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(54) Hydraulic sealing ring on the inlet of the impeller in single-stage and multistage pumps.

(57) The hydraulic sealing ring (1) on the inlet (5) of the impeller (6), particularly for single-stage and multistage pumps is made in a rubber-like material the inner face (3) whereof couples to the outer surface (4) of the inlet (5) of an impeller (6). The ring (1) has substantially radial openings which connect a shimming face to the outer one to allow a slight injection of liquid bled from the higher-pressure chamber in output from the impeller blades in the shimming region and to allow the creation and the maintainance of an extremely thin layer of liquid adapted to ensure a lubrication of the scraping surfaces with a reduced leakage towards the lower-pressure region at the input of the impeller (6) and to counterbalance the radial force which tends to press the ring around the inlet (5) of the impeller (6), said force being generated by the pressure of the liquid acting on the outer face (4) of said ring.

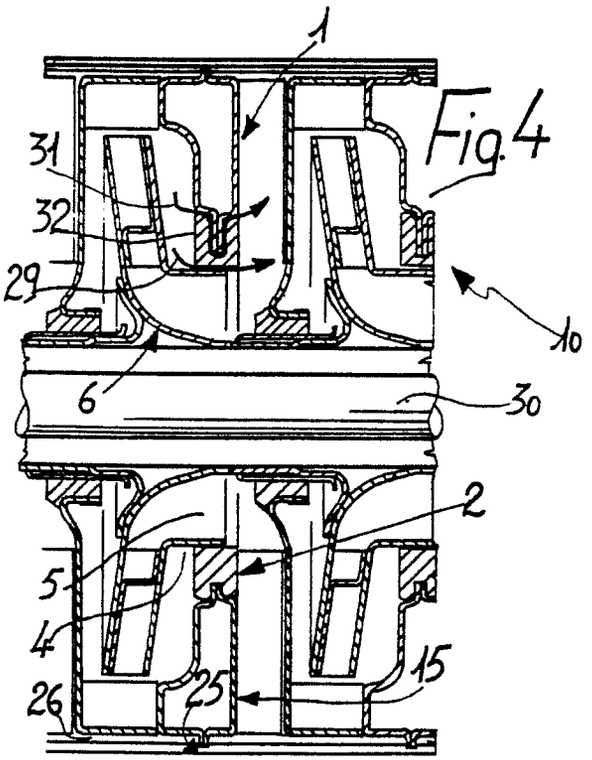

Fig. 4

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HYDRAULIC SEALING RING ON THE INLET OF THE IMPELLER IN SINGLE-STAGE AND MULTISTAGE PUMPS

The present invention relates to a hydraulic sealing ring on the inlet of the impeller in single-stage and multistage pumps.

In centrifugal pumps, in which the element which imparts energy to the liquid consists of one or more impellers, there is always a limited external surface of the inlet of the rotor part (the impeller) which interfaces a corresponding inner surface of a box-like (fixed) part between which play is reduced to the minimum practical value.

Said interfacing surfaces, which act as separating boundaries between the chamber at the inlet of the blades of each impeller (hereinafter termed upstream chamber) and the chamber at the outlet of the blades of each impeller (hereinafter termed downstream chamber), are known as shimming surfaces.

A pressure differential occurs between the downstream chamber of the impeller and the upstream chamber due to the amount of energy imparted to the liquid by the impeller.

Therefore a small amount of the liquid at greater pressure of the downstream chamber tends to leak into the upstream chamber in quantities which increase as the play between the shimming surface increases.

The greater this leak, the lower the performance of the pump.

It is therefore necessary to minimize the leakage with sealing means which allow to provide extremely small play between the fixed part and the rotating part.

The possibility is known of using sealing rings in rubber-like material having a small shimming surface (European patent application No. 85107012.8 filed on June 5,1985 and U.S. Patent No. 3741674 dated June 26, 1973) such as "OR" rings accommodated in seats connected by holes or channels to the liquid in the delivery chamber to cause the liquid pressure acting on the outer side of the ring to generate thereon radial forces tending to keep the ring elastically adherent to the inlet of the impeller.

