

United States Patent

Nichols

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[54] HIGH-PRESSURE CENTRIFUGAL PUMP

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[51] Int. Cl. F04d 29/00, F01d 11/00
[58] Field of Search 415/169, 122, 204, 206, 205,
415/203, 104, 105, 106, 112, 170 C

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[57] ABSTRACT

This centrifugal pump for high-pressure service has novel sealing means for preventing the fluid being pumped from reaching the bearings of the impeller shaft. The back of the impeller on the side opposite the pumping vanes has shallow vanes that run close to a confronting face of the pump housing for displacing leakage fluid back to the pump inlet. Leakage is maintained at a low value by a generally cylindrical portion on the back of the impeller running with close running clearance in a plastic sleeve in the backwall of the pump housing. The impeller shaft bearings are in a gear housing secured to the pump and have their own means of lubrication.

8 Claims, 7 Drawing Figures

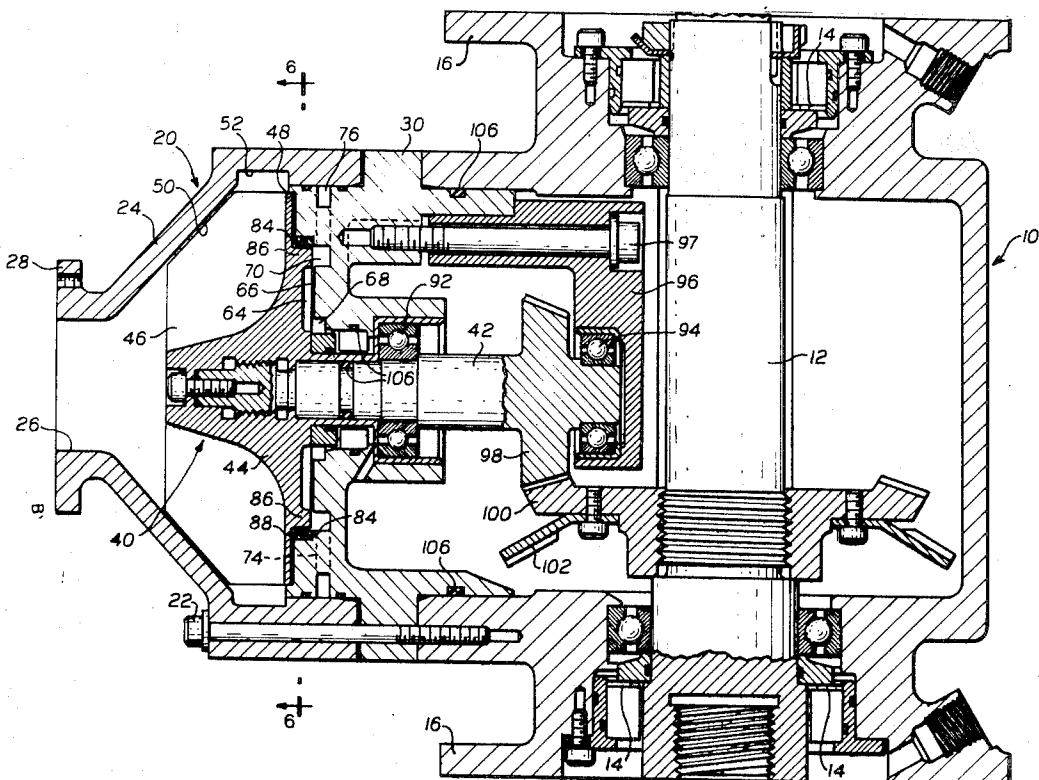


FIG. 1.

