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(54) **Seal device for interposition between a pump body and pump impeller**

Dichtungsanlage zwischen einem Pumpengehäuse und einem Pumpenrad

Dispositif d'étanchéité pour interposition entre un boîtier de pompe et une roue à aube

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Description

This invention relates to a seal device, particularly of a type for interposition between a pump body and pump impeller.

In current commercial production of electric pumps, the level of accuracy must be kept within acceptable limits for the economy of the product.

For this reason and owing to the number of the pieces subjected with their couplings to tolerance of average precision, centrifugal pumps utilise a seal ring placed between the impeller port and pump body which restricts its radial play.

A problem encountered with prior types is connected with the scraping action undergone by that ring in operation, which in time jeopardises its integrity.

Further, even after significantly long inoperative periods, that scraping action may result in the impeller being seized on starting.

Such drawbacks are due to the inverse proportionality that relates the radial play to the volumetric efficiency of the pump.

In fact, the greater is the play, the more reliable the impeller rotation becomes, and accordingly, the lesser becomes the risk of seizure thereof, since the hydraulic losses of a centrifugal pump depend on the rationality of the impeller and pump body shapes, as well as the recycles of liquid which are created therein.

Furthermore a seal device is known from US-A-2 162 486, where the lubricating film is provided by means of oil in a separate circuit in order to additionally prevent leakage past the seal element. Such solution is however complex and could result in an undesired mixture of the centrifugated fluid and lubricating oil.

It is a primary aim of the invention to obviate such prior drawbacks affecting known pump types, while ensuring, in the rotation geometry of the impeller, a reliable rotation which causes no scraping of the seal element.

A further important object is to provide a device which affords maximisation of the hydraulic performance while minimising the recycle flow.

A main object is also that of providing a device which can simultaneously achieve the two preceding objects.

Another object is to provide a device which allows the utilisation of ring seals of suitable materials also for specific liquids and temperatures.

These and other objects are achieved by a seal device for interposition between a pump impeller and a pump body of single or multistage type, as defined in appended claim 1.

It will be understood that the device of this invention may be used also in multistage pumps in connection with all or some of the impeller stages.

The features and advantages of the invention will be apparent from the following detailed description of a preferred, but not exclusive, embodiment of a device according to the invention, with reference to the accompa-

nying illustrative but not limitative drawings, in which:

Figure 1 is a sectional view taken on the longitudinal centerplane peripheral portion of the device according to a first embodiment as mounted between a pump body and an impeller;

Figure 2 is a similar view to Figure 1, showing another embodiment of the device according to the invention; and

Figure 3 is a fragmentary axial section of a multistage centrifugal pump in which the device of this application is applied.

With reference to the cited figures, the device 1 comprises two rings 2 and 3 positionable between the pump body 4 and impeller 5 of any centrifugal pump.

The ring 2, having an essentially L-like cross-sectional shape is spot welded and rests with the longer flange 6 on the pump body 4, while the other flange 7, perpendicular to the axis of the impeller 5, contacts the zone 8 located downstream from the inlet end of the intake or port 9.

In the zone 8 there is present the fluid centrifuged by the impeller 5, which is subjected to a higher pressure than that prevailing in the suction zone 10. In fact the zone 8 is enclosed by the body 4 of the pump within the cavity or compartment thereof where the impeller 5 rotates between the inner walls of the pump body and the impeller. Within the zone 8 the fluid is substantially stagnant but it takes up the delivery pressure of the pump, the liquid flowing according to the arrow A through the hollow interior of the impeller owing to the centrifugal action thereon.

The flange 7 has a plurality of openings 11 formed proximately to the point of connection with the flange 6.

The second ring 3 has an essentially S-like cross-sectional shape, with the bottom lug or flange 12 being slightly longer than the upper lug or flange 13.

The upper lug 13 abuts and is spot welded on the flange 6 of the ring 2, while the bottom lug 12 is disposed parallel to that same flange and rests with its free end on the pump body 4.

The rings 2 and 3 define a groove or seat 14, whose base is defined by the upper lug 13 of the second ring 3 for a sealing element 15 comprising, for example, a circular cross-section elastomer ring.

The seat 14 has a greater depth than the external diameter of the element 15, or corresponding external dimension of a sealing element having other than a circular cross-section, so that a chamber 16 is defined between the base of said seat 14 and a portion of said sealing element.

The device 1 operates as follows: on operating the pump, the pressurized liquid present in the zone 8 will flow, through the openings 11, into the chamber 16 of the seat 14.

