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(54) **Title:** A SEALING ARRANGEMENT FOR A HYDRODYNAMIC MACHINE

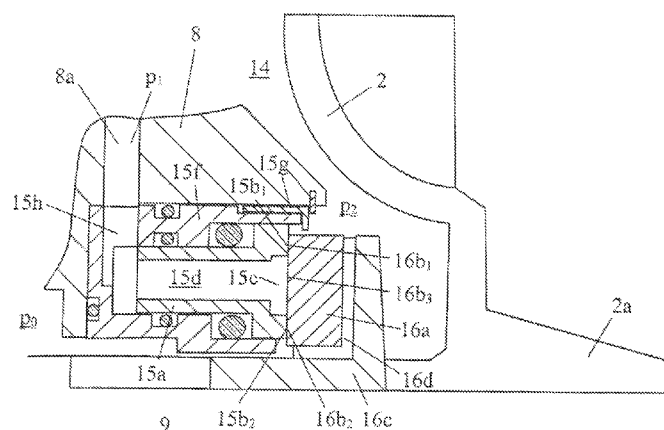


Fig 3

(57) **Abstract:** The invention relates to a sealing arrangement for a hydrodynamic machine. The hydrodynamic machine comprises a housing (8), a rotary shaft (9) extending through an opening (8a) of the housing (8), a rotary component (2) arranged in the housing (8) connected to the rotary shaft (9), a sealing arrangement (15, 16) and a lubrication passage. The sealing arrangement comprises a stationary part (15) which is connected to the housing (8) and which comprises a first sealing ring (15a) provided with a first annular sealing surface (15b), and a rotatable part (16) which is connected to the rotary component (2) and which comprises a second sealing ring (16a) provided with a second annular sealing surface (16b) configured to sealingly abut against the first annular sealing surface (15b), and a lubrication passage configured to supply a lubricant to the sealing surfaces (15b, 16b). The lubrication passage comprises a lubrication channel (15c) formed in a space between a radially outer part of the annular sealing surfaces (15b1, 16b1) and a radial inner part of the annular sealing surfaces (15b2, 16b2).



5 **A sealing arrangement for a hydrodynamic machine**

BACKGROUND OF THE INVENTION AND PRIOR ART

10 The present invention relates to a sealing arrangement for a hydrodynamic machine according to the preamble of claim 1.

15 A hydrodynamic machine such as a hydrodynamic retarder comprises a stator and a rotor arranged in a housing. The stator and rotor may have a substantially corresponding design with a multiplicity of blades arranged in a respective annular
20 shell. The stator and the rotor are arranged such that the annular shells together form a toroidal space. During activation of the retarder a working medium is supplied to the toroidal space. A rotary shaft which extends through an opening of the housing transfers a rotary motion from a drive line of the vehicle to the rotor. A mechanical face seal is usually arranged in the space between the opening of the housing and the
25 rotary shaft in order to prevent leakage of the working medium out of the housing. A mechanical face seal comprises a sealing ring connected to the housing and a sealing ring rotating with the shaft. The sealing rings comprise sealing surfaces of a high degree of flatness abutting against each other. During operation, the sealing surfaces of the sealing rings slide in relation to each other. The working medium may be oil, water
30 or a water mixture. It has been found that the sealing surfaces is worn out relatively fast when water or a water mixture are used as working medium.

35 WO 2011/082759 shows a hydrodynamic retarder comprising a stator and a rotor arranged inside a casing. A drive shaft drives the rotor. The drive shaft being sealed off with respect to the casing by means of a sliding ring seal in order to prevent any escape of working medium between the drive shaft and the casing. The sliding ring seal has a sealing liquid supply in order to cool and/or to lubricate the sliding ring seal. The sliding ring seal has a first sliding ring and a second sliding ring which are arranged to enclose one another concentrically in the radial direction and each have a sealing
40 surface, and which, together with a mating element, seal off a sealing gap running in the radial direction with respect to the drive shaft. A sealing liquid channel opens into

the sliding ring seal in the radial direction between the two sealing surfaces in order to cool and/or to lubricate the two sealing surfaces with sealing liquid.

