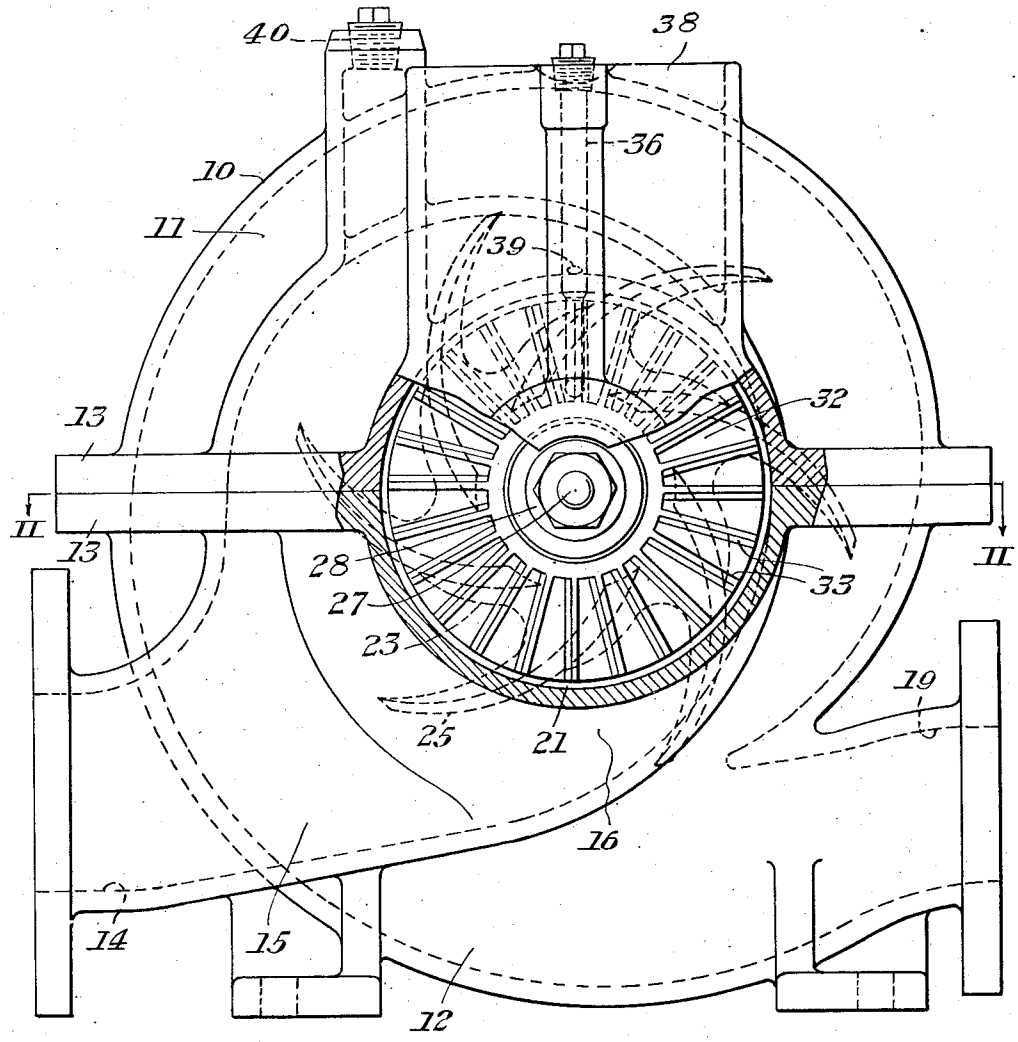
March 6, 1934. E. I. McGEE 1,949,428

FLUID SEAL

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Fig. 1.



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Byrnes, Stevens, Pennelle & Blenko

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FLUID SEAL

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Fig. 2.

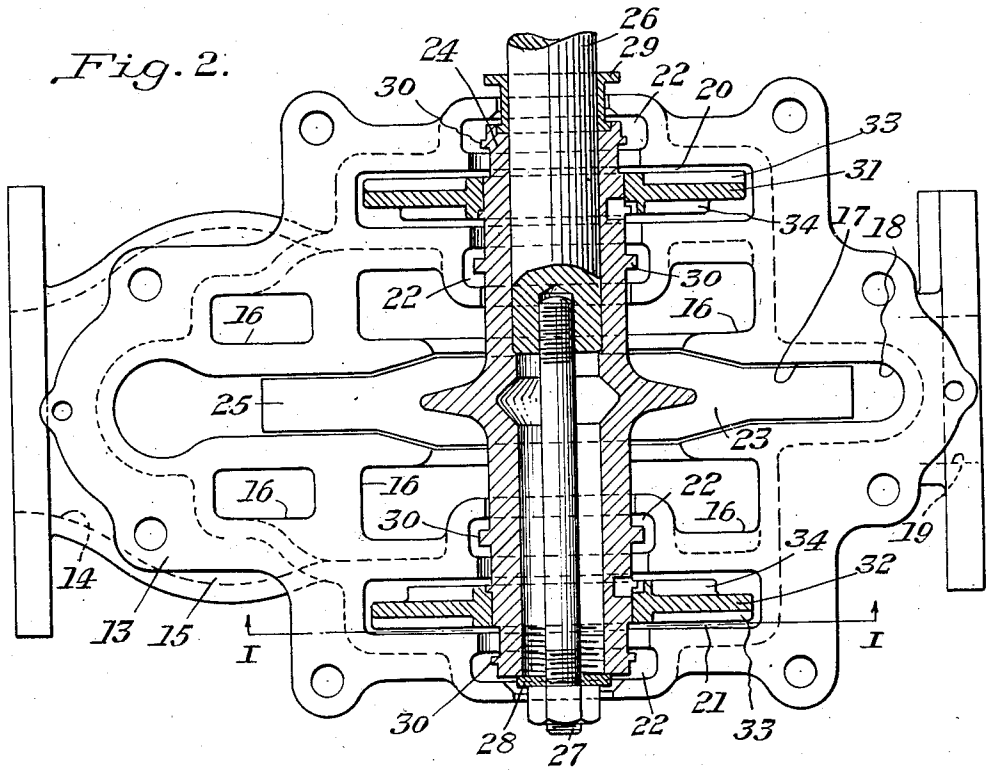


Fig. 3.

