

Feb. 16, 1965

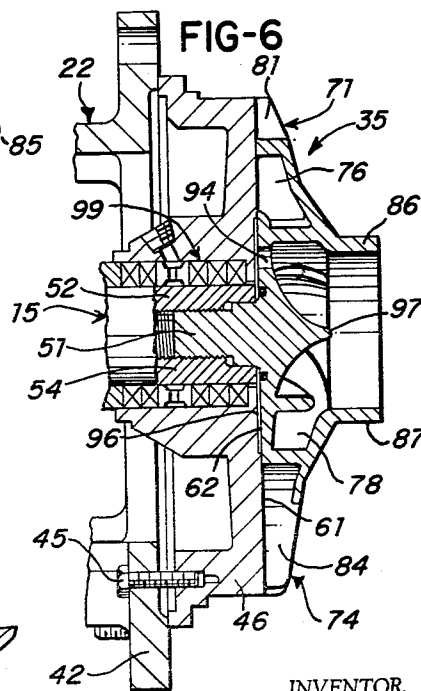
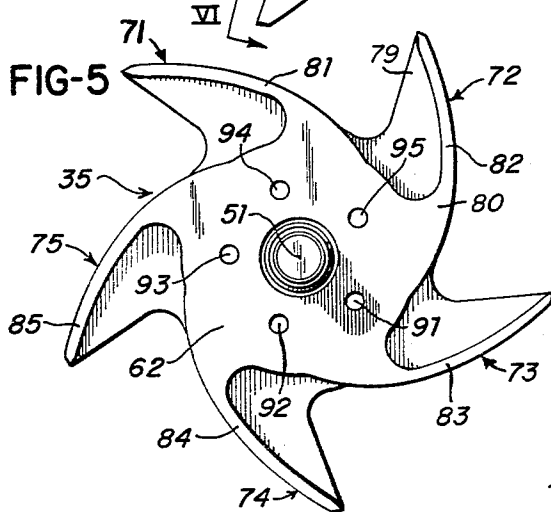
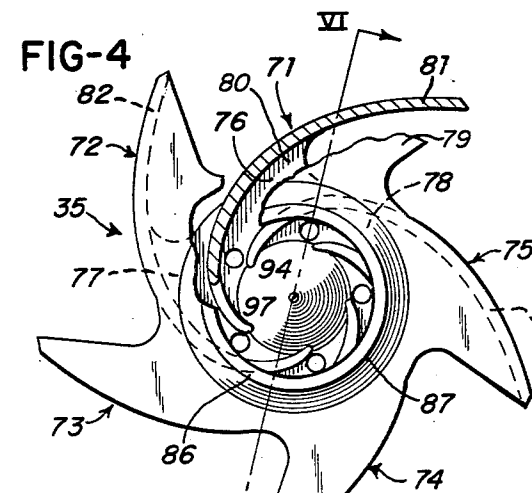
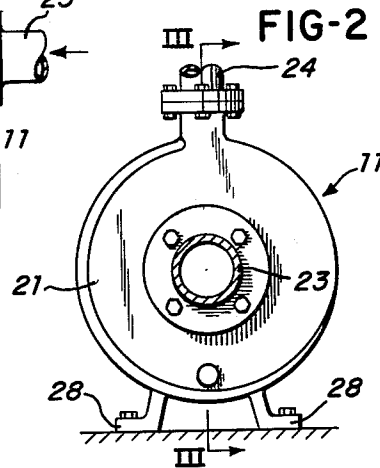
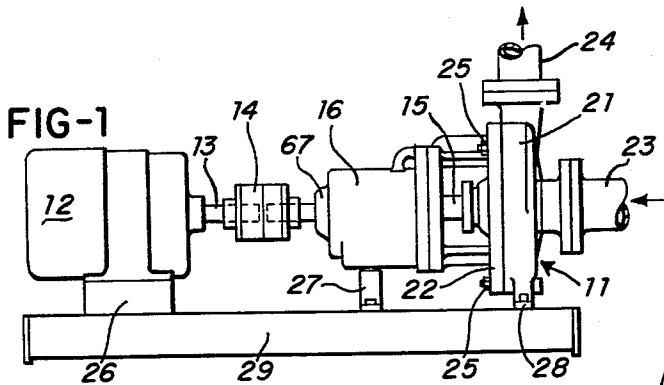
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3,169,486