SUMMARY OF THE INVENTION

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The object of the present invention is to provide a sealing arrangement for a hydrodynamic machine where the sealing surfaces achieve a cooling and lubrication, which prevent wear of the sealing surfaces substantially independent of the working medium used in the hydrodynamic machine.

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The above mentioned objects are achieved by the sealing arrangement according to the characterizing portion of claim 1. The sealing arrangement seals a space between a surface defining an opening of a housing and a rotary shaft having an extension through the opening. The sealing arrangement comprises a first sealing ring connected to the housing having an annular sealing surface and a second sealing ring connected to the rotary component having an annular sealing surface configured to sealingly abut against the sealing surface of the first sealing ring. Even if the sealing surfaces have a very high degree of flatness and smoothness, they are heated when the sealing rings slides in contact with each other. In order to cool the sealing surfaces and reduce the wear between the sealing surfaces, lubricant is supplied to a lubrication channel formed in a space between a radially outer part of the annular sealing surfaces and a radially inner part of the annular sealing surfaces. The supply of lubricant to the lubricant channel cools the radially outer part of the sealing surfaces as well as the radially inner part of the sealing surfaces in a very effective manner substantially independent of the working medium used in the hydrodynamic machine.

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According to an embodiment of the invention, said lubrication channel is formed as a circular arc. In this case, the lubrication channel is located at a constant radial distance from a rotational axis of the rotary shaft. As a consequence, the radial extension of the radially outer part of the sealing surfaces as well as the radially inner part of the sealing surfaces will be constant. However, it is possible to give the lubrication channel a substantially arbitrary shape along the sealing surfaces where the lubricant cools and lubricates the radially outer part of the sealing surfaces as well as the radially inner part of the sealing surfaces in a favorable manner.

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According to an embodiment of the invention, said lubrication channel extends almost completely around the annular sealing surfaces. In this case, it is possible to cool and lubricate all areas around the annular sealing surfaces in a favorable manner. The lubrication channel may extend at least 350° around the annular sealing surfaces.

- 5 Alternatively, it is possible to use two or more separate lubricant channels extending along different parts of the annular sealing surfaces.

- According to an embodiment of the invention, the lubrication channel comprises an end portion provided with an inlet hole where the lubricant enters the lubrication
10 channel and an opposite end portion with an outlet hole where the lubricant leaves the lubrication channel. Such a positioning of the inlet hole and the outlet hole ensure a lubricant flow along the whole lubrication channel. However, it is possible to provide the lubrication channel with several inlet holes and several outlet holes. The inlet hole and/or the outlet hole may extend through the first sealing ring. It is practical and
15 relatively easy to arrange the inlet hole and the outlet hole of the lubricant channel in the form of through holes extending through the first non-rotatable sealing ring.

- According to an embodiment of the invention, the end portions of the lubrication channel is connected to each other via a lubrication passage having a smaller cross
20 section area than the lubrication channel. In this case, the lubrication channel and the lubrication passage form together a continuous annular lubrication groove. Such a lubrication groove divides completely a radial outer sealing portion from a radially inner sealing portion. The lubrication passage is designed with a flow areas of a size such that it does not significantly influence on the lubricant flow through the
25 lubrication channel.

- According to an embodiment of the invention, the second sealing ring rotates in a specific direction of rotation around an axis of rotation of the rotary shaft, wherein the lubrication channel is designed such that the lubricant flows in the same direction of
30 rotation around said axis of rotation in the lubrication channel. Thereby, the rotational movement of the second sealing ring helps to drive the lubricant flow in the lubricant channel from the inlet hole to the outlet hole.

- According to an embodiment of the invention, said lubrication channel is defined by a
35 groove in at least one of the sealing surfaces. The annular sealing surfaces of the first-sealing ring and the second sealing ring are flat. In order to provide a lubrication

channel between the radially outer part and the radially inner part of the sealing surfaces, it is necessary to provide a groove in at least one of the sealing surfaces. Preferably, said lubrication channel is defined by a groove in the sealing surfaces of the first sealing ring and a flat portion of the sealing surface of the second sealing ring.