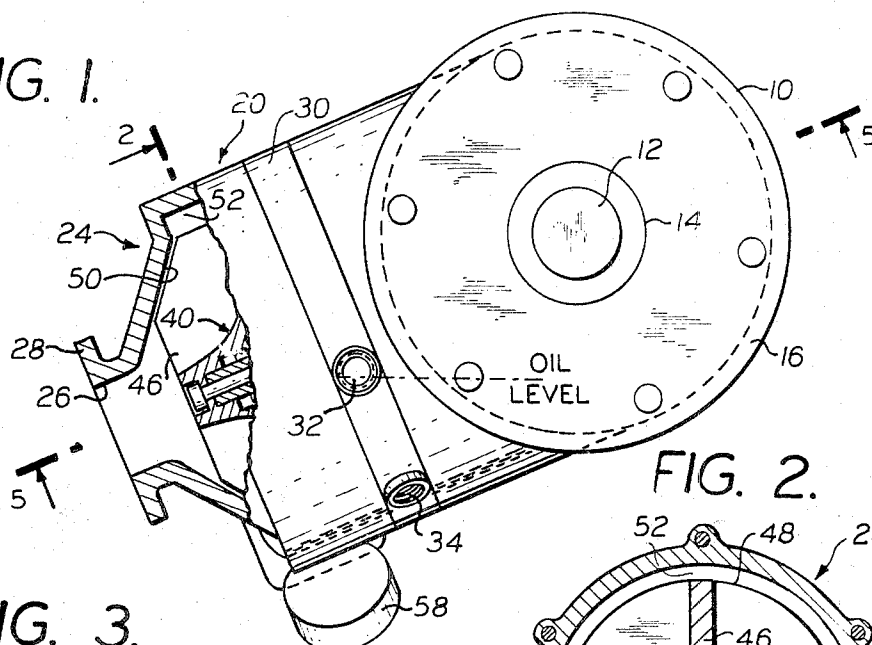


FIG. 2.

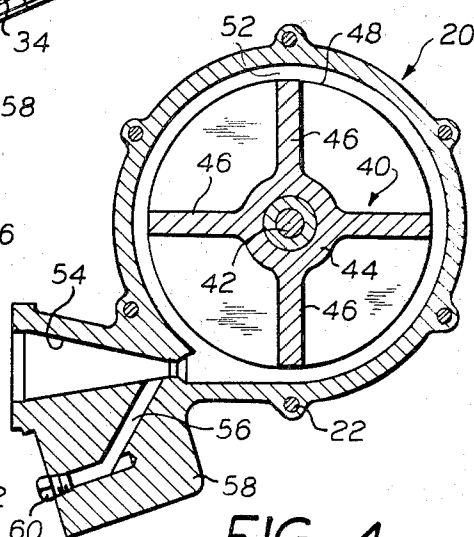


FIG. 3.

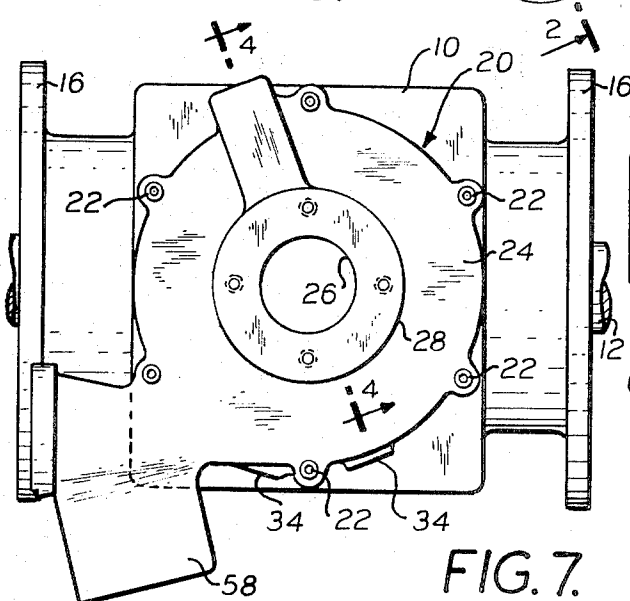


FIG. 4.

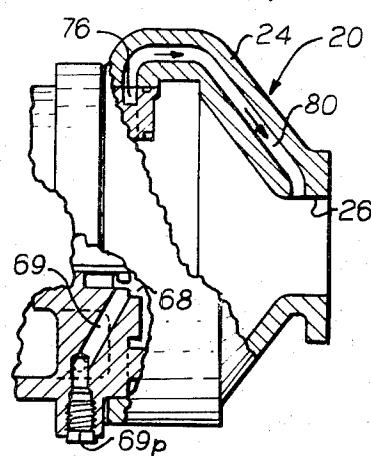


FIG. 6.