PUMPS

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

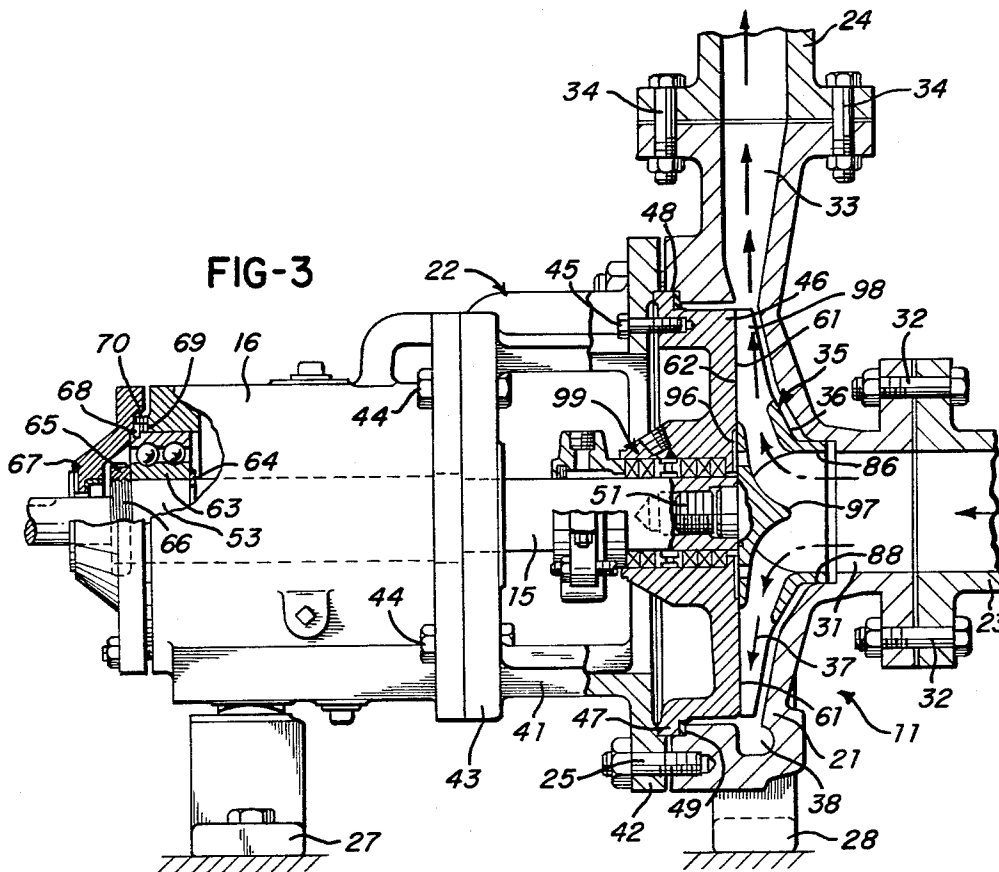
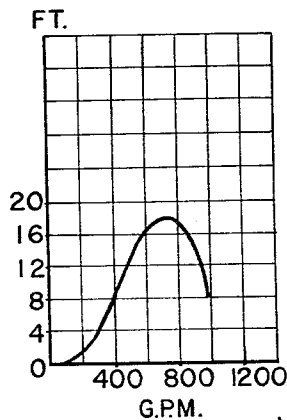
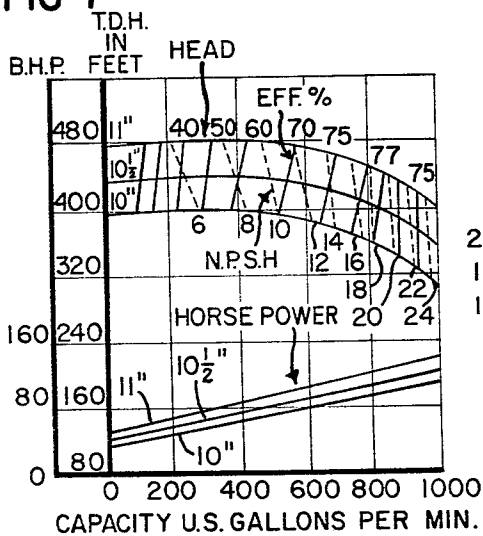


FIG-7



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3,169,486
PUMPS

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The invention disclosed in this application relates in general to pumps and in particular to centrifugal pumps for handling corrosive chemical fluids and the like.