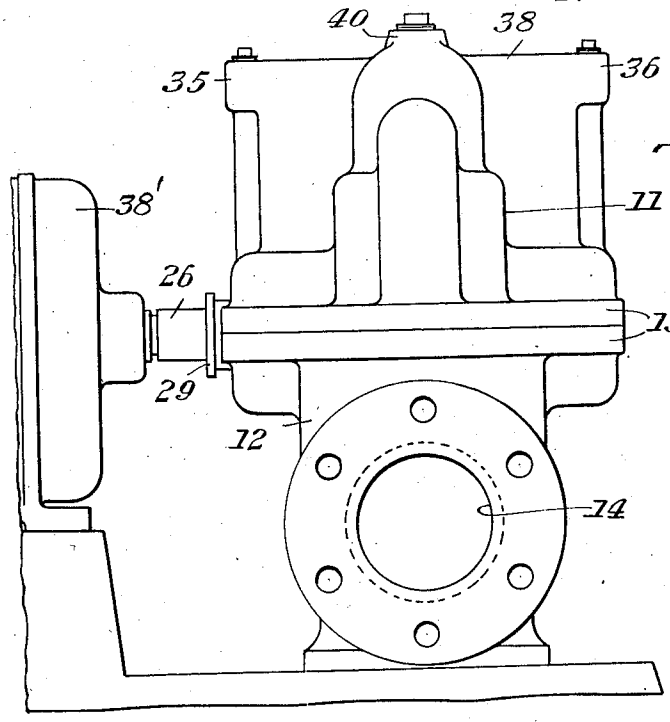


Fig. 7.

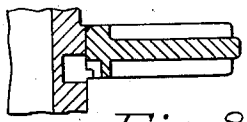
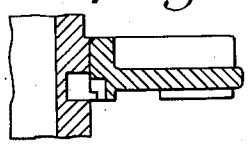


Fig. 8.



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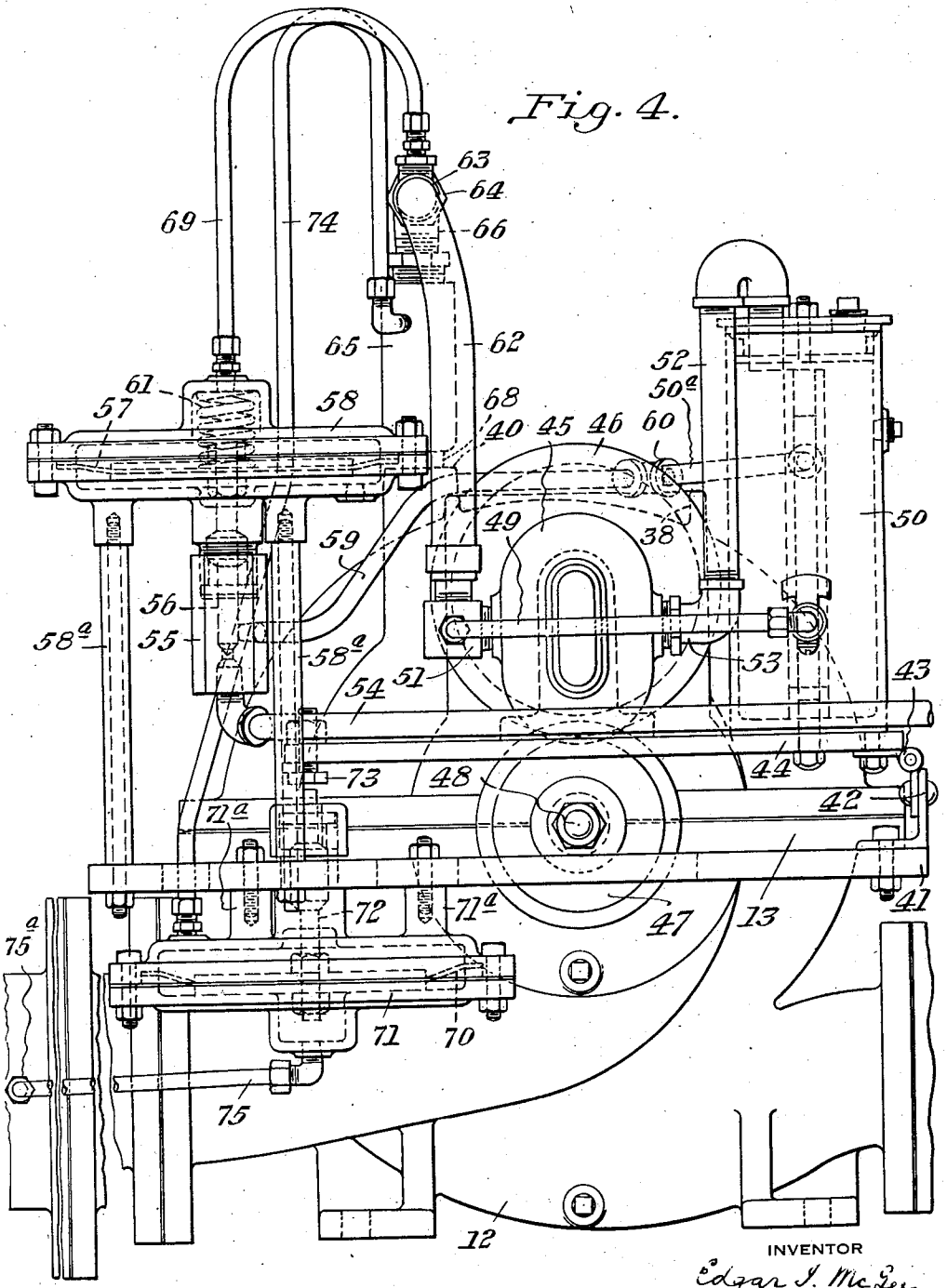
Twimeier & Brenko

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FLUID SEAL

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Fig. 4.