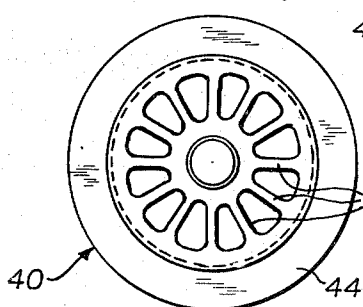
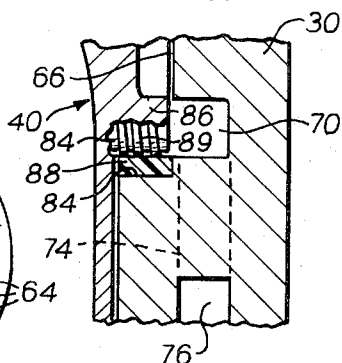
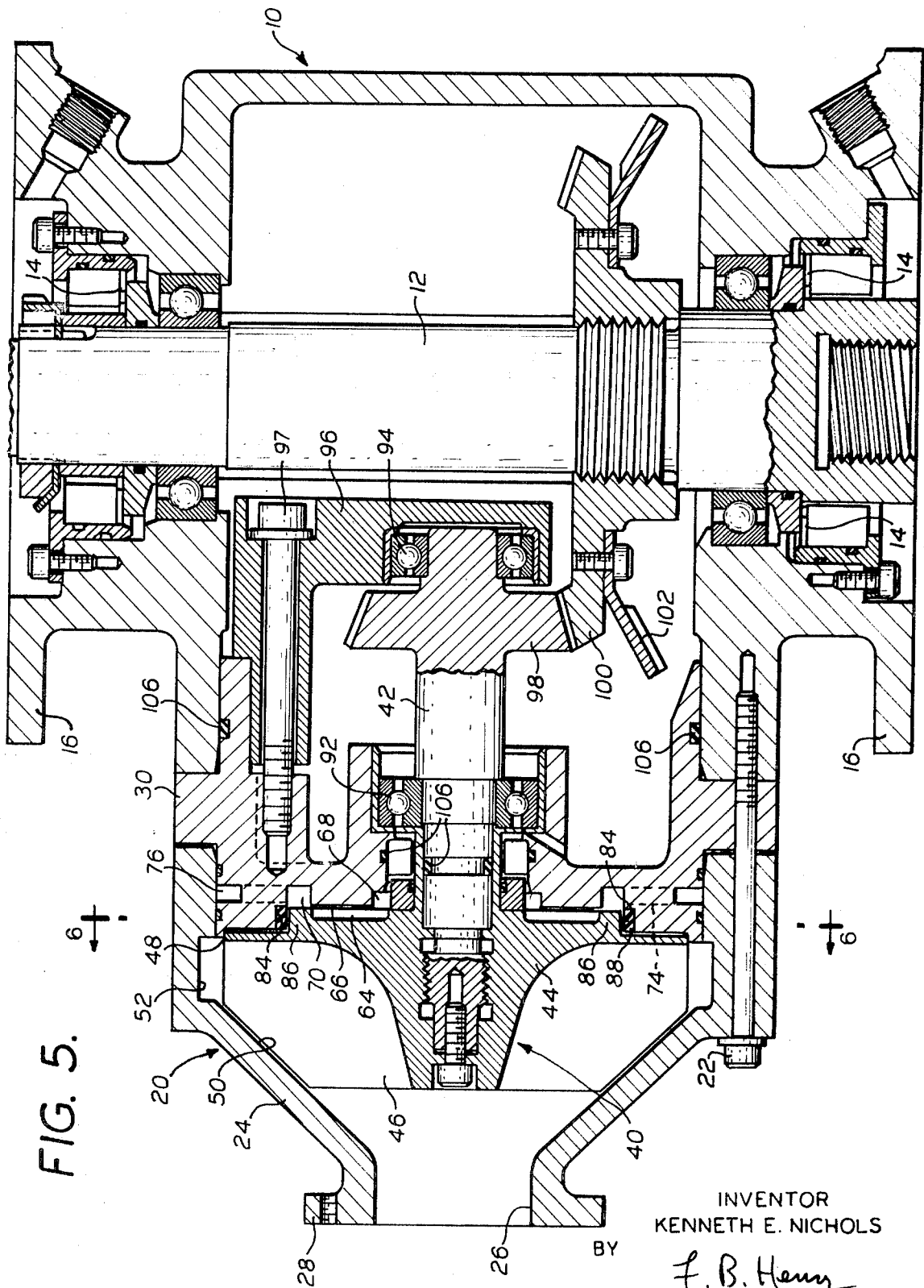