It is also known to provide the seat of the elastomeric sealing ring with abundant space in the radial direction, so as to allow said ring to oscillate along a plane which is normal with respect to the axis of rotation, to compensate for ovalizations and eccentricities in manufacture.

On the other hand, it is also known and easily verifiable that a ring in elastomeric material, particularly if it has a wide shimming surface and is applied to pumps which generate high pressures in the conditions described above, soon wears out by friction since it is subjected to a considerable radial force and to a high specific shimming pressure.

The aim of the present invention is to provide an elastomeric ring adapted to eliminate the disadvantages described above yet maintain unchanged all the advantages offered by "OR"-type shimming rings applied to low-pressure pumps.

A second object is to provide an elastomeric ring which can be easily adapted to the ordinary structures of single-stage and multistage pumps.

Still another object is to provide a ring with a simple structure which can be easily produced with modest costs.

The aims proposed are achieved by a hydraulic sealing ring on the inlet of the impeller, particularly for single-stage and multistage pumps, characterized in that it consists of an adapted rubber-like material the inner face whereof of the ring-like structure couples to the outer surface of the inlet of an impeller having substantially radial openings which connect the shimming face to the outer one.

This provision, which is the fundamental object of the invention, consists of said radial openings with circular or elongated cross section, distributed along the ring, which allow a greater lubrication of the shimming region, determined by the recirculation of pressurized liquid originating from the output of the blades of the impeller.

Said liquid generates a counterpressure which balances the centripetal radial force of adherence to the inlet up to a state of hydrodynamic balance, the optimum achievement whereof is a function of the initial position and of the size of the openings.

A further characteristic of the ring is its shape, which is characterized , in the peripheral region, by two circumferential facing edges, which define between themselves a recess which is also circumferential and is adapted to couple to the complementarily shaped margin of the accommodation hole in the supporting element connected to the fixed part of the pump.

The ring is furthermore characterized by protruding raised portions provided inside the ring assembly seat, said raised portions engaging with complementarily shaped notches provided on the margin of the supporting element.

Further characteristics and advantages of the invention will become apparent from the detailed description of a hydraulic sealing ring, with reference to the accompanying drawings, wherein:

Fig. 1 is a perspective view of the shimming ring;

Fig. 2 is a perspective view, in partial cross section, of the supporting element;

Fig. 3 is a cross section view, along a diametral plane, of a ring according to the invention; and

Fig. 4 is a longitudinal cross section view of a detail of a multistage pump illustrating the location of the sealing ring.

With reference to the above described Figures, a hydraulic sealing ring according to the invention, generally indicated by the reference numeral 1, comprises a shimming element 2, in rubber having an adequate mix and hardness, its inner face 3 having a considerable thickness in the axial direction and being adapted to couple with the external surface 4, shaped complementarily thereto, of the inlet 5 of the centrifugal impeller 6.

Along its external peripheral region, the shimming element 2 has a pair of circumferential borders, respectively a low-pressure-side border 7 and a high-pressure-side border 8, which extend facing one another on a plane substantially parallel to the plane of arrangement of said element 2.

Said borders 7 and 8 define, comprising between them, a circumferential recess 9 for coupling with a corresponding supporting element connected to the fixed part of the pump 10.

In this regard, it is important to note the fact that protruding raised portions 12, adapted to fix the element 2 to the supporting element, are evenly distributed on the bottom 11 of the recess 9.

According to the invention, the element 2 is characterized in that openings 13 are provided distributed along the recess 9 and have a cross section which is for example circular or elongated, and, extending substantially radially, connect the bottom 11 of said recess to the inner face 3 whereto they lead.

Obviously, according to the requirements, said openings 13 can vary in number and in dimensions, and can furthermore be distributed at mutually equal distances or arranged, for example, in clusters.

For the sake of descriptive completeness, it should also be specified that recessed regions 14 are furthermore provided on the inner face 3 of the element 2, and, arranged advantageously on the opposite side with respect to the raised portions 12, allow the discharge of sand, silt or any other solid material which may infiltrate between the element 2 and the impeller 6.