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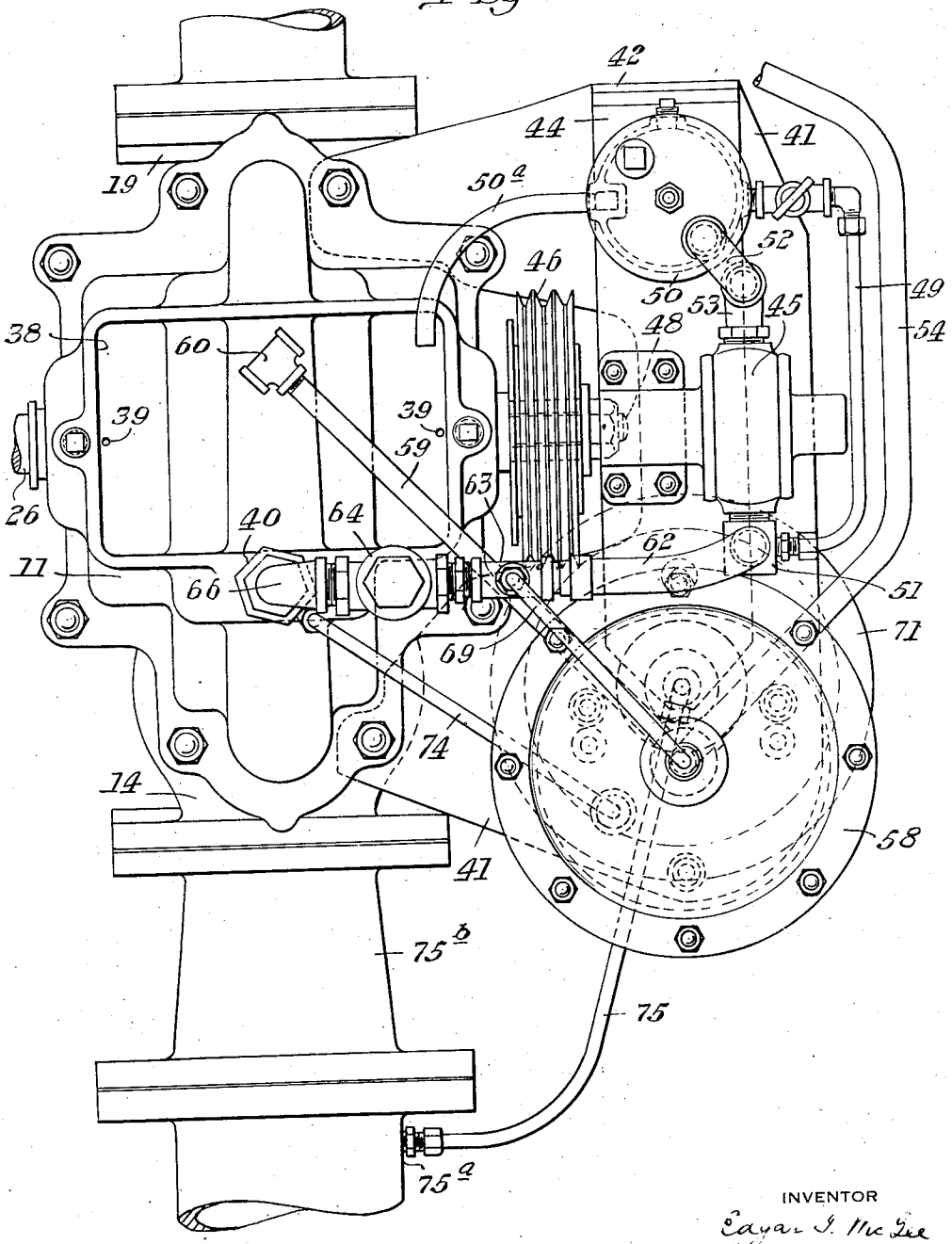
Byrnes, Stebbins, Parmelee & Kibenko

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FLUID SEAL

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Fig. 5.



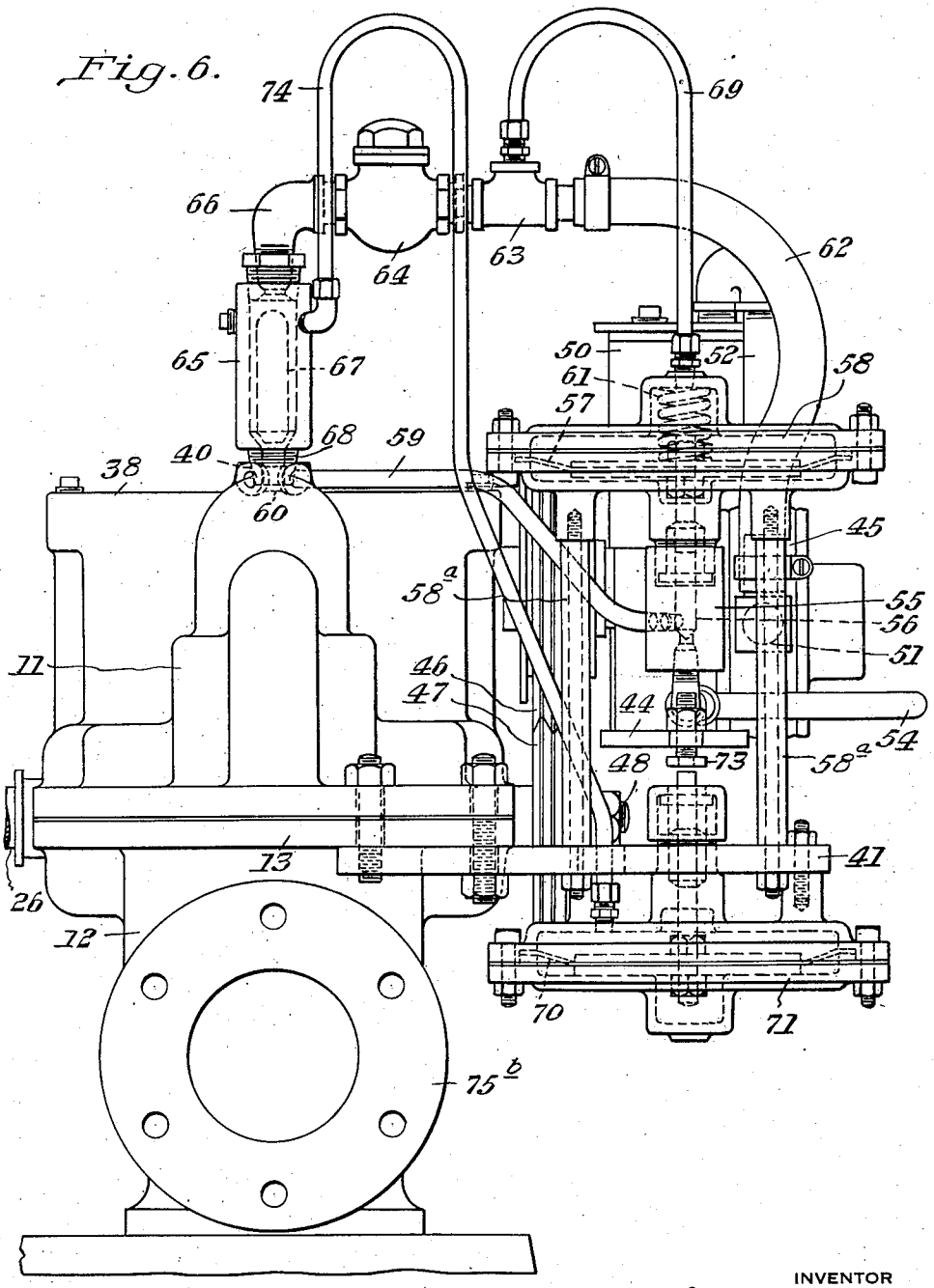
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FLUID SEAL