FIG. 7.



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HIGH-PRESSURE CENTRIFUGAL PUMP

RELATED PATENTS AND BACKGROUND OF THE INVENTION

High-pressure centrifugal pumps required some means for sealing the impeller shaft, and "dynamic seals," consisting of slinger discs have been used to force leakage fluid back to the impeller housing, as disclosed in U.S. Pat. No. 3,162,135. With the present invention, the back of the impeller itself performs the function of the slinger disc so that the disc can be omitted without omitting its function. This feature is combined with novel structure for reducing to a minimum the amount of leakage that occurs across the back of the impeller and the amount of fluid that has to be fed back to the pump inlet is very small.

SUMMARY OF THE INVENTION

The back face of a centrifugal pump impeller, i.e., the face opposite the impeller blades, runs with close clearance from the back of the pump housing. The back surface of the impeller is shaped to provide a generally cylindrical surface, preferably with threads on it, which extends into a recess in the confronting face of the backplate of the pump housing. In the preferred construction, this recess is lined with a sleeve made of plastic, such as polytetrafluoroethylene, with small running clearance. This construction reduces to a low value the amount of fluid that can leak around the impeller and inward toward the impeller drive shaft and bearings.

Vanes formed on the back surface of the impeller pump fluid back toward the periphery of the impeller, and by locating these vanes inward of the cylindrical seal of the impeller, the amount of leakage fluid to be pumped is kept to a minimum. These vanes on the back of the impeller do not force the fluid back through the cylindrical clearance, but displace it into a chamber, preferably annular, that communicates with another chamber communicating with the pump inlet passage.

The preferred embodiment of the invention has the pump combined with driving means including a power takeoff with a gear box that contains the bearings for the pump impeller shaft, and these bearings are lubricated by the same means that provide lubrication for the gears in the gear box. The invention keeps the fluid which is being pumped from entering and contaminating the lubricant in the gear box.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

FIG. 1 is a side elevation, partly broken away and in section, showing a centrifugal pump made in accordance with this invention;

FIG. 2 is a sectional view taken on the line 2—2 of FIG. 1;

FIG. 3 is an end elevation of the left-hand end of the pump shown in FIG. 1;

FIG. 4 is a fragmentary view, partly in section, along with line 4—4 of FIG. 3;

FIG. 5 is a sectional view taken on the line 5—5 of FIG. 1;

FIG. 6 is a sectional view of the line 6—6 of FIG. 5; and

FIG. 7 is an enlarged detail view of the cylindrical seal structure shown in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a gear box 10, through which a power shaft 12 extends, there being bearings 14 at opposite ends of the gear box 10 for the power shaft 12; and the gear box having flanges 16 at both ends for connecting it with the apparatus on which it is intended to be used.

A centrifugal pump 20 is connected to one side of the gear box 10 by fastening means consisting of screws 22 (FIG. 3).

The centrifugal pump 20 has a housing 24 with an inlet passage 26 having a flange 28 for connecting the pump housing with a pipe to supply fluid to the pump.

The pump housing 24 has a backplate 30 which forms a partition between the interior of the pump housing 24 and the interior of the gear box 10. There is an oil fill opening 32 in the backplate 30 leading into the gear box 10 at the intended level of oil for the gear box and there is an oil drain 34 at the bottom of the plate 30 for draining oil from the gear box.

An impeller 40 in the pump housing 24 is connected to a drive shaft 42. This impeller has a body portion 44 and has a periphery 48 which is substantially even with the ends of the vanes 46, as best shown in FIG. 5.