That liquid pressure urges the sealing element or elastomer ring 15 against the external circumferential

face of the intake 9 of the impeller 5 because the fluid working in the zone 17 has a much lower pressure than that in the zone 8.

The liquid present in this latter zone 8, however, tends to leak out also through the space 18, and below the element 15, thus forming, in a condition of equilibrium, a ring or film of liquid, for lubricating the sliding motion between the sealing element 15 and the port 9 of the impeller 5, its thickness being such as to ensure a minimal recycle of the liquid, and hence, a high volumetric efficiency, whilst avoiding any scraping action occurring between the sealing element and the impeller. In fact, the sealing element is held stationary within the seat 14.

It will be understood that a slight radial displacement of the sealing element 15 under the action of the pressure forces as above explained is made possible by the elastic nature of the sealing element 15.

It will be further noted that the pressure in the zone 14 is somewhat greater than the pressure in the zone 17 owing to the pressure drop caused by the leaks through the space 18 and the communication with the suction side of the pump. Therefore the ring 15 is urged radially inwards and allows compensation.

Thus, it has been shown how the pressure compensating seal device according to the invention can act on a sealing element to achieve all of the objects set forth, while also allowing the seal element to be self-centering, owing to the provision of the chamber 16 and the working pressure forces existing therein and, thereby accommodating any lack of coaxiality between the forward portion or shaft of the impeller 5 and the seat 14.

The ring or sealing element 15 is also self-compensated, by virtue of the fact that, the higher the pressure in the pump becomes, consequently, the greater become the forces applied by the fluid, to the sealing element, thereby compensating the play existing between its surface and the outer circumferential surface of the port or forward portion 9 of the impeller 5.

The invention herein is susceptible to many modifications and variations without departing from the purview of the inventive concept, one further embodiment of which is illustrated in Figure 2, where reference numerals increased by one hundred, indicate like-parts, described heretofore.

Thus, as an example, where a semirigid sealing element 115 e.g. of plastics material such as a wear ring is to be used, the device 101 could also include two rings 102 and 103, but with the latter being formed with a guide 119 projecting into a correspondingly shaped seat 114, provided on the element 115. Instead of a semirigid ring of plastics material also an elastic metallic split ring may be used.

This will advantageously allow, for the self-centering feature of the element itself, in the space between its surface 115a and outer surface of the intake 109, to be held constant and at a minimum.

Of course, any materials may be used contingent

on requirements, such as the type and temperature of the liquid being pumped.

5 Claims

1. A seal device (1; 101) for interposition between a pump impeller (5; 105) and a pump body (4; 104) of single or multi-stage type, comprising at least one seal element (15; 115) encircling a portion (9; 109) of said impeller (5; 105), said seal element (15; 115) being accommodated within a housing means (14; 114) provided on said pump body (4; 104) and allowing a radial movement of said seal element (15; 105) therein, first means (11; 111) being provided for allowing a pressure force to act on said seal element (15; 115) to push said seal element radially against said impeller (5; 105), and second means (18; 118) for allowing a further reduced pressure force to act on said seal element (15; 115) to push said seal element radially away from said impeller (5; 105), so as to admit a thin lubricating film of fluid between said seal means (15; 115) and said impeller (5; 105), wherein said housing means (14; 114) has a greater radial depth than said seal element (15; 115), and a chamber (16) being formed by a portion of said sealing element (15) and a portion of said housing means (14), said chamber (16) being separated from said second means, said first means for applying a pressure force comprises a plurality of openings (11; 111) formed in said housing means (14; 114) near to said pump body (4; 104) for communicating the delivery pressure of the fluid being centrifugated by the impeller (5; 105) in said chamber (16) to a portion of said seal element (15; 115) facing said pump body, and said second means for applying a further reduced pressure force comprises a space (18; 118) formed in said housing means (14; 114) near to said impeller (5; 105) for communicating the delivery pressure of the fluid being centrifugated to a portion of said seal element (15; 115) facing said impeller (5; 105), thereby said thin film of fluid is caused by leakage of fluid centrifugated by said impeller.
2. A seal device according to claim 1, characterized in that said housing means comprises at least one seat (14; 114) formed by a first and a second ring (2; 3; 102, 103), said first ring (2; 102) defining a substantially L-like cross-section including a longer flange (6; 106) which is rigid with the pump body (4; 104) and a shorter flange (7; 107) located downstream of the portion (9; 109) of said impeller (5; 105) facing said seal element (15; 115), and said second ring (3; 103) defining a substantially S-like cross-section including a lug (13; 113) made rigid with said longer flange (6; 106) of said first ring (2; 102) to define the bottom of said seat (14; 114).