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Fig. 6.



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UNITED STATES PATENT OFFICE

1,949,428

FLUID SEAL

Edgar I. McGee, Scottdale, Pa., assignor to Fluid Seal Corporation, Connellsville, Pa., a corporation of Delaware

Application October 5, 1931, Serial No. 566,845

29 Claims. (Cl. 103—113)

My invention relates to the production of a seal between relatively moving parts of an apparatus without mechanical contact therebetween. In particular, the invention relates to a seal for closing the space between the impeller and the casing of a centrifugal pump, and to apparatus for automatically establishing such seal and priming the pump.

I am aware that it has been proposed heretofore to provide centrifugal pumps with fluid seals, in which a body of water put in mo ion by the rotation of an impeller establishes a centrifugal seal against the pressure developed in the pump. So far as I am aware, however, there has as yet, been no practical embodiment of this idea in a pump which is commercially feasible. The prior art discloses several instances in which it was attempted to apply centrifugal seals in pumps, but, in all such instances with which I am familiar, the embodiment of the idea disclosed is far from a practical commercially operative device.

The pumps of the prior art having centrifugal seals, with which I am familiar, require the presence of an attendant, usually a skilled mechanic, to establish the seals, prime the pumps and oversee the operation thereof, to prevent damage in case of an emergency such as the pump losing its vacuum, or the like. A further object of my invention, therefore, is to provide automatic sealing and priming means so the pump may be operated unattended. The construction of the pump is such that it is not damaged by running dry, and no supervision of its operation is required.

In accordance with my invention, I provide a centrifugal pump having a casing and an impeller rotatable therein. The casing is split horizontally and has divided axial inlets. The impeller is in one piece and is provided with a hub extending laterally of the blades thereof to a point close to the end wall of the casing. The hub is bored for the reception of a shaft of a standard driving motor, which forms the sole support for the impeller, no special bearings on the motor being required or any bearings at all in the pump casing. Adjacent the ends of the casing, sealing channels are formed therein. Sealing discs keyed to the hub of the impeller and having blades on both sides thereof cooperate with said channels to whirl water supplied thereto to provide a centrifugal seal for the inlet chambers of the pump casing against atmospheric pressure. On each side of the sealing discs, the impeller hub is provided with integral collecting rings. In alinement with said rings, collecting grooves are formed in the pump casing. The rings and grooves cooperate to collect any leakage from the sealing chambers and to return it thereto. The pump casing is provided with ports communicating with the sealing chambers for introducing fluid thereto and also with a port communicating with the inlet chamber to permit the evacuation of the latter to prime the pump.

While the initial sealing may be effected with water or other liquid, the seals are maintained during the operation of the pump by the liquid handled by the pump. There is no necessity, therefore, for a special supply of sealing fluid.

A priming pump driven by the pump motor through the impeller of the latter primes the pump and establishes the seals. The pump motor may be controlled by any automatic or remote control device, such as a float switch, pressure switch, time clock or supervisory control system. When the pump has been sealed and primed, the priming pump is stopped automatically.

Since the pump impeller is designed with a substantial clearance from the casing at all points, the pump may be run dry without any injury whatever. The normal procedure in starting the pump, in fact, is to drive the impeller and to supply water to the sealing channels. The pump casing, being thus sealed against atmosphere, may be exhausted for priming. The liquid in the sealing chambers is retained for long periods but any loss is made up immediately by resupply from the interior of the pump casing.

The pump construction, to be described in greater detail hereinafter, is characterized by extreme simplicity. The entire pump consists of only a very few parts. The construction is also very compact, which is a special advantage where acid fluids are to be handled, because it requires a smaller amount of the more costly acid resisting metals. The simplicity of the design makes it easy to cast the pump of these metals, most of which are difficult both to cast and to machine.

Since the pump impeller is supported entirely on the shaft of a standard driving motor, and since there is no contact between the impeller and the casing, no close machining is necessary and wearing rings, packing glands, stuffing boxes and the like are entirely avoided. The motor shaft, in addition, is entirely enclosed by the impeller hub, and is, therefore, protected from contact with the fluid traversing the pump which, if acid bearing, would, of course, immediately deteriorate the steel shaft of the motor.

There is no possibility, furthermore, of mechanical wear due to solid material suspended

in the liquid handled by the pump. Even if the liquid contains a high percentage of solids, it serves just as well for sealing purposes as pure water. Other liquids than water will also serve the same purpose.

Other advantages of the construction disclosed will be apparent. The impeller requires no separate shaft or special coupling. Accurate alinement of the motor shaft and the pump impeller is not necessary, and the close coupling of the pump and motor permits the use of a unitary base of short length and great rigidity. Since there are no bearings, no bearing cooling system is necessary and no injury can result to the pump from its running dry.

For a thorough understanding of the invention, reference is made to the accompanying drawings, illustrating a present preferred embodiment.