According to the invention, a previously mentioned supporting element advantageously consists of the appropriately manufactured diffuser cover 15, according to what is illustrated in Fig. 2.

Said cover 15 has a substantially disc-like shape with a central hole 16 and is obtained by the rigid coupling of two appropriately shaped metallic half-shells, the one facing towards the higher-pressure region being indicated by 17 and the one facing towards the lower-pressure region being indicated by 18.

The two half-shells 17 and 18 provide, in the coupling of their inner flaps, respectively 19 and 20, a margin 21 shaped complementarily with respect to the circumferential recess 9 of the ring 2, whereon locator notches 22 are conveniently provided, within which accommodate the raised portions 12 provided on the bottom 11 of said recess.

In the accompanying Figures, the two half-shells 17 and 18 are also provided with external flaps, respectively 23 and 24, having a shorter extension, which define a circumferential raised portion 25 which, as illustrated in Fig. 4, by engaging against tubular spacer elements 26 allows an appropriate positioning of the cover 15 inside the pump body 10.

The shape of these half-shells is in any case not relevant and is determined by the type of pump.

From what has been described, the operation and the operative behaviour of a hydraulic sealing ring according to the invention can be summarized as follows.

After the first few moments of operation of the pump 10, required for the stabilization of running conditions, the pressure of the water acting on the sides 27 and 28 of the circumferential borders 7 and 8 and on the bottom 11 of the element 2 generates centripetal radial stresses which tend to cause the inner face 3 to adhere to the outer surface 4 of the inlet 5.

These stresses, which in themselves would produce an excessive adherence which would cause a rapid degradation of the element 2, are partially balanced by the water pressure which, infiltrating between the element 2 and the impeller 6 throught the openings 13, exerts a centrifugal action on the inner face 3.

It is thus possible to obtain, by providing appropriate dimensions and positions of the compensation openings 13, a correct gradient between the pressing action of the element 2 and the opposite action so as to facilitate the onset, between the impeller 6 and the element 2, of a fluid film a few tens of microns thick; in this manner the leakage of water which may occur along the path indicated by the arrow 29 towards the lower-pres-

sure regions is minimized, though allowing the element 2 to operate in optimum conditions of pressure and lubrication which reduce its wear to negligible values.

It is also important to take into account the fact that the onset of a correct hydrodynamic balance, by virtue of the particular coupling between the recess 9 and the margin 21, allows the element 2, which cannot rotate due to the presence of the raised portions 12 and of the notches 22, to oscillate on a plane which is normal with respect to the axis of rotation of the impeller 6, thus allowing the element 2 to follow any ovalizations or eccentricities of rotation of the shaft 30 and of the impeller 6 though always ensuring an optimum hydraulic seal.

Regarding the leakage of water through the recess 9, along the path indicated by the arrow 31, it is evident that such leakage is practically eliminated, observing that the pressure itself of the water downstream with respect to the impeller 6, which is greater than the upstream pressure, acts on the inside 32 of the circumferential border 8 determining a force which tends to keep the element 2 adherent to the margin 21.

In practice it has thus been observed that a hydraulic sealing element of the type described achieves the aim and all the intended objects, ensuring extremely high functional results though offering considerable assurances of reliability and durability in use.

By virtue of the described characteristics, which cause the pressure difference itself to increase the sealing action, it is furthermore possible to provide, in the dimensions of the various components, a greater dimensional play between the inner face 3 of the ring and the external surface 4 of the inlet 5, thus allowing, among other things, to reduce the resistance due to mechanical friction which occur in starting up the pump 10, allowing a low-acceleration startup which is particularly favorable for the motor means.

In practice, the materials employed, so long as compatible with the contingent use, as well as the dimensions, may be any according to the requirements and to the state of the art.