Centrifugal pumps are usually of one of two types (i.e. either open type impeller or closed type impeller). Fully open impellers have somewhat lower efficiency and somewhat higher N.P.S.H. (net positive suction head) requirements than closed impellers. On the other hand fully closed impellers are subject to clogging difficulties and wear more than open impellers. However, the pump casing wears more with an open impeller. All of the previously designed open impellers are believed to be so designed that the working clearance between the impeller and the casing is set while the impeller is hidden within the casing.

One of the objects of the invention disclosed herein is the provision of a centrifugal pump having a partially open, partially closed impeller wherein the above described disadvantages of both the fully open type impeller and the fully closed type impeller are largely obviated.

A further object is the provision of a centrifugal pump having a close running semi-open and/or semi-closed impeller which is adjusted to a close fixed operating clearance relative to the cover plate and which is removable as a unit from the casing with the cover plate so that the clearance may be adjusted when necessary while the connections of the casing with the supply and discharge lines are undisturbed. An additional advantage of such an impeller which is adjusted to a fixed operating clearance relative to the cover plate and which is removable as a unit together with the cover plate is the ability provided thereby to adjust or correct the operating clearance of the impeller relative to the cover plate where both parts may be seen instead of in the blind.

A further object is the provision of a pump having only relatively small surfaces requiring machining.

One of the features of the invention is the provision of a pump for handling corrosive chemical fluids in which all surfaces of the pump which might be exposed to corrosive attack by the chemical fluids are formed of a corrosion resistant alloy.

Another feature of the invention is the provision of openings or holes through the impeller so that operation of the impeller applies essentially suction pressure to the stuffing box through which the operating shaft extends and so that corrosive liquids are not driven toward the stuffing box and leakage of such liquids through the stuffing box is prevented or minimized.

Other objects, advantages, and features of the invention will be apparent from the following description, the accompanying drawings, and the appended claims.

In the drawings:

FIG. 1 is a view in side elevation of a pump constructed according to the invention, shown assembled with a drive motor and a coupling unit and with supply and discharge lines, said supply and discharge lines being partially broken away;

FIG. 2 is a view in front end elevation of the structure shown in FIG. 1 (i.e. looking from the right in FIG. 1), the supply and discharge lines being broken away and shown partially in section and the structure being shown on a slightly larger scale than in FIG. 1;

FIG. 3 is a fragmentary view partially in side elevation

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of a portion of the structure shown in FIGS. 1 and 2, shown on a larger scale even than FIG. 2 and having portions broken away and portions shown in a vertical section taken substantially on the line III—III of FIG. 2, the impeller, however, being shown diagrammatically merely to illustrate the flow of the liquid through the pump;

FIG. 4 is a fragmentary view of the impeller, shown largely in elevation but having parts broken away and parts shown in section and shown as if looking at the impeller from the front or inlet side of the pump (i.e. from the right as shown in FIGS. 1 and 3);

FIG. 5 is a view in rear elevation of the impeller looking at the impeller from the rear cover of the pump (i.e. from the left as shown in FIGS. 1 and 3);

FIG. 6 is a sectional view through the impeller taken substantially on the line VI—VI of FIG. 4; and

FIG. 7 is a graph showing the efficiency, the N.P.S.H., and the stuffing box pressure of a pump constructed according to the invention under each of several operating conditions.

The drawings illustrate a preferred embodiment of the invention. Referring thereto for a detailed description of the embodiment, it may be seen that in FIGS. 1 and 2, there is shown a pump 11, operated by a motor 12. The motor 12 is provided with a motor drive shaft 13 which is coupled by a coupling unit 14 to an impeller drive shaft 15. The impeller drive shaft 15 is supported by a bearing housing 16.

The pump 11 includes a casing 21 and a rear cover assembly 22. The casing 21 is connected to the inlet conduit 23 which constitutes a supply line and to the outlet conduit 24 which constitutes a discharge line. The rear cover assembly 22 is secured to the casing 21 as by studs and nuts 25. The motor 12, the bearing unit 16 and the casing 21 are individually supported by feet 26, 27 and 28 respectively which are each bolted to a fixed base such as 29.

Referring now to FIG. 3, it may be seen that the casing 21 is formed with an inlet 31 secured to the inlet conduit 23 by bolts 32 and is also formed with an outlet 33 secured to the outlet conduit 24 by bolts 34. The showing in FIG. 3 of the impeller 35 is not a true sectional view thereof but is largely diagrammatic. This showing is in order to illustrate the passage of liquid from the inlet conduit 23 through the inlet 31 and through the pump chamber 36 (which is formed in the body of the casing 21) and outward centrifugally therefrom as indicated by the arrows 37 to the annular space 38 and thence to the outlet 33 and the outlet conduit 24.