3. A seal device according to claims 1 to 2, characterized in that said seal element (15) comprises an elastomer ring.
4. A seal device according to claims 1 to 3, characterized in that said seal element (115) comprises a semi-rigid wear ring or a metallic split ring having a lateral seat (114) adapted for radial sliding movement on a matchingly shaped guide (119) formed on said second ring (103).
5. A pump having a sealing device according to claims 1 to 4.
6. A multi-stage pump having in at least one stage thereof a sealing device according to claims 1 to 4.

Patentansprüche

1. Dichtungseinrichtung (1; 101) zum Einsetzen zwischen einem Pumpenrad (5; 105) und einem Pumpenkörper (4; 104) vom Einstufen- oder Mehrstufentyp, enthaltend mindestens ein einen Abschnitt (9; 109) des Pumpenrads (5; 105) einschließendes Dichtelement (15; 115), das in einem an dem Pumpenkörper (4; 104) vorgesehenen und eine radiale Bewegung des Dichtelements (15; 105) darin zulassenden Gehäusemittel (14; 114) untergebracht ist, wobei erste Mittel (11; 111) vorgesehen sind, um es zuzulassen, daß eine Druckkraft auf das Dichtelement (15; 115) einwirkt, um das Dichtelement radial gegen das Pumpenrad (5; 105) zu drücken, und zweite Mittel (18; 118) vorgesehen sind, um es zuzulassen, daß eine weitere reduzierte Druckkraft auf das Dichtelement (15; 115) einwirkt, um das Dichtelement radial von dem Pumpenrad (5; 105) wegzudrücken, um dadurch einen dünnen Schmierfilm eines Fluids zwischen dem Dichtmittel (15; 115) und dem Pumpenrad (5; 105) zuzulassen, wobei das Gehäusemittel (14; 114) eine größere radiale Tiefe als das Dichtelement (15; 115) aufweist und eine Kammer (16) von einem Abschnitt des Dichtelements (15) und einem Abschnitt des Gehäusemittels (14) gebildet ist, die von den zweiten Mitteln getrennt ist, und die ersten Mittel zum Anlegen einer Druckkraft eine Vielzahl von in den Gehäusemitteln (14; 114) im Bereich des Pumpenkörpers (4; 105) gebildeten Öffnungen (11; 111) aufweist, um den Abgabedruck des von dem Pumpenrad (5; 105) in der Kammer (16) zentrifugierten Fluids einem dem Pumpenkörper zugewandten Abschnitt des Dichtelements (15; 115) mitzuteilen, und die zweiten Mittel zum Anlegen einer weiteren reduzierten Druckkraft einen in den Gehäusemitteln (14; 114) im Bereich des Pumpenrads (5; 105) gebildeten Raum (18; 118) umfassen, um den Abgabedruck des zentrifugierten Fluids einem dem Pum-

penrad (5; 105) zugewandten Abschnitt des Dichtelements (15; 115) mitzuteilen, wodurch der dünne Fluidfilm durch Lecken von von dem Pumpenrad zentrifugiertem Fluid verursacht wird.

2. Dichtungseinrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Gehäusemittel mindestens einen von einem ersten und zweiten Ring (2; 3; 102, 103) gebildeten Sitz (14; 114) aufweisen, wobei der erste Ring (2; 102) einen im wesentlichen L-förmigen Querschnitt mit einem längeren Flansch (6; 106), der mit dem Pumpenkörper (4; 104) starr ist, und einem kürzeren Flansch (7; 107) definiert, der stromab des dem Dichtelement (15; 115) zugewandten Abschnitts (9; 109) des Pumpenrads (5; 105) angeordnet ist, und der zweite Ring (3; 103) einen im wesentlichen S-förmigen Querschnitt mit einem Ansatz (13; 113), der mit dem längeren Flansch (6; 106) des ersten Rings (2; 102) starr gemacht ist, definiert, zur Bildung des Bodens des Sitzes (14; 114).
3. Dichtungseinrichtung nach Anspruch 1 bis 2, dadurch gekennzeichnet, daß das Dichtelement (15) einen Elastomerring aufweist.
4. Dichtungseinrichtung nach Anspruch 1 bis 3, dadurch gekennzeichnet, daß das Dichtelement (115) einen halbstarren Abnutzungsring oder einen metallischen Spaltring mit einem seitlichen Sitz (114) aufweist, der zur radialen Gleitbewegung auf einer übereinstimmend geformten Führung (119) ausgebildet ist, die auf dem zweiten Ring (103) gebildet ist.
5. Eine Pumpe mit einer Dichteinrichtung nach Anspruch 1 bis 4.
6. Vielstufenpumpe, die in mindestens einer ihrer Stufen ein Dichtgerät nach Anspruch 1 bis 4 aufweist.

