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(21) International Application Number: PCT/SE00/00454 (22) International Filing Date: 8 March 2000 (08.03.00) (30) Priority Data: 9900862-5 9 March 1999 (09.03.99) SE (71) Applicant (for all designated States except US): ALFA LAVAL AB [SE/SE]; Hans Stahles väg, S-147 80 Tumba (SE). (72) Inventor; and (75) Inventor/Applicant (for US only): HEDIN, Sven [SE/SE]; S:t Eriksvägen 5, S-141 32 Huddinge (SE). (74) Agent: STRANDÉN, Lars-Erik; Alfa Laval AB, Hans Stahles väg, S-147 80 Tumba (SE).		(81) Designated States: CN, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: SEALING RING FOR A CENTRIFUGAL SEPARATOR		
(57) Abstract Sealing ring (1) for a centrifugal separator with an axially open annular groove (7) for the sealing ring in a first rotor part (2) and a second rotor part (3) relative to the first rotor part (2) axially movable second rotor part (3), against which the sealing ring (1) sealingly abuts. Both the sealing ring (1) and the groove (7) has a first annular portion (8 and 9, respectively) turned towards the second rotor part (3) and a second annular portion (14 and 11, respectively) turned away from the second rotor part (3). The second portion (11) of the groove has an outer annular recess (12) and an inner annular recess (16) whereas the second annular portion (14) of the sealing ring (1) has at least one projection (15), which is arranged to at least partly fill up the outer recess of the groove (7). The sealing ring (1) and the groove (7) are so shaped and adapted to one another that the sealing ring is kept in the groove locked by its shape and the tightening force is transferred from the sealing ring (1) to the first rotor part (2) by pressing the sealing ring (1) against the bottom (13) of the groove and so that the sealing ring (1) upon elastic deformation of the same and/or the first rotor part (2) can be brought into position in and be taken out of the groove.		

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Sealing ring for a centrifugal separator

The present invention concerns a sealing ring intended upon mounting to be inserted in an axial open annular groove in a first rotor part of a centrifugal separator, which has a second rotor part movable relative to the first rotor part, the second rotor part having an abutment surface intended to be brought in and out of sealing abutment against a sealing surface of a sealing ring mounted in the groove, the sealing ring being pressed axially in a direction into the groove.

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In Us 4 534 570 a sealing ring of this kind is disclosed, which is exposed to very high loads. To be able during operation to prevent liquid from leaking out of the centrifugal separator passing the sealing ring, the second rotor part has to be pressed with its abutment surface against the sealing surface with a force, which gives a sealing pressure, which with enough margin exceeds the liquid pressure, which the sealing ring shall keep tight against.

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The liquid pressure next to sealing rings of this kind in centrifugal separators is often very high as a result of the high number of revolutions at which rotors of centrifugal separators rotate. Therefore, the force needed for the tightening often is very high.

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It is then very important that the sealing ring with guarantee is firmly fixed in its groove after every axial movement of the second rotor part in and out of sealing abutment against the sealing surface of the sealing ring.

25

For this purpose sealing rings of this kind have conical radial delimiting surfaces and are pressed into annular grooves in the first rotor part, which also has conical delimiting surfaces.

30

However, this means that a very great portion of the tightening force is taken up by the conical surfaces, which causes high concentrations of stresses in adjacent portions of the first rotor part.

- 5 The object of the present invention is to accomplish a sealing ring of the kind initially described, which with guarantee can be kept in its groove in the first rotor part without causing high stresses in adjacent portions of the first rotor part.
- 10 According to the present invention this is accomplished by the fact
- that the sealing ring has a first annular portion turned towards the second rotor part, the first annular portion in unloaded condition having an outer radius, which at least is as large as the outer radius of a first
15 annular portion of the groove, which is arranged to receive this first annular portion of the sealing ring,
 - that the first annular portion of the sealing ring has a radial width, which at least is as large as the radial width of a section of the first
20 annular portion of the groove located closest to the second rotor part,
 - that the groove has a second annular portion turned away from the second rotor part, the second annular portion connecting to an axial end of the first annular portion of the groove and having an outer
25 annular recess, which extends axially from this axial end radially outwardly from the outer radius of the first portion at this axial end,
 - that the groove has a bottom located in the second annular portion of the groove at its end turned away from the second portion of the rotor,

