith.

7. A seal for the drive shaft opening in a housing of a pump of the type having an impeller with vanes for driving fluid away from said opening, said seal comprising a circular metal ring adapted to be mounted on said shaft adjacent said impeller for rotation therewith; a plurality of spaced, resilient biasing fingers extending radially from said ring and fixedly attached thereto; and a resilient disc having a portion axially offset from the plane of said disc and having a face adapted normally to be biased by said fingers to seal against said housing around said opening to prevent loss of fluid therethrough, and to be moved away from said housing by centrifugal force during rotation of said seal, said fingers being embedded in said disc.

8. A seal as set forth in claim 7, in which the ends of said fingers are provided with generally axially extending flanges embedded within said offset portion of said disc.

References Cited in the file of this patent

UNITED STATES PATENTS

2,140,356	Gutmann	Dec. 13, 1938
2,207,371	Blackmore et al.	July 9, 1940
2,253,904	Haug	Aug. 26, 1941
2,258,527	Warman	Oct. 7, 1941
2,665,929	Sawyer	Jan. 12, 1954
2,693,761	Mytling	Nov. 9, 1954
2,787,960	Wightman	Apr. 9, 1957
2,936,715	Southam et al.	May 17, 1960
2,938,467	Fearon et al.	May 31, 1960

FOREIGN PATENTS

1,068,562	Germany	Nov. 5, 1959
1,084,781	France	July 13, 1954