In the drawings—

Figure 1 is an end view of the pump, the end wall thereof being partly broken away, exposing the free end of the pump impeller;

Figure 2 is a sectional view, taken along the line II—II of Figure 1; in Figure 2, the line I—I indicates the plane along which the end wall of the pump casing is broken away;

Figure 3 is a side elevation of the pump showing its association with a driving motor of standard design;

Figure 4 is an end view of the pump with the automatic priming and sealing mechaninsm connected therewith;

Figure 5 is a top plan view of the structure shown n Figure 4;

Figure 6 is a side view of the same structure with certain parts omitted for the sake of clearness;

Figure 7 is a partial sectional view illustrating a modified form of sealing disc; and

Figure 8 is a view similar to Figure 7, showing a further modified form.

Referring in detail to the drawings and, for the present to Figures 1 through 3 showing the pump apart from the automatic priming mechanism, the pump casing, indicated at 10, is composed of an upper portion 11 and a lower portion 12, each provided with a flange 13 by which said portions are adapted to be bolted together. The pump inlet is shown at 14 and is divided into passages 15, communicating with the inlet chambers 16 within the casing.

The inlet chambers 16 communicate with the impeller chamber 17, which opens into the discharge chamber 18. The discharge chamber 18 communicates with a discharge port 19. In addition to the inlet discharge and impeller chambers, the pump casing is provided with sealing channels 20 and 21 and also with collecting grooves 22.

The pump impeller is illustrated at 23 and comprises a hub 24 having blades 25 cast integral therewith. The hub 24 is bored out to receive the shaft 26 of a standard motor, which forms the sole support for the impeller. The impeller is pressed on and keyed to the shaft 26 and further secured thereto by means of a stud bolt 27 and a washer 28. A flanged sleeve 29 surrounds the shaft 26 at the motor end of the pump. The hub 24 of the impeller, together with the sleeve 29, protects the shaft 26 from any contact whatever with the fluid traversing the pump. Collecting rings 30 are formed on the hub 24 to cooperate with the grooves 22. If fluid tends to run along the hub, it is thrown off by the rings 30 into grooves 22 which drain into the sealing channels 20 and 21.

Sealing discs 31 and 32 are keyed to the hub 24 in such positions that they extend into the sealing channels 20 and 21. Each disc is provided with blades 33 on the outside thereof and blades 34 on the inside. It will be noted that the blades 34 are shorter than the blades 33. The function of the blades, of course, is to whirl the water supply in the channels 20 and 21 so as to establish a centrifugal seal which cuts off the inlet chambers 16 from communication with the atmosphere through the openings in the ends of the pump casing. Since the blades 33 are longer than the blades 34, there is no leakage or splashing out of the end openings of the casing and any excess sealing fluid is forced into the inlet chambers.

It will be noted that the impeller 23 has a substantial overall clearance with respect to the pump casing at all points. All close fits are eliminated, as well as wearing rings, stuffing boxes, packing glands, and the like. The impeller is entirely free from mechanical friction and wear and all the maintenance difficulties characterizing packing glands and the like are entirely done away with. The pump is thus well adapted for the handling of liquids containing a high percentage of suspended solids, since there is no chance for abrasive materials to cause any damage because of close clearances.

On the top half 11 of the pump casing 10, ports 35 and 36 are provided for introducing sealing fluid initially into the channels 20 and 21. The ports 35 and 36 are normally closed by plugs. Pipes having manual valves may also be used to supply sealing water. A sealing water reservoir 38 on the casing member 11 has ports 39 communicating with the same passages as the ports 35 and 36. A port 40 communicates with the interior of the casing to permit the latter to be evacuated to prime the pump. A valved priming conduit (not shown in Figure 1) is connected to the port 40.

The operation of the pump may be briefly outlined as follows: The driving motor illustrated at 38' is first started to spin the impeller 23. Water is then supplied to the sealing channels 20 and 21 through the ports 35 and 36, or through the ports 39. This water is immediately whirled in the channels by means of the paddles 33 and 34, on the sealing discs 31 and 32. Because of the greater length of the blades 33, the centrifugal pressure on the water in the outer half of the channels is greater than that on the water in the inner half thereof. These pressures, however, immediately establish a condition of equilibrium under which the depth of the water in the channels is greater on the inside of the discs than on the outside. The pump is now ready to be primed, assuming that the inlet port 14 has been connected to a source of water or other fluid to be handled. The pump is primed by evacuating the casing thereof through the port 40. Water is thus drawn into the inlet 14 and into the chambers 16, whence it flows into the impeller and is forced out through the discharge chamber 18 and the port 19. As the pump casing is evacuated, the atmospheric pressure on the exterior thereof, of course, affects the level of water in the sealing channels 20 and 21. These channels are, of course, designed to preserve the seal under full atmospheric pressure at the rated speed of the impeller.

While the pump is in operation, any evapora-

tion of water in the sealing channels is made up by resupply from the inner portions of the pump casing. The collecting rings 30 prevent water from leaking along the impeller hub beyond the collecting grooves 22, which return such leakage to the sealing chambers. Loss of sealing water into the pump while priming is thus precluded. The flow of water from the inlet chambers through the grooves 22 into the channels 20 and 21, however, is not prevented. An ample supply of water in the sealing channels is thereby continuously maintained.

It is necessary that the sealing discs be provided with blades on both sides; otherwise it would be impossible to start the pump. If the discs are bladed only on the outer side, the centrifugal force of the water on the outer portions of the channels is unbalanced by any corresponding force on the water on the inside of the disc. The water in the channel would thus be forced around the disc and the seal would be broken. If only the inside of the discs are bladed, the sealing water would be forced into the outer portion of the channel and through the end of the casing, before the evacuation of the pump casing would permit atmospheric pressure to come into play to maintain the sealing fluid in the channels. With blades only on the outside of the discs, obviously atmospheric pressure would aid the centrifugal effect in forcing the fluid out of the sealing channels. By providing blades on both sides of the discs, the water in the channels is maintained under conditions of equilibrium until the pump casing is primed. This produces a slight shift in the equilibrium condition but does not destroy the seal.