5 Both sealing rings are manufactured of hard materials.

According to an embodiment of the invention, the sealing arrangement comprises a power member configured to press the sealing surfaces of the sealing rings against each other. It is necessary to press the sealing surfaces against each other with a certain
10 force for providing a tight sealing between the sealing surfaces. The power member may be a spring member. By means a suitably dimensioned spring member it is possible to provide a force of a suitable size pressing the sealing surfaces together. Furthermore, with a suitable design of the sealing arrangement, the pressure inside the housing may help to press the sealing surfaces of the sealing rings against each other.

15 According to an embodiment of the invention, the stationary part of the sealing arrangement comprises said spring member and an annular mounting unit by which the stationary part is releasably mounted in the housing. Such a stationary part of the sealing arrangement includes few components. The annular mounting unit may
20 comprises an inlet channel receiving lubricant from a lubrication inlet line in the housing and an outlet channel delivering lubricant to a lubrication outlet line in the housing. Thus, the mounting unit and the first sealing ring of the stationary part of the sealing arrangement comprises parts of the lubrication passage supplying lubricant to and from the lubrication channel where the lubricant lubricates and cools the sealing
25 surfaces.

According to an embodiment of the invention, the rotatable part of the sealing arrangement comprises an annular support member which is fixedly arranged on the rotary component and which supports the second sealing ring. By means of such a
30 support member it is possible to support the second sealing ring in a corresponding radial position radial position in relation to the rotary shaft as the first sealing ring. The second sealing ring may be supported on the annular support member via a rubber sealing. The rubber sealing provides a tight connection between the second sealing ring and the annular support member. Furthermore, it provides a somewhat resilient support
35 of the second sealing ring in relation to the first sealing ring which facilitate a tight abutment between the annular sealing surfaces of the sealing rings.

According to an embodiment of the invention, the lubricant is coolant. In certain hydrodynamic apparatus such as hydrodynamic retarders, coolant is used as working medium instead of oil. In this case, it is a higher risk that the sealing surfaces are worn out. In view of this fact, it is especially appropriate to use the sealing arrangement according to the invention in hydrodynamic machines using other mediums than oil.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, a preferred embodiment of the invention is described, as an example, with reference to the attached drawings, on which:

- Fig. 1 shows a cross section view of a hydrodynamic retarder with a sealing arrangement according to the invention,
- Fig. 2 shows the first sealing ring in Fig. 1 more in detail,
- Fig. 3 shows a cross section view of an inlet hole to the sealing arrangement,
- Fig. 4 shows a cross section view of a resilient portion of the sealing arrangement and
- Fig. 5 shows a cross section view of an outlet hole of the sealing arrangement.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Figure 1 shows a hydrodynamic brake in the form of a retarder of a vehicle powered by a combustion engine or an electric engine. The retarder comprises a stator 1 and a rotor 2. The stator 1 has an annular shell 3 with a multiplicity of blades 4. The blades 4 are usually arranged at equal spacing along the annular shell 3. The rotor 2 is of corresponding design and it comprises an annular shell 5, which incorporates a multiplicity of blades 6. The blades 6 are usually arranged at equal spacing. The shells 3, 5 of the stator 1 and rotor 2 are arranged so that they together form a toroidal space 7. The stator 1 is arranged firmly on a stationary surface of the vehicle. A housing 8 encloses the stator 1 and the rotor 2. The rotor 2 incorporates a shaft portion 2a which is connected firmly to a rotary shaft 9 extending through an opening 8a of the housing 8. The rotary shaft 9 is rotatably arranged around a rotary axis A. An outer portion of the rotary shaft 9 is engaged by a driveline of the vehicle. Thus, the rotor 2 will thus rotate with the driveline of the vehicle.