Revendications

1. Dispositif d'étanchéité (1; 101) destiné à être interposé entre un rotor de pompe (5; 105) et un corps de pompe (4; 104), de type à étage unique ou à étages multiples, comprenant au moins un élément d'étanchéité (15; 115) entourant une portion (9; 109) dudit rotor (5; 105), ledit élément d'étanchéité (15; 115) étant reçu à l'intérieur de moyens de logement (14; 114) prévus sur ledit corps de pompe (4; 104) et autorisant un mouvement radial dudit élément d'étanchéité (15; 115) à l'intérieur, des premiers moyens (11, 111) étant prévus pour permettre à une force de pression d'agir sur ledit élément d'étanchéité (15; 115) pour pousser ledit élément d'étanchéité radialement contre ledit rotor (5; 105)

et des seconds moyens (18; 118) pour permettre à une force de pression supplémentaire réduite d'agir sur ledit élément d'étanchéité (15; 115) de manière à pousser et éloigner ledit élément d'étanchéité radialement à partir dudit rotor (5; 105), de façon à admettre un mince film lubrifiant de fluide entre ledit moyen d'étanchéité (15; 115) et ledit rotor (5; 105), dans lequel lesdits moyens de logement (14; 114) ont une profondeur radiale supérieure à celle dudit élément d'étanchéité (15; 115) et une chambre 16 est formée par une portion dudit élément d'étanchéité (15) et une portion desdits moyens de logement (14), ladite chambre (16) étant séparée desdits seconds moyens, lesdits premiers moyens d'application d'une force de pression comprennent plusieurs ouvertures (11; 111) formées dans lesdits moyens de logement (14; 114) à proximité dudit corps de pompe (4; 104) de façon à faire communiquer la pression de refoulement du fluide qui est centrifugé par le rotor (5; 105) dans ladite chambre (16) avec une portion dudit élément d'étanchéité (15; 115) qui fait face audit corps de pompe, et lesdits seconds moyens pour appliquer une force de pression supplémentaire réduite comportent un espace (18; 118) formé dans lesdits moyens de logement (14; 114) à proximité dudit rotor (5; 105) en vue de faire communiquer la pression de refoulement du fluide centrifugé avec une portion dudit élément d'étanchéité (15; 115) qui fait face audit rotor (5; 105), le mince film de fluide étant causé par une fuite du fluide centrifugé par ledit rotor.

2. Dispositif d'étanchéité selon la revendication 1, caractérisé en ce que lesdits moyens de logement comprennent au moins un siège (14; 114) formé par un premier et un second anneaux (2; 3; 102; 103), ledit premier anneau (2; 102) définissant une section transversale sensiblement en forme de L comprenant un flasque plus long (6; 106) qui est solidaire du corps de pompe (4; 104) et un flasque plus court (7; 107) disposé en aval de la portion (9; 109) dudit rotor (5; 105) qui est face audit élément d'étanchéité (15; 115), et ledit second anneau (3; 103) définissant une section transversale sensiblement en forme de S et comprenant une patte (13; 113) solidarisée audit flasque plus long (6; 106) dudit premier anneau (2; 102) pour définir le fond dudit siège (14; 114).

3. Dispositif d'étanchéité selon les revendications 1 à 2, caractérisé en ce que ledit élément d'étanchéité (15) comprend un anneau en élastomère.

4. Dispositif d'étanchéité selon les revendications 1 à 3, caractérisé en ce que ledit élément d'étanchéité (115) comprend un anneau d'usure rigide présentant un siège latéral (114) adapté à un mouvement de coulissement radial sur un guide (119) conformé

de façon correspondante et formé sur ledit second anneau (103).

5. Pompe comprenant un dispositif d'étanchéité selon les revendications 1 à 4.
6. Pompe à étages multiples comprenant dans un au moins l'un de ses étages un dispositif d'étanchéité selon les revendications 1 à 4.