The automatic priming and sealing mechanism is illustrated in Figures 4 through 6 showing a pump identical with that illustrated in Figures 1 through 3, the parts of which are indicated by corresponding reference numerals. The automatic priming and sealing mechanism is, for the most part, supported on a plate 41 bolted to the flange 13 of the lower half 12 of the pump casing. A bracket 42 on the plate 41 carries a hinge 43 on which an auxiliary supporting plate 44 is pivotally supported from the plate 41. An oil-sealed, rotary vacuum pump 45, for evacuating the pump casing for priming, is mounted on the plate 44. A grooved friction pulley 46 on the shaft of the priming pump 45 engages a similar pulley 47, having a hub pressed into the end of the hub of the impeller 23. The impeller is secured to the motor shaft 26 by a keyed, frictional fit, and by means of a stud bolt 48 corresponding to that shown at 27 in Figures 1 and 2.

The oil circulating system of the priming pump 45 includes an inlet conduit 49 extending from a reservoir 50 to the pump inlet 51 and conduit 52 extending from the pump outlet 53 to the top of the reservoir 50. The reservoir 50 is also supported on the plate 44. A hose 50*a* permits the discharge of any water accumulating within the reservoir 50 into the chamber 38 on the pump casing. When the main pump impeller is at rest, the plate 44 is in the illustrated position and the pulley 46 is urged into frictional engagement with the pulley 47 by the weight of the pump 45 and the reservoir 50.

Sealing water for the channels 20 and 21 is obtained from any suitable source and is conducted through a conduit 54 to a valve 55. The conduit 54 may be connected, however, for example, to the discharge line from the main pump beyond the usual check valve. The valve 55 has a piston 56 controlled by a diaphragm 57 in a chamber 58. The chamber 58 is supported from the plate 41 on columns 58*a*. A conduit 59 conducts the sealing water from the valve 55 to the chamber 38 on the upper casing member 11. A T 60 at the end of the conduit 59 insures the distribution of sealing fluid on the two sides of the chamber 38. From the chamber 38, the sealing water flows through the ports 39 into the sealing channels 20 and 21. A spring 61 within the chamber 58 tends to maintain the piston 56 of the valve 55 in its closed position.

A flexible hose 62 extends from the inlet 51 of the priming pump 45 to a T fitting 63. The fitting 63 is connected to a check valve 64. The check valve 64, in turn, is connected to a water-surge arrester 65 through a fitting 66. The water-surge arrester 65 comprises a cylinder with a float valve 67 movable therein. The arrester has a tapered threaded end 68 so that it can be threaded into the priming port 40 of the main pump casing. The check valve 64 maintains the vacuum established by the priming pump in the main pump casing and prevents the suction of oil from the priming system into the main pump. It is spring-loaded so that the initial effect of the pump 45 is to create a vacuum in the hose 62 and the T 63. The water-surge arrester 65 prevents the flow of water into the priming system from the pump casing.

A conduit 69 extends from the chamber 58, enclosing the diaphragm 57 for operating the valve 55, to the T 63. As previously explained, the main pump impeller may be driven even though the pump casing is dry, and this is the usual method of starting the pump. The pump motor may be started by any suitable control device as above pointed out. The priming pump 45, of course, is driven as soon as the pump motor starts, because of the engagement between the friction pulleys 46 and 47. As the priming pump creates a vacuum in the hose 62, the valve 55 is opened by the reduction in pressure on the diaphragm 57. Because of the spring loading on the check valve 64, the priming pump is not initially effective to exhaust the pump casing. The latter cannot be accomplished until the inlet seals have been established.

On the opening of the valve 55, sealing water flows through the conduits 54 and 59 and into the sealing channels through the ports 39. As the sealing water is admitted, it is whirled to constitute centrifugal seals for the inlet chambers of the pump. When the seals have been established, the priming pump 45 is effective, on further operation, to open the check valve 64 and to exhaust the pump casing through the water-surge arrester 65. After the pump has been primed and sealed, there is no longer any need for the operation of the priming pump 45. I provide automatic mechanism, therefore, for raising the plate 44 so that the pulley 46 no longer engages the pulley 47.

The means for operating the plate 44 includes a pressure-operated diaphragm 70 in a chamber 71. The chamber 71 has legs 71*a* secured to the under side of the plate 41. A piston 72 secured to the diaphragm 70 extends upwardly through a hole in the plate 41 and, on movement of the diaphragm, is adapted to engage an adjustable screw 73 threaded through the end of the plate 44 opposite the hinge 43.

A conduit 74 extends from the upper portion of the chamber 71 to the water-surge arrester 65. A conduit 75 extends from the lower portion

of the chamber 71 to a point 75a on the intake side of the pump with which it makes connection. This point should be chosen so that the difference in vacuum between it and a point within the pump casing is about 2 inches of mercury. This difference in vacuum exists, after the pump has been primed, because of the resistance encountered by the water, such as that due to the reducer 75b, between the point 75a in the intake and the pump casing itself, as well as the difference in elevation between the two points.

As long as the pump is being primed, the priming pump creates a vacuum within the pump casing and intake which is communicated equally to both sides of the diaphragm 70 by the conduits 74 and 75. The piston 72, therefore, remains in its lower position as shown in Figure 4. In other words, there is no difference in vacuum between the point 75a on the intake at which the conduit 75 is connected, and the interior of the pump casing, as long as air only is being drawn therethrough, because all portions of the pump and intake are in communication and at the same pressure. As soon as water is drawn into the intake, and fills the casing, however, the before-mentioned difference in vacuum between the point on the intake and the casing manifests itself.

Because of the higher vacuum within the pump casing, which is necessary to draw the water through the intake and up to the casing, the diaphragm 70 is lifted and the piston 72 thereof engages the screw 73 to raise the plate 44 on its hinge 43. The engagement between the pulleys 46 and 47 is thereby broken and the priming pump stops operating. When the priming pump 45 stops, the spring 61 closes the valve 55 to cut off the supply of sealing water from outside the main pump. The seals are maintained, however, from the main pump inlets. The priming pump is maintained inoperative as long as the main pump is fully primed for handling the normal volume of water. If the flow of water through the main pump is reduced, however, as, for example, by strangling the suction line, or in case the motor speed is reduced by some reason, the pressure equality will tend to be reestablished for permitting engagement of the priming pump pulley with its driving pulley, to re-prime the main pump. When the main pump loses its vacuum in stopping, the equalization of pressure in both sides of the diaphragm 70 permits the hinged plate 44 to drop so that engagement between the pulleys 46 and 47 is restored for a repetition of the operating cycle. Thus if the main pump loses its vacuum, for any reason, while operating, the priming pump will operate, as in starting, to restore the vacuum.