To exert a braking action on the hydrodynamic brake, a working medium is supplied to the toroidal space 7. In this case, the working medium is coolant, which is supplied from a cooling system cooling the engine of the vehicle. The coolant is supplied, via a
5 coolant passage 10 and a multiplicity of apertures 11 in the stator 1 to the toroidal space 7. During the braking process, the kinetic energy of the coolant is converted to thermal energy in the toroidal space 7. The coolant leaves the toroidal space 7 via a multiplicity of apertures 19 at high pressure. The high pressure is created by the high
10 medium flow in the toroidal space 7. The multiplicity of apertures 19 lead the coolant to a coolant passage 20 and then to the cooling system. The coolant is also connected to a circular groove 13 via a circular aperture 12 between the radially outer parts of the stator 1 and rotor 2. The groove circular aperture 13 is connected to a space 14 located between the housing 8 and an outer surface of the rotor 2. As a consequence, coolant with a corresponding high pressure enters into the space 14. A sealing arrangement is
15 configured to prevent leakage of coolant from the space 14 to the ambient via the opening 8a of the housing 8.

The sealing arrangement comprises a stationary part 15 connected to the housing 8 and a rotatable part 16 firmly connected to the rotary shaft 9. The stationary part 15
20 comprises a first sealing ring 15a, which is shown more in detail in Figs. 2-5. The rotatable part 16 comprises a second sealing ring 16a, which is shown more in detail in Figs. 3-5. Fig. 2 shows the first sealing ring 15a in a separated state. The first sealing ring 15a may consist of carbon or another hard material. The first sealing ring 15a comprises at one side a flat annular sealing surface 15b provided with a circular arc-
25 shaped groove 15c. The arc-shaped groove 15c extends nearly one lap around the annular sealing surface 15b. An inlet hole 15d is located at one end of the arc-shaped groove 15c and an outlet hole 15e is located at an opposite end of the arc-shaped groove 15c. The inlet hole 15d and the outlet hole 15e are through holes extending through the first sealing ring 15a. The inlet hole 15d and the outlet hole 15e are located
30 at a relatively short distance from each other. The coolant enters the arc-shaped groove 15c via the inlet hole 15d and it leaves the arc-shaped groove 15c via the outlet hole 15e. A lubricant passage 18 is arranged between the end portions of the lubrication channel 15c. The lubrication passage 18 has a smaller flow area than the lubrication channel 15c. Thus, the lubricant flow through the lubrication passage is smaller than
35 the lubricant flow through the lubrication channel 15c. The lubrication passage 18 and the lubrication channel 15c separate a radially outer sealing surface 15b₁ and a radially

inner sealing surface 15b₂ of the first sealing ring 15 from each other. A number of spring members 17, which are indicated with dotted lines in Fig 2, are arranged at equal or almost equal spacing on an opposite side to the side including the sealing surface 15b and the arc-shaped groove 15c.

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Fig. 3 shows a cross section view through the inlet hole 15d of the first sealing ring 15a when it is in a mounted state. The stationary part 15 of the sealing arrangement comprises an annular stationary unit 15f. The annular stationary unit 15f is releasably mounted in an annular recess of the housing 8 by means of suitable mounting elements 15g. The annular stationary unit 15f includes the spring members 17 and the first sealing ring 15a. The housing 8 comprises a coolant inlet line 8a directing coolant at pressure p₁ to an inlet channel 15h of the stationary unit 15f. The inlet channel 15h directs the coolant, via the inlet hole 15d, to inlet portion of the arc-shaped groove 15c. The sealing surface 15b of the first sealing ring 15a comprises a radially outer part 15b₁ arranged radially outside of the arc-shaped groove 15c where it is in contact with a radially outer part 16b₁ of the second sealing surface 16b. The sealing surface 15b comprises a radially inner part 15b₂ arranged radially inside of the groove 15c where it is in contact with a radially inner part 16b₂ of the second sealing surface 16b. The first sealing ring 15a and the second sealing ring 16a may be manufactured of carbon, silicon carbide, ceramic or tungsten carbide or equal hard materials. The second sealing ring 16a comprises an annular support member 16c fixedly arranged on the shaft portion 2a of the rotor 2. The support member 16c supports the second sealing ring 16a by means of a rubber sealing 16d or similar material to assure a tight connection.