The rear cover assembly 22 includes the bearing housing adaptor or spider 41 which is provided integrally with a forward ring 42 secured by the studs and nuts 25 to the casing 21 and with a rearward ring 43 secured by bolts 44 to the bearing housing 16. Forward of the ring 42, a cover for the casing 21 sometimes hereinafter designated as rear cover plate 46 is secured to the ring 42 as for example by screws such as 45. The cover plate 46, which is a part of the rear cover assembly 22, has an annular shoulder 47 which seats in a well 48 at the rear of the casing 21. A complementary well in the forward face of the ring 42 also encloses the cover 46. Sealing the joint between well 48 in the casing 21 and shoulder 47 of the plate 46 is a gasket 49. The studs 25 clamp the cover 46 between the ring 42 and the casing 21 and clamp tightly the gasket 49 to insure a sure seal between the casing 21 and the cover 46.

The impeller 35 is one of the important features of the structure disclosed and its mounting, design, configuration, and arrangement are illustrated in FIGS. 3-6 inclusive. As stated above, the showing of its design and configuration in FIG. 3 is diagrammatic and not exactly true but

the mounting of said impeller 35 relative to the rear cover plate 46 is an important feature and is illustrated in FIGS. 3 and 6.

The impeller 35 is formed with a threaded concentric stub 51 which is secured in a threaded recess 52 in the drive shaft 15.

The forward face of the cover plate 46 is machined to a substantially flat smooth surface as at 61 and the rearward face of the impeller 35 is similarly machined to a substantially flat smooth surface as at 62 so that when these parts are adjusted close to each other without being in contact they are in a substantially sealing relationship. In order to adjust the impeller 35 relative to the plate 46, the impeller drive shaft 15 is adjusted relative to the bearing housing 16.

The impeller 35 is firmly secured to the front end of the shaft 15; and the bearing housing 16, the rear cover assembly 22 and the cover plate 46 are all secured fixedly to each other. The rear portion 53 of the shaft 15 is mounted in a double bearing 63 and is held against endwise movement relative to the bearing by the washer 64 and a lock nut 65 secured on threads 66 formed on said rear portion 53. The bearing 63 is positioned relative to the bearing housing 16 and its rear cover 67 of the housing by a circular key or washer 68 positioned in a slot in the outer face of bearing 63, by a plurality of gaskets 70, and by a plurality of shims 69. The addition of more shims 69 and/or gaskets 70 moves the bearing 63 and the shaft 15 and the impeller 35 rearwardly relative to the bearing housing 16, the adaptor 22 and the cover plate 46. Thus the impeller 35 may be moved closer to the cover plate 46 to compensate for wear on the rear face 62 of the impeller 35 or wear on the forward face 61 of the cover plate 46 or for the remachining of either or both of said faces 61 and 62 to resurface them after wear or to remove irregularities. Alternatively shims may be eliminated to increase the clearance between the faces should such action be necessary.

The impeller 35, as best shown in FIGS. 4, 5 and 6, is a partially open, partially closed impeller. It is formed with a plurality of vanes such as 71, 72, 73, 74 and 75. Each of these vanes has a curved internal closed passageway as for example the closed passageways defined between the vanes 71, 72 and 75 at 76, 77 and 78, respectively and the partial front shroud 79 (FIG. 4) and partial rear shroud 80 which cover only a portion of the passageway defined between the vanes. These partial shrouds inherently reduce the total axial thrust exerted on the impeller as a result of the hydraulic pressure within the pump. Each of the vanes 71-75 inclusive has a curved open blade such as the blades 81, 82, 83, 84 and 85, respectively. As stated above, the flat smoothly machined face 62 of the impeller 35 is adjusted close to the flat smoothly machined face 61 of the rear cover plate 46 so that the two are in substantially sealed proximity and relationship without contacting each other to obtain the maximum discharge pressure from the pump. Thus the blades 81, 82, 83, 84 and 85 cooperate with the cover or cover plate 46 to provide a continuation of the internal passageways defined between the vanes 71, 72, 73, 74 and 75 respectively. The impeller 35, when driven from the motor 12 through the shafts 13 and 15 provides centrifugal driving force for urging liquid coming to and through the curved internal passageways and outwardly through the continuations of the passageways formed by the blades 81-85 inclusive and the cover plate 46, to the annular space 38, the outlet 33, and the outlet conduit or discharge 24.