- that the sealing ring has a second annular portion turned away from the second rotor part, the second annular portion connecting to an axial end of the first annular portion of the sealing ring and having at least one projection, which at least partly fills up the outer annular recess in the second annular portion of the groove and abuts at least against an inner surface of the recess located closest to this axial end, the axial end of the first annular portion of the sealing ring and the axial end of the first annular portion of the groove being located at substantially the same axial level,
 - that the groove also has an inner annular recess, which extends axially from the bottom of the groove to said section and radially inwardly from the inner radius of the section at an end of the section turned away from the second rotor part, the sealing ring in mounted condition being located radially outside the inner annular recess, and
 - that the inner annular recess is adapted, upon elastical deformation of at least one of the first rotor part, the first annular portion of the sealing ring and the second annular portion of the sealing ring, to enable the sealing ring to be turned in an inclined position in an axial cross-section to an insertion and removal direction, the maximum dimension perpendicular to this insertion and removal direction of the sealing ring being less than the minimum dimension of the groove perpendicular to this insertion and removal direction.
- Hereby, the retaining force is accomplished by means of locking by shape instead of by means of a clamping joint and the tightening force is transferred from the sealing ring to the first rotor part by pressing the sealing ring against the bottom of the groove, which causes much lower stress concentrations.

In a preferred embodiment the first and the second annular portion of the sealing ring are formed in one single integrated piece. The projection on the second annular portion of the sealing ring suitably extends substantially along the entire periphery of the sealing ring.

5

In a special embodiment of the invention the radial width of said section decreases by distance from the second rotor part.

Hereby, it can be prevented that liquid and pollutions are leaking into the groove.

10

The rotor parts are as suggestion rotatable around a rotational axis, the sealing ring extending concentrically around the rotational axis.

15 In a further embodiment of the invention the sealing ring is made of a polymer such as polyetheretherketone or polyoxymethylene.

In the following the invention is described more closely with reference to the figures on the attached drawings in which

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figure 1 schematically shows an axial section through a part of a centrifugal separator, which is provided with one embodiment of a sealing ring according to the invention, and

25 figure 2 shows the sealing ring in more detail.

In figure 1 a part of a rotor of a centrifugal separator is shown, which is provided with a sealing ring 1 according to the present invention. The rotor, which is rotatable around a rotational axis, not shown, has a first
30 rotor part 2 and a second rotor part 3. The two rotor parts 2 and 3 delimit

together a separation chamber 4. The second rotor part is axially movable with an abutment surface 5 in and out of abutment against a sealing surface 6 of the sealing ring 1, which is inserted in an annular groove 7, which surrounds a rotational axis, not shown.

5

The closer design of the sealing ring 1 and of the groove 7 according to the invention is apparent from figure 2.

The sealing ring 1 has a first sealing portion 8 turned towards the second rotor part 3, the first annular portion 8 having in unloaded condition an outer radius, which is at least as large as the outer radius of a first annular part 9 of the groove 7, which is arranged to receive this first annular portion 8 of the sealing ring 1.

15 The first annular portion 8 of the sealing ring has a radial width which is at least as large as the radial width of an axial section 10 of the first annular portion 9 of the groove 7 located closest to the second rotor part 3. The groove 7 has a second annular portion 11 turned away from the second rotor part 3 and a bottom 13 located in the second annular portion 11 of the groove 7 at the end of it turned away from the second rotor part 3.

20 This second annular portion 11 connects to an axial end of the first annular portion 9 of the groove 7 and has an outer annular recess 12. The recess 12 extends axially from this axial end and radially outwardly from the outer radius of the first portion 9 at this axial end.

25

The sealing ring has a second annular portion 14 turned away from the second rotor part, the second annular portion 14 connecting to an axial end of the first annular portion 8 of the sealing ring and having a projection 15, which at least partly fills up the outer annular recess 12 in the

30 second annular portion 11 of the groove 7 and abuts at least against an

inner surface of the recess 12 located closest to this axial end. The axial end of the first annular portion 8 of the sealing ring 1 and the axial end of the first annular portion 9 of the groove 7 are located at substantially the same axial level. The groove 7 also has an inner annular recess 16,
5 which extends axially from the bottom of the groove 7 to said section 10 and radially inwardly from the inner radius of the section 10 at the end of the section 10 turned away from the second rotor part 3, the inner annular recess 16 being empty.

10 The inner annular recess 16 is arranged upon elastical deformation of at least one of the first rotor part 2, the first annular portion 8 of the sealing ring and the second annular portion 14 of the sealing ring, to enable the sealing ring 1 to be put in an inclined position in an axial cross-section relative to the groove 7 to a direction of insertion and removal, the
15 maximum dimension of the sealing ring 1 perpendicular to this insertion and removal direction being less than the minimum dimension of the groove 7 perpendicular to this insertion and removal direction.

Which one of the elements which is deformed or which is deformed
20 mostly depends on their stiffnesses relative to one another. The decisive thing is that the turning of the sealing ring into an inclined position is made possible by the deformation so that the sealing ring can be brought in and out of the groove. If a sealing ring made of a stiff metallic material such as bronze is used instead, the first rotor part 2 is mainly deformed.
25 If a sealing ring made of a polymer such as polyetheretherketone or polyoxymethylene is used instead the sealing ring 1 is mainly deformed by the second annular portion 14 of it being compressed.