Figure 7 illustrates a slightly modified form of sealing disc in which the blades on both sides of the disc are of the same length. This type of sealing disc has been found satisfactory in operation. The form of disc shown in Figure 2, however, is preferred because it prevents the sealing water from dribbling out of the seals under low-suction lifts and during the process of priming the pump when the seals are in operation.

Figure 8 illustrates a further modified form of sealing disc in which the blades on the outside are wider than those on the inside. The inside blades, furthermore, are cut back from the hub, rather from the periphery of the disc as in the modification of Figure 2. The sealing disc shown in Figure 8 furnishes more storage space for sealing water when the pump is stopped and therefore allows it to be primed on low-suction lifts with little or no additional sealing water. The blades being cut back from the hub, rather than from the periphery of the disc, accomplish practically the same result as the reverse arrangement shown in Figure 2. In the modification of Figure 8, however, the effectiveness is increased because the blades take immediate action on the water standing in the seal chambers when the pump is started. The form of disc shown in Figure 8 thus utilizes to better advantage the water remaining in the sealing channels when the pump is idle and permits the use of a smaller diameter channel and disc to accomplish the same results.

The advantages resulting from the construction described herein have been briefly adverted to previously. Some of these warrant consideration through emphasis and repetition, especially the fact that the design and construction of the pump is of the utmost simplicity, consisting of only three parts which can be assembled very readily by unskilled labor, without any necessity for special tools or equipment. By using centrifugal seals on the inlet side of the pump only, the excessive power consumption of such seals on the discharge side is avoided and the efficiency is maintained at a high value. Since there are no close mechanical clearances, the necessity for accurate machining is eliminated and all friction and wear obviated. The use of centrifugal seals makes it possible to dispense with packing glands, stuffing boxes, and the like. The impeller does not require a separate shaft, coupling, or bearings, and the motor shaft, which is the sole support of the impeller, is entirely protected from contact with the fluid traversing the pump. The operation of the pump does not require any particular skill, and none of the maintenance problems heretofore experienced are met with.

The automatic priming and sealing mechanisms, furthermore, is effective on the starting of the pump impeller to supply sealing fluid to the sealing channels of the pump and, subsequently, to prime the pump casing, after which the priming motor and mechanism are rendered inoperative as long as the normal operation of the main pump continues. This automatic mechanism makes it unnecessary to provide an attendant for operating the pump. All of the starting steps are carried out automatically. As soon as the priming pump is stopped, the external supply of sealing water is cut off. When the main pump stops, the priming pump is restored to operative position for a repetition of the starting steps. The priming pump is of well known construction and has not, therefore, been described in detail.

The check valve 64 prevents the main pump from pulling oil from the priming system. The water-surge arrester prevents water from flowing into the priming system, but in case water accumulates in the oil of the latter, this accumulated water is discharged by the conduit 50a. The entire priming mechanism is mounted as a unit on the lower half of the main pump casing so that the upper half of the casing can be readily removed by breaking a few simple connections. This makes it possible to mount the priming unit on pumps already in service without requiring any special base plate, although the latter can be provided in pumps in which the primer is incorporated when building.

Although I have described the pump as handling water, experience has shown that it will function satisfactorily for many different types of liquids, including those in which a large percentage of solids are suspended. The pump is,

therefore, particularly adapted for use in mines, coal washeries, and the like. The practical difficulties in the way of utilizing centrifugal seals according to disclosures of prior patents have been entirely overcome and the tests which have been satisfactorily performed by the invention clearly demonstrate its practicability, utility and efficiency. As previously pointed out, the pump is adapted for handling fluids containing a high percentage of solids without injury to the parts because of the wide running clearances provided. The liquid handled by the pump, whatever its nature, provides the material for establishing the suction seals. A pump having an open type impeller has been described, but it will be apparent that the invention is also applicable to pumps with closed type impellers.

Although I have described herein but a single preferred embodiment of the invention, it will be apparent that many changes in the details of the construction disclosed may be made without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. In a centrifugal pump having a casing and an impeller and impeller hub rotatable therein, a centrifugal fluid seal for the inlet chamber in said casing, including a channel in the casing and a disc on the impeller hub projecting therein, and having paddles on both faces.

2. In a centrifugal pump having a casing and an impeller and impeller hub rotatable therein, a centrifugal fluid seal for the inlet chamber in said casing, collecting rings and grooves on said impeller hub and in said casing, respectively, on both sides of said seal, said grooves being drained into said seal.

3. In a centrifugal pump, an impeller having laterally extending hubs provided with sealing discs having paddles on both sides, and collecting rings on said impeller hubs on both sides of said discs.

4. In a centrifugal pump a casing, an impeller therein having integral laterally extending hubs for surrounding the shaft of a driving motor and protecting it from contact with the fluid traversing said pump, and centrifugal sealing discs on said hubs.

5. The combination with a centrifugal seal, of collecting grooves on either side thereof for returning fluid to said seal and for supplying fluid to maintain the seal.

6. In a centrifugal pump, a casing having a plurality of inlet chambers and a discharge chamber, an impeller in said casing, and centrifugal seals for the inlet chambers only, for precluding the admission of air to said inlet chambers between said casing and impeller.

7. In a pump having a casing and an impeller and impeller hub therein, a centrifugal seal including a channel in the pump casing, a disc on the impeller hub running in said channel and a collecting ring on the impeller hub cooperating with a groove in the casing draining into said channel.

8. In a centrifugal pump, a casing having inlet and discharge chambers, an impeller rotatable in said casing, a centrifugal seal for said inlet chamber, a port in said casing communicating with said inlet chamber and means for priming the pump after the seal has been established by driving said impeller.

9. In a centrifugal pump, a casing with inlet and discharge chambers, an impeller rotatable in said casing, centrifugal seals between the impeller and casing for the inlet chamber, means for introducing fluid into said seals, and means for priming the pump by evacuating said inlet chamber after the seals have been established by rotation of the impeller.

10. In a centrifugal pump, a casing, an impeller rotatable therein but free from contact therewith, fluid seals between the impeller and the casing whereby the impeller may be driven while the casing is dry, means for introducing sealing fluid to said seals, and means for the priming of the pump after the establishment of said seals by rotation of said impeller.