The impeller 35 is formed with a cylindrical hub 86 of which the outer surface 87 is closely machined. A portion of the inner surface of the inlet 31 has an interior cylindrical surface 88 which corresponds to the outer surface 87 of the hub 86. This also is smoothly machined. The hub 86 revolves in close proximity to surface 88, and the two machined surfaces form substantially a seal to pre-

vent the escape of liquid from the casing area or pump chamber 36 and from the annular space 38 to the inlet 31. Thus the rear face of the impeller at 62 is smoothly machined to a substantially sealing finish, the outer surface 87 of the hub 86 is similarly machined, the inner surface of the cylindrical portion 88 of the inlet 31 is similarly machined, and the inner face 61 of the cover 45 is similarly machined. Aside from these four surfaces, no close machining of any part of the casing 21, the cover 46, or the impeller 35 is required.

The impeller 35 is formed with a plurality of holes such as 91, 92, 93, 94 and 95 and the forward face of the cover 46 is formed with a recess 96 (see FIGS. 3 and 6) with which all of these holes communicate. Thereby the extremely low, substantially suction pressure usually existing in the pumping chamber 36 at about the center of the impeller 35, as for example at 97 is communicated to the recess 96 and prevents the high pressures which are built up outward of the impeller (as for example at 98 and as for example in the annular space 38 and the outlet 33) from being communicated to the stuffing box 99 (see FIG. 3). The back vane effect of the impeller 35 continually reduces the pressure in the stuffing box 99. The lower stuffing box pressures generally allow more positive stuffing box seals.

FIG. 7 is a reproduction of several graphs. The upper three curves show the efficiency, the net positive suction head, and the total dynamic head of the three pumps constructed according to the disclosure hereof corresponding to operation of the pumps at 3,500 r.p.m. for pumping water at various rates in gallons per minute. The three pumps all have identical casings which have pumping chambers having internal diameters of thirteen inches, inlet diameters of four inches and outlet diameters of three inches. The impeller diameter of one pump is ten inches (the lower curve of the upper three), of the second pump is ten and one half inches (the intermediate curve of the three) and of the third pump is eleven inches (the upper curve of the three).

The curve on the right shows the stuffing box pressures above total suction head for these three diameters corresponding to pumping water at various rates in gallons per minute. The three lines, at the bottom of the graph, show the brake horsepower requirements for pumping the indicated gallons of water per minute for the three diameters respectively.

The area of a cross section of the closed passageways varies from the center of impeller outward. Although the width of the passageways increases outwardly as appears in considering the showing of the passageway 76 in FIG. 4, yet because the thickness at right angles narrows outwardly as appears in considering passageway 76 in FIG. 6, the cross sectional area of each passageway is greatest adjacent the center of the impeller. This facilitates the handling of slurry and minimizes clogging.

The partially closed impeller of the present invention has greater efficiency and lower N.P.S.H. than corresponding fully open impellers. The pump casing wears much less than do casings where an open impeller has an operating clearance set relative to a wall of such casing. This point will be discussed further below. On the other hand, because the impeller is only partially closed, it is less subject to clogging difficulties than are corresponding fully closed impellers, and the impeller itself is less subject to wear than are corresponding fully closed impellers.

The front shroud 79 converging partially the curved internal closed passageways between the vanes 71, 72, 73, 74 and 75 protect the forward wall of casing 21 from abrasive action of the corrosive and gritty slurry handled by these pumps adjacent the center of the pump where the slurry is turning so that there is relatively little wear on the casing 21. What little wear there is, appears mainly on the face 61 of the cover plate 46 and on the impeller 35. Both of these parts may be removed and refinished

with relative ease as compared to refinishing the walls of the casing 21.

The impeller is spaced a relatively great distance from the forward wall of the casing 21. When heated liquids or slurries are being pumped, as for example, slurries having temperatures of 300° F. to 500° F., the heat tends to cause the shaft 15 to expand. This causes the impeller 35 to move towards the front of the chamber 36 but because of the wide spacing, the heat does not cause the impeller to move into contact with, rub at high speeds against, and wear the forward wall of the casing, as occurs especially in pumps (whether open or closed but especially in fully open pumps) where the impeller is set in close operating relationship relative to a wall (e.g. the front wall of the casing).