In the shown example the sealing ring 1 is shaped in one single integrated piece, which extends around the rotational axis. Suitably, the projection extends along the entire periphery of the sealing ring.

Claims

1. A sealing ring (1) intended upon mounting to be inserted in an axial open annular groove (7) in a first rotor part (2) of a centrifugal separator, which has a second rotor part (3) movable relative to the first rotor part (2), the second rotor part having an abutment surface (5) intended to be brought in and out of sealing abutment against a sealing surface (6) of a sealing ring (1) mounted in the groove (7), the sealing ring being pressed axially in a direction into the groove (7),
- characterised in
- that the sealing ring (1) has a first annular portion (8) turned towards the second rotor part (3), the first annular portion in unloaded condition having an outer radius, which at least is as large as the outer radius of a first annular portion (9) of the groove (7), which is arranged to receive this first annular portion (8) of the sealing ring (1),
 - that the first annular portion (8) of the sealing ring (1) has a radial width, which at least is as large as the radial width of a section (10) of the first annular portion (9) of the groove (7) located closest to the second rotor part (3),
 - that the groove (7) has a second annular portion (11) turned away from the second rotor part (3), the second annular portion (11) connecting to an axial end of the first annular portion (9) of the groove (7) and having an outer annular recess, which extends axially from this axial end radially outwardly from the outer radius of the first portion (9) at this axial end,

- that the groove has a bottom (13) located in the second annular portion (11) of the groove (7) at its end turned away from the second portion (3) of the rotor,
- 5 – that the sealing ring (1) has a second annular portion (14) turned away from the second rotor part (3), the second annular portion (14) connecting to an axial end of the first annular portion (8) of the sealing ring (1) and having at least one projection (15), which at least partly fills up the outer annular recess (12) in the second annular portion (11) of the
10 groove (7) and abuts at least against an inner surface of the recess (12) located closest to this axial end, the axial end of the first annular portion (8) of the sealing ring (1) and the axial end of the first annular portion (9) of the groove (7) being located at substantially the same axial level,
15 – that the groove (7) also has an inner annular recess (16), which extends axially from the bottom (13) of the groove (7) to said section (10) and radially inwardly from the inner radius of the section (10) at an end of the section (10) turned away from the second rotor part (3),
20 the sealing ring (1) in mounted condition being located radially outside the inner annular recess (16), and
– that the inner annular recess (16) is adapted upon elastical deformation of at least one of the first rotor part (2), the first annular portion (8)
25 of the sealing ring (1) and the second annular portion of the sealing ring (1) to enable the sealing ring (1) to be turned in an inclined position in an axial cross-section to an insertion and removal direction, the maximum dimension perpendicular to this insertion and removal direction of the sealing ring being less than the minimum dimension of
30 the groove (7) perpendicular to this insertion and removal direction.

2. A sealing ring according to claim 1, characterised in that the first and the second annular portion (8 and 14, respectively) of it are formed in one single integrated piece.
- 5 3. A sealing ring according to any one of the claims 1 or 2, characterised in that the projection (15) on the second annular portion (14) of the sealing ring (1) extends substantially along the entire periphery of the sealing ring (1).
- 10 4. A sealing ring according to any one of the claims 1-3, characterised in that the radial width of the section (10) decreases by distance from the second rotor part (3).
5. A sealing ring according to any one of the preceding claims, characterised in that the rotor parts (2 and 3) are rotatable around a rotational axis, the sealing ring (1) extending concentrically around the rotational axis.
- 15 6. A sealing ring according to any one of the preceding claims, characterised in that it is made of a polymer.
- 20 7. A sealing ring according to claim 6, characterised in that it is made of polyetheretherketone.
- 25 8. A sealing ring according to claim 6, characterised in that it is made of polyoxymethylene.