Claims

1. Hydraulic sealing ring on the inlet of the impeller, particularly for single-stage and multistage pumps, characterized in that it is made in a rubber-like material the inner face whereof couples to the outer surface of the inlet of an impeller, said ring having substantially radial openings which connect the shimming face to the outer one to allow a slight injection of liquid bled from the higher-pressure chamber in output from the impeller blades in the shimming region and to allow the creation and the maintainance of an extremely thin layer of liquid adapted to ensure a lubrication of the scraping surfaces with a reduced leakage towards the lower-pressure region at the input of the impeller and to counterbalance the radial force which tends to press the ring around the inlet of the impeller, said force being generated by the pressure of the liquid acting on the outer face of said ring.

2. Sealing ring, according to claim 1, characterized in that it is provided, on the face opposite to the shimming face, with a pair of substantially facing circumferential borders which define between each other a circumferential recess which couples to the complementarily shaped margin of a circular hole provided on a corresponding supporting element connected to the box-like part of the pump.

3. Sealing ring, according to one or more of the preceding claims, characterized in that protruding raised portions are evenly distributed on the bottom of said recess and couple to complementarily shaped locator notches provided in said margin to set the angular position of said ring on said supporting element.

4. Sealing ring, according to one or more of the preceding claims, characterized in that said openings, preferably having a circular or elongated cross section, are distributed regularly along said recess.