The vanes 46 extend across the full width of the part of the interior of the pump housing 24 which constitutes a pumping chamber 50. The inlet passage 26 expands and merges with the pump chamber 50. There is an annular circumferential chamber 52 into which the blades or vanes 46 displace fluid in accordance with the conventional operation of centrifugal pumps; and the fluid under pressure flows from the annular chamber 52 to an outlet passage 54, best shown in FIG. 2.

The outlet passage 54 is located at the bottom of the housing 24 and there is a downwardly extending passage 56 in a boss 58 for draining the pumping chamber when desired. Ordinarily the drain passage 56 is closed by a plug 60 threaded into the boss 58.

On the back surface of the impeller 40, there are shallow vanes 64 integral with the body portion 44 of the impeller, and preferably of one-piece construction with the body portion. These vanes 64 run close to an annular surface 66 of the backplate 30 throughout most of the radial extent of the vanes 64, but their inner ends overlap an annular chamber 68 from which the vanes 64 withdraw fluid, if any fluid leaks into this chamber 68. There is a drain passage 69 (FIG. 4) in the bottom of the housing for draining the chamber 68, if necessary, when the pump is not running. This drain passage 69 is normally closed by a plug 69p.

Another annular chamber is formed by a recess 70 in the surface of the backplate 30 which confronts the back of the impeller 40. This recess 70 is preferably annular and it communicates through angularly spaced passages 74 with a chamber 76 formed by a peripheral recess in the back plate 30. The vanes 64 displace fluid into the recess 70 and the pressure on this fluid causes it to flow through the passages 74 into the chamber 76 which communicates with the inlet passage 26 through a connecting passage 80, shown in FIG. 4, formed in the wall of the pump housing 24.

Referring to FIGS. 5 and 7, the back plate 30 has a substantially cylindrical recess 84 which is coaxial with the axis of rotation of the impeller shaft 42. The back surface of the impeller 40 is formed with a complementary generally cylindrical portion 86 which fits into the recess 84 with very close running clearance. In the illustrated construction, the recess 84 is lined with a plastic sleeve 88, preferably made of polytetrafluoroethylene so as to have low friction where the generally cylindrical surface 86 touches the sleeve.

The purpose of the generally cylindrical portion 86 and the recess 84 is to obtain a seal to prevent leakage of fluid radially inward between the back of the impeller 40 and the backplate 30 of the pump housing. This seal is made more effective by providing threads 89 on the generally cylindrical surface 86 with the direction of the threads correlated with the direction of rotation of the impeller so as to act as a spiral conveyor for moving fluid to the left along the seal, i.e., against the direction of leakage.

It is a feature of the invention that any fluid which does leak past the seal provided by the generally cylindrical portion 86 and the recess 84 is vented through passages leading to the inlet of the pump. The vanes 64 prevent the fluid from flowing radially into the shaft recess 68.

The impeller shaft 42 has a bearing 92 in a hub of the backplate 30 and has another bearing 94 in an outboard support 96 attached to the backplate 30 of the pump housing by

screws 97. This outboard bearing support 96 extends far enough into the gear box 10 to bring the gear 98 into mesh with the gear 100 when the pump housing is attached to the gear box by the screws 22. A bevel gear 98 on the impeller shaft 42 meshes with another bevel gear 100 on the shaft 12. This bevel gear 100 provides a power takeoff in the box 10 for driving the centrifugal pump 20. Blades 102 on the bevel gear 100 splash the oil in the gear box 10 to provide lubrication for the gears 98 and 100 and also for the impeller shaft bearings 92 and 94. O-ring seals 106 are provided at appropriate locations, as illustrated.

The pump can be removed from the gear box 10 by unscrewing the fastening screws 20. This permits the front of the housing 24 to be taken off the backplate 30, and also permits the backplate, with the outboard bearing support 96, to be withdrawn from the gear box 10. A plate can be placed over the opening left by the removal of the pump if the power shaft 12 is to be used while the pump is not on the gear box.