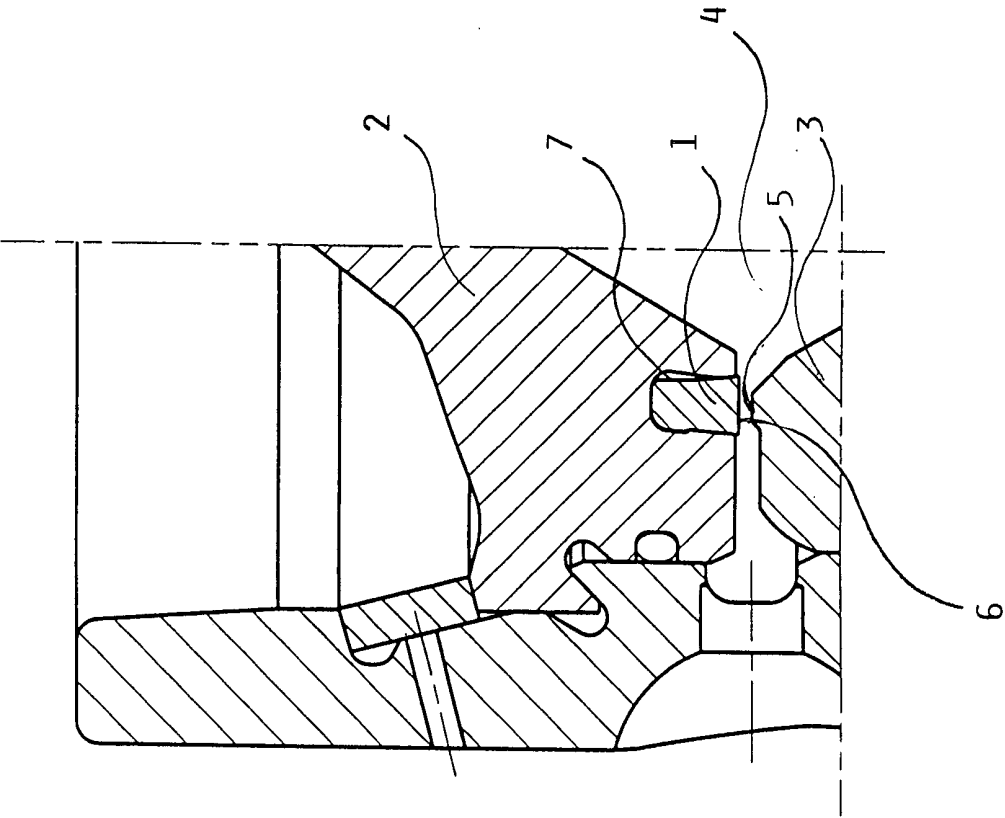


Fig. 1

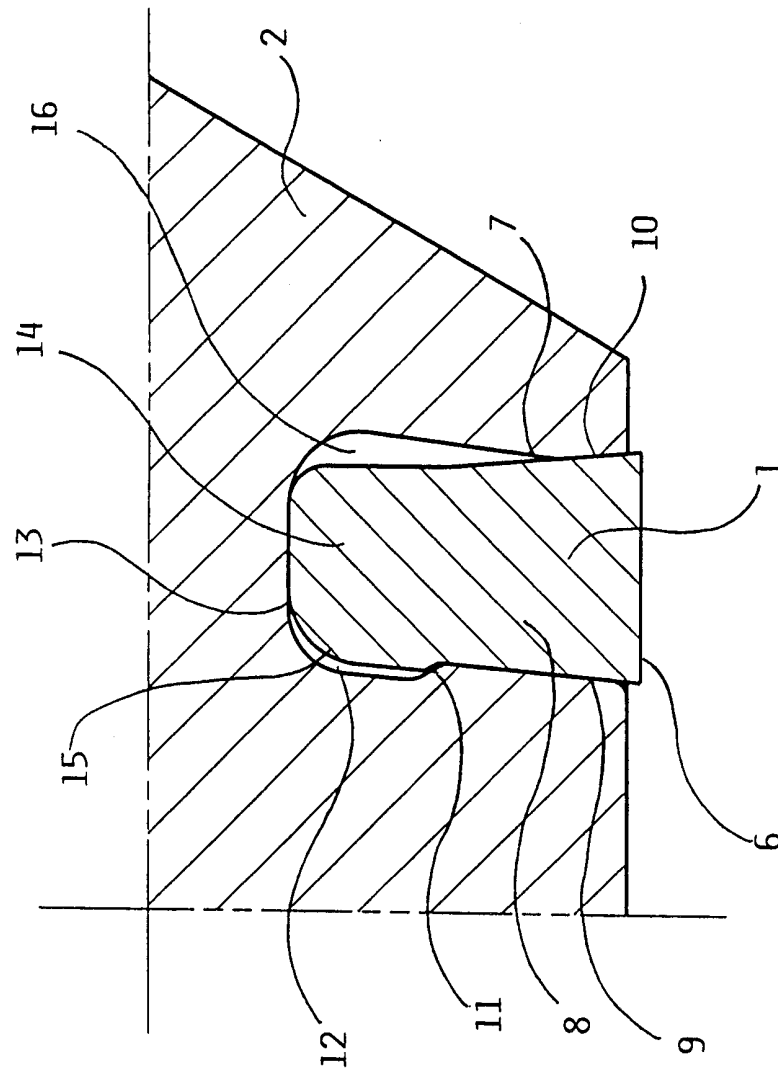


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/00454

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B04B 1/14, B04B 7/08, F16J 15/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4534570 A (MUNDE), 13 August 1985 (13.08.85), figures 1-3 --	1
A	US 2828069 A (P. STEINACKER ET AL), 25 March 1958 (25.03.58), figures 1-6 -- -----	1

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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