While the specific forms of apparatus herein described, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms and that changes may be made without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. An improved centrifugal pump for handling corrosive chemical fluids and the like adapted to be connected to fluid supply and discharge lines, comprising a casing defining a pump chamber and having a forward inlet portion including an internal cylindrical surface formed therein, a cover member connected to the rear of said casing and including a central hub portion for supporting a stuffing box and a flat inner surface defining the rear wall of said pumping chamber, a drive shaft extending through said hub and said stuffing box, bearing means rotatably supporting said shaft, a housing enclosing and retaining said bearing means and connected to said casing with said cover member spaced therebetween, a centrifugal impeller including a plurality of vanes defining passageways therebetween and spaced within said chamber and connected to said drive shaft, said impeller including an inlet hub defining an outer cylindrical surface spaced in close sealing relationship with said internal cylindrical surface of said casing to provide for axial adjustment and expansion of said impeller without changing the sealing clearance between said inlet hub and said casing, said impeller including a partial front shroud covering a portion of said passageways to minimize wear on said casing in addition to providing strength to said vanes and reducing the hydraulic thrust on the forward side of said impeller, said impeller also including a rear shroud covering only a portion of said passageways for reducing the hydraulic thrust on the rear side of said impeller, means for axially adjusting said drive shaft for spacing said rear shroud and vanes of said impeller in close sealing relationship with said flat inner surface of said cover to maintain maximum pressure, and means for removing as a unit said housing, cover, shaft and impeller from said casing to enable visual setting and adjustment of the closely spaced relationship between said impeller and said cover.

2. An improved centrifugal pump for handling corrosive chemical fluids and the like and adapted to be connected to fluid supply and discharge lines, comprising a casing defining a pump chamber and including a forward inlet portion having an internal cylindrical surface formed therein, a cover member connected to the rear of said casing and including a central tubular hub portion supporting a stuffing box and a flat inner surface defining the rear wall of said pumping chamber, a drive shaft extending through said hub and said stuffing box, bearing means rotatably supporting said shaft, a housing enclosing and retaining said bearing means and connected to said casing with said cover member spaced therebetween, a centrifugal

impeller having a plurality of vanes defining passageways therebetween and spaced within said chamber and connected to said drive shaft, said impeller including an inlet hub defining an outer cylindrical surface spaced in close sealing relationship with said internal cylindrical surface of said casing to provide for axial adjustment and expansion of said impeller without changing the sealing clearance between said inlet hub and said casing, said impeller including a partial front shroud covering a portion of said passageways to minimize wear on said casing in addition to providing strength to said vanes and reducing the hydraulic thrust on the forward side of said impeller, said impeller also including a partial rear shroud covering only a portion of said passageways for reducing the hydraulic thrust on the rear side of said impeller, said rear shroud having a series of openings formed therein for fluid communication with a recessed chamber formed within said cover to produce a suction on said stuffing box, means for adjustably spacing said rear shroud and vanes of said impeller in close sealing relationship with said flat inner surface of said cover to maintain maximum pressure, and means for removing as a unit said housing, cover, shaft and impeller from said casing to enable visual setting and adjustment of the closely spaced relationship between said impeller and said cover.

3. An improved centrifugal pump for handling corrosive chemical fluids and the like and adapted to be connected to fluid supply and discharge lines, comprising a casing defining a pump chamber and including a forward inlet portion having an internal cylindrical surface formed therein, a removable cover member connected to the rear of said casing and including a central hub portion and a flat inner surface defining the rear wall of said pumping chamber, a drive shaft extending through said hub portion, bearing means rotatably supporting said shaft, a housing enclosing and retaining said bearing means and connected to said casing with said cover member spaced therebetween, a centrifugal impeller having a plurality of vanes defining passageways therebetween and spaced within said chamber and connected to said drive shaft, said impeller including an inlet hub defining an outer cylindrical surface spaced in close sealing relationship with said internal cylindrical surface of said casing to provide for axial adjustment and expansion of said impeller without changing the sealing clearance between said inlet hub and said casing, said impeller including a rear shroud covering only a portion of said passageways for reducing the hydraulic thrust on the rear side of said impeller, means for adjustably spacing said rear shroud and vanes of said impeller in close sealing relationship with said flat inner surface of said cover to maintain maximum pressure, and means for removing as a unit said housing, cover, shaft and impeller from said casing to enable visual setting and adjustment of the closely spaced relationship between said impeller and said cover.

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