The preferred embodiment of the invention has been illustrated and described but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

I claim:

1. A centrifugal pump including a pump housing enclosing a pumping chamber, an impeller in the pumping chamber, an inlet passage through which fluid flows to the impeller in the pumping chamber, the impeller having a body portion with axially spaced front and back surfaces, vanes extending from the front surface across the pumping chamber and smaller vanes on the back surface, a shaft for driving the impeller, a backplate of the pump housing providing a backwall through which the shaft extends, said backwall having an annular surface close to the vanes on the back surface whereby said vanes on the back surface displace fluid outward away from the shaft, bearing means for the shaft rearward of the impeller, the body portion of the impeller extending radially beyond the vanes on the back surface, and a portion of the back surface beyond the back surface vanes having a close running clearance with the backwall to reduce leakage of fluid between the impeller and the backwall toward the shaft, a recess in the backplate between the back surface vanes and said close running clearance into which fluid is displaced by the back surface vanes, passage means through which fluid flows out of said recess, said passage means communicating with said inlet passage whereby fluid which leaks between the impeller and the backwall is fed back to the inlet passage.

2. The centrifugal pump described in claim 1 characterized by the recess in the backplate being annular and confronting the back surface of the impeller, another annular recess in a peripheral surface of the backplate and radially outward from the first annular recess, a cylindrical portion of the housing surrounding the periphery of the backplate and closing the peripheral surface recess in the backplate, said passage means including angularly spaced passages connecting said recesses and a passage in the housing communicating with the peripheral recess and extending within a wall of the housing and opening at said inlet passage through which fluid flows to

the impeller.

3. The centrifugal pump described in claim 1 characterized by a gear box into which the shaft extends and in which the bearing means are located, gearing in the gear box for driving the impeller drive shaft, and common means for lubricating the shaft bearing means and said gearing.

4. The centrifugal pump described in claim 3 characterized by the bearing means for the impeller shaft being carried by parts of the pump housing including a part that fits into the gear box, detachable fastening means holding the pump in assembled relation with the gear box, a power shaft extending into the gear box, said gearing for driving the impeller drive shaft including a bevel gear secured to the power shaft in the gear box, a bevel gear on the impeller shaft in position to mesh with the bevel gear on the power shaft when the pump is fastened to the gear box.

5. The centrifugal pump as described in claim 1 characterized by a cylindrical surface of the backwall surrounding a generally cylindrical portion of the back surface of the impeller, said cylindrical surface comprising a smooth plastic sleeve inserted into a recess in said backwall, and threads on the generally cylindrical portion of the back surface of the impeller with the diameters of the tops of the threads substantially equal to the inside diameter of the smooth plastic sleeve.

6. A centrifugal pump including a pump housing enclosing a pumping chamber, an impeller in the pumping chamber, the impeller having a body portion with axially spaced front and radially back surfaces, vanes extending from the front surface across the pumping chamber and smaller vanes on the back surface, a shaft for driving the impeller, a backplate of the pump housing providing a backwall through which the shaft extends, said backwall having an annular surface close to the vanes on the back surface whereby said vanes on the back surface displace fluid outward away from the shaft, bearing means for the shaft rearward of the impeller, the body portion of the impeller extending radially beyond the vanes on the back surface and a portion of the back surface beyond the back surface vanes having a close running clearance with the backwall to reduce leakage of fluid inward along the back of the impeller, a generally cylindrical portion of the back surface of the impeller coaxial with the axis of rotation of the impeller, a complementary surface on the backwall close to the generally cylindrical portion of the back surface of the impeller, at least a portion of said close running clearance being between said generally cylindrical portion of the back surface of the impeller and the cylindrical surface of the backwall.

7. The centrifugal pump described in claim 6 characterized by the cylindrical surface of the backwall surrounding the generally cylindrical portion of the back surface of the impeller and comprising a smooth plastic sleeve inserted into a recess in said backwall, and threads on the generally cylindrical portion of the back surface of the impeller with the diameters of the tops of the threads substantially equal to the inside diameter of the smooth plastic sleeve.

8. The centrifugal pump described in claim 6 characterized by the smooth plastic sleeve being made of polytetrafluoroethylene.

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