11. The combination with a main centrifugal pump having centrifugal seals, of a priming pump, means for driving the priming pump from the main pump, means responsive to the initial vacuum created by the priming pump for supplying fluid to the main pump sealing channels, and means responsive to the priming of the main pump by said priming pump for rendering the priming pump driving means inoperative.

12. Automatic sealing and priming mechanism for a main centrifugal pump having centrifugal sealing channels, comprising a priming pump, driving means for the latter on the main pump, means responsive to the vacuum created initially by the priming pump for supplying fluid to said sealing channels, and means responsive to the vacuum of the priming pump, when the main pump has been primed, for disconnecting the priming pump from the main pump.

13. Priming and sealing mechanism for a centrifugal pump having centrifugal sealing channels therein, comprising a priming pump movably mounted for driving engagement with the main pump, a diaphragm means responsive to the initial vacuum of said priming pump for supplying sealing fluid to said channels and a diaphragm means responsive to the difference in vacuum between a point on the intake side of the pump and a point in the pump casing, when the pump has been primed, for moving the priming pump out of driving relation to the main pump.

14. Priming and sealing mechanism for a centrifugal pump having centrifugal seals, comprising a priming pump movably mounted and having a pulley adapted to engage a pulley driven by the main pump, a vacuum line extending from the priming pump to the casing of the main pump, a spring-loaded check valve in said line, a spring-closed diaphragm valve responsive to the vacuum in said line on the priming pump side of said check valve, for supplying sealing water to the channels of the main pump on the initial operation of said priming pump.

15. Priming and sealing mechanism for a centrifugal pump having centrifugal seals, comprising a priming pump movably mounted and having a pulley adapted to engage a pulley driven by the main pump, a vacuum line extending from the priming pump to the casing of the main pump, a spring-loaded check valve in said line, a spring-closed diaphragm valve responsive to the vacuum in said line on the priming pump side of said check valve for supplying sealing water to the channels of the main pump on the initial operation of said priming pump, and means responsive to the difference in vacuum at a point on the intake side of the pump and a point in the pump casing, when the latter has been primed by further operation of the priming pump, for moving the priming pump to break the engagement between said pulleys.

16. The combination with a centrifugal pump

having centrifugal seals, of a priming pump movably mounted thereon so as to be driven thereby, means responsive to the initial operation of the priming pump for supplying sealing fluid to said centrifugal seals, and means actuated in response to the priming of the centrifugal pump by said priming pump for moving the priming pump out of driving relation to the centrifugal pump.

17. In a centrifugal pump, the combination with a closed casing including annular inlet and discharge members, of an impeller having a laterally extending integral hub for receiving the shaft of a driving motor and protecting it from contact with the liquid passing through said pump, said pump casing having sealing channels formed therein adjacent its ends, and said impeller hub having sealing discs thereon at each end provided with paddles on both sides thereof, for entering said channels to whirl fluid supplied thereto from the inlet chamber and forming a seal between said hub and casing to exclude air from the latter.

18. In a centrifugal pump, the combination with a two piece closed casing split horizontally, of an open-type impeller having a hub for engaging the shaft of a driving motor, said casing having sealing channels formed therein, and sealing discs on said impeller hub cooperating with said channels, and having paddles on both sides thereof, to seal the clearance between the hub and casing.

19. In a fluid seal for excluding atmosphere from closed pump casings, the combination with a sealing channel at each end of the pump casing, of an impeller having an integral hub, a disc on the impeller hub rotatable therewith, said disc having paddles on both sides, and said casing having an inlet passage between said channels.

20. A centrifugal pump having a casing and an impeller and impeller hub, an annular inlet chamber in said casing, one seal only between the casing and impeller on each side of said chamber, each seal comprising a sealing recess in the casing and a sealing disc on said impeller hub, with paddles on both sides, projecting thereinto.

21. A centrifugal pump having a casing and an impeller and impeller hub, only two seals therebetween, one at each end of the impeller, each seal comprising a sealing channel in the casing, a sealing disc on the impeller hub extending into said channel, said disc having paddles on both sides thereof.

22. In a centrifugal pump having a casing, an inlet chamber, an impeller and impeller hub, one liquid seal only for each end of the pump casing, each seal comprising a sealing channel in the casing, a sealing disc on the impeller hub extending into said channel, and paddles on both sides of said disc, the paddles on one side of the disc being longer than those on the other.

23. The combination with a centrifugal pump having centrifugal fluid seals, of means responsive to the starting of said pump for automatically admitting fluid to said seals.

24. The combination with a centrifugal pump having a casing, an inlet chamber therein, and channels in said casing for forming centrifugal seals, of grooves connecting said inlet chamber and said channels for supplying fluid from the former to the latter.

25. A centrifugal pump comprising a casing providing an impeller chamber, an impeller rotatable in the chamber, an impeller hub, the impeller and hub being spaced from the casing so that they may be rotated while the casing is dry and providing an air passage between the impeller chamber and the outside of the pump, a sealing channel at each end of the pump casing, and a disc on the impeller hub rotatable therewith and cooperating with each channel, said disc having paddles on both sides.

26. In a fluid seal for excluding air from the inlet chamber of a centrifugal pump, the combination with a sealing channel in the pump casing, of an impeller having a hub, a disc on the hub rotatable therewith, said disc having paddles on both sides, the paddle on one side being longer than that on the other.

27. In a fluid seal for excluding air from the inlet chamber of a centrifugal pump, the combination with a sealing channel in the pump casing, of an impeller having a hub, a disc on the hub rotatable therewith, said disc having paddles on both sides, the paddle on the air side of the disc being longer than that on the side adjacent the impeller chamber.

28. In a fluid seal for excluding air from the inlet chamber of a centrifugal pump, the combination with a sealing channel in the pump casing, of an impeller having a hub, a disc on the hub rotatable therewith, said disc having paddles on both sides, the paddle on the air side of the disc being wider than that on the side adjacent the impeller chamber.

29. In a fluid seal for excluding air from the inlet chamber of a centrifugal pump, the combination with a sealing channel in the pump casing, of an impeller having a hub, a disc on the hub rotatable therewith, said disc having paddles on both sides, the paddle on the air side of the disc being longer and wider than that on the side adjacent the impeller chamber.

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