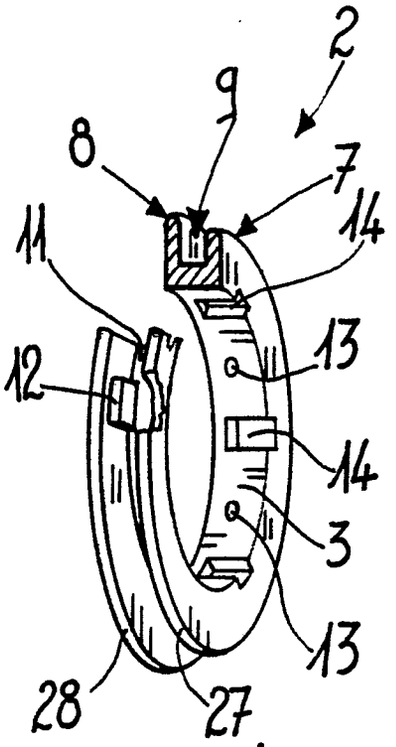

Fig.1

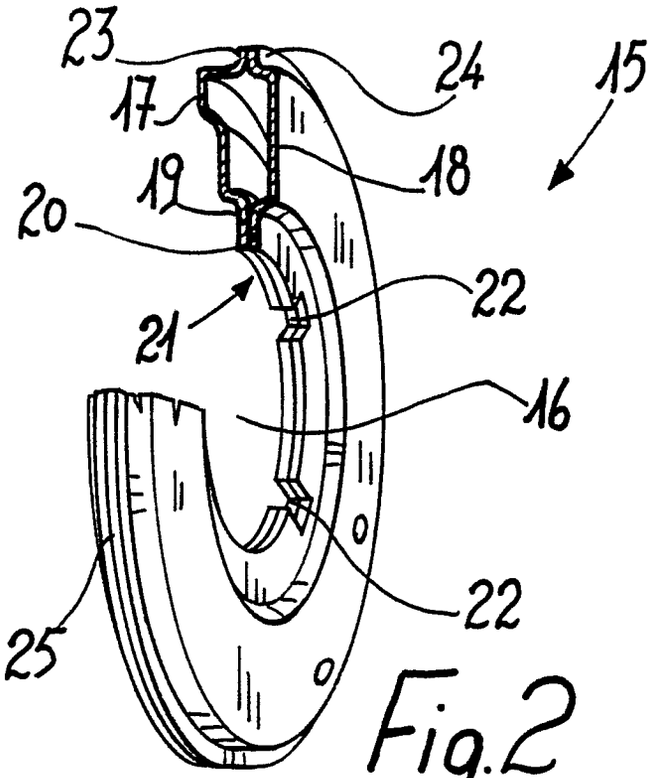

Fig.2

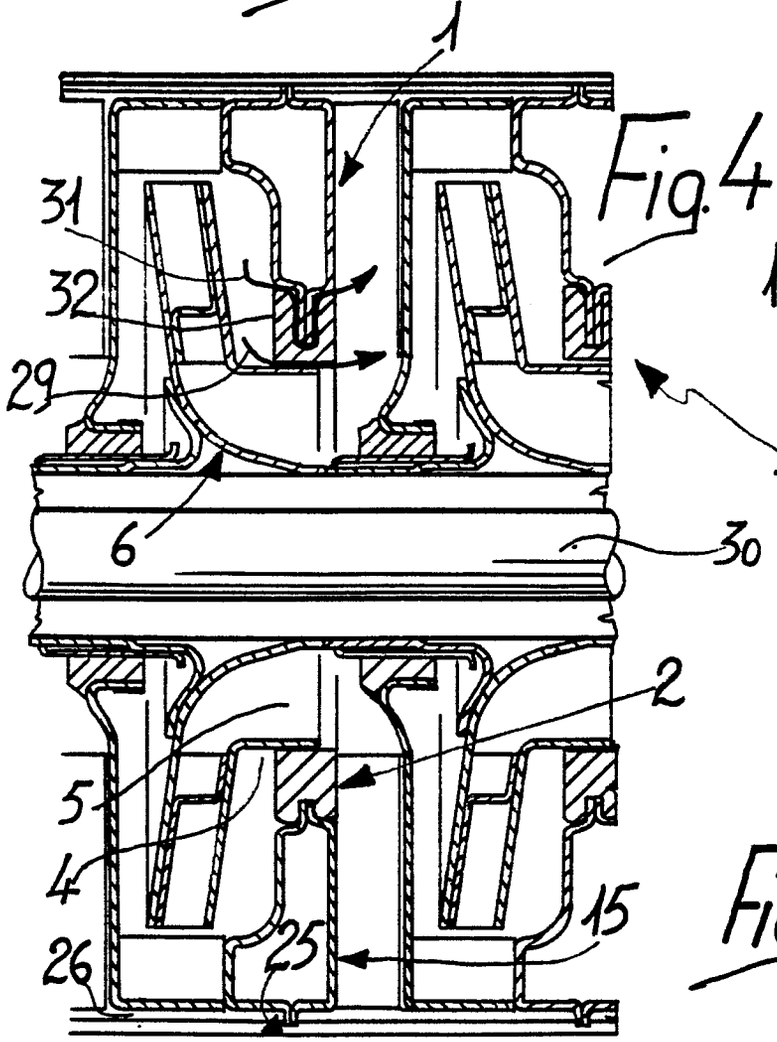

Fig.4

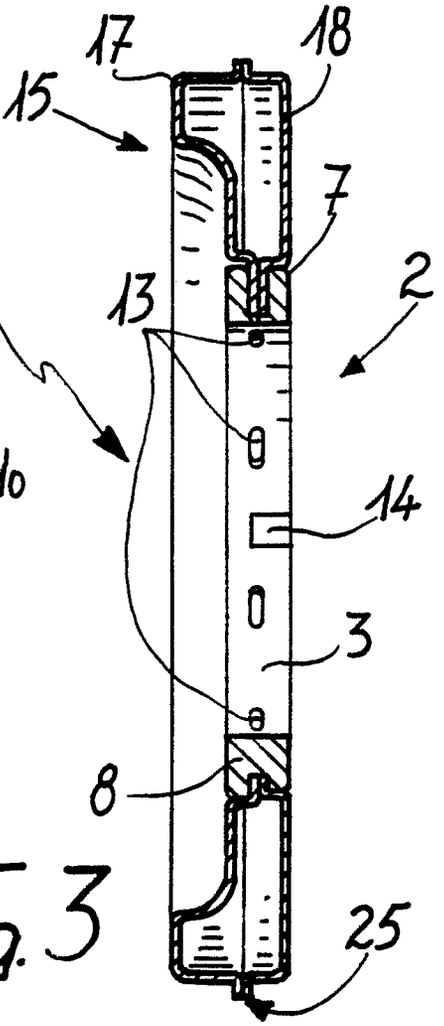

Fig.3