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Fig. 4 shows a cross section view of a part of the first sealing ring 15a including one of the spring members 17. The spring members 17 is a compression spring arranged in a recess of the stationary unit. The spring member 17 acts between a bottom surface in the recess and a surface of the first sealing ring 15a located on opposite side to the sealing surface 15b and the arc-shaped groove 15c. Consequently the spring members 17 act with a spring force on the first sealing ring 15a pressing the sealing surface 15b of the first sealing ring 15a against the sealing surface 16b of the second sealing ring 16a.

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Fig. 5 shows a cross section view through the outlet hole 15e of the first sealing ring 15a. When the coolant has flown through lubrication channel formed by the arc-shaped

groove 15c in the first sealing ring 15a and a flat surface of the second sealing ring 16a, it leaves the lubrication channel and enters the outlet hole 15e. The outlet hole 15e directs the coolant to an outlet channel 15i in the stationary unit 15f whereupon the coolant is directed back to the cooling system via an outlet line 8b in the housing 8 at the pressure p_3 which is slightly lower than the pressure p_1 due to flow pressure drop.

Ambient air pressure p_0 prevails on the outside of the housing 8. The coolant is continuously supplied to the arc-shaped groove 15c with a certain positive pressure p_1 corresponding to the pressure of the coolant in the cooling system. When the retarder is activated, coolant is let into the toroidal space 7 and into the space 14 between the housing 8 and the rotor 2. At high braking torque the pressure p_2 is higher than the pressure p_1 and p_3 . At low braking torque the pressure p_2 may be lower than the pressure p_1 and p_3 . The radially outer sealing surface 15b₁ of the first sealing ring 15a and the radially outer sealing surface 16b₁ of the second sealing ring 16a provides a tight sealing between the coolant with the pressure p_2 in the housing 8 and the coolant with the pressure p_1 in the groove 15c close to the inlet hole 15d and the pressure p_3 close to the outlet hole 15e when the retarder is activated. The inner radially sealing surface 15b₂ of the first sealing ring 15a and the inner radially sealing surface 16b₂ of the second sealing ring 16a provides a tight sealing between the coolant with the pressure p_1 in the groove 15c close to the inlet hole at 15d and the pressure p_3 close to the outlet hole 15e and the ambient air pressure p_0 on the outside of the housing 8. As a consequence, the sealing arrangement provides a sealing acting in two steps between the high coolant pressure p_2 in the space 14 in the housing 8 and the ambient air pressure p_0 . Such a sealing arrangement prevents leakage of coolant to the ambient air in a very effective manner.

When the vehicle runs, the power train of the vehicle provides a rotary movement of the rotor 2. As a consequence, the sealing surface 16b of the second sealing ring 16a slides in contact with the sealing surface 15b of the first sealing ring 15a. Inevitably, the friction between the sealing surfaces 15b, 16b generates heat. In order to cool the sealing surfaces 15b, 16b and reduce wear of the sealing surfaces 15b, 16b, coolant is continuously supplied from the cooling system, via the inlet line 8a in the housing 8, the inlet channel 15d and the inlet hole 15c, to the arc-shaped groove 15c of the first sealing ring 15a. In the arc-shaped groove 15c, the coolant comes in contact with a flat part 16b₃ of the sealing surface 16b located between the radially outer part 16b₁ and the radially inner part 16b₂ of the second sealing surface 16b. When the coolant flows

- along the arc-shaped groove 15c, it cools and lubricates the radially outwardly located parts 15b₁, 16b₁ of the sealing surfaces 15b, 16b and as well the radially inwardly located parts 15b₂, 16b₂ of the sealing surfaces 15b, 16b in a very effective manner. Since the arc-shaped groove 15c nearly extends one lap around the first sealing ring 15a,
- 5 the coolant cools and lubricates the entire sealing surfaces 15b, 16b. Furthermore, the second sealing ring 16a rotates in a direction such that it promotes the coolant flow along the circular arc-shaped groove 15c from the end portion comprising the inlet hole 15d to the end portion comprising the outlet hole 15e.
- 10 The invention is not restricted to the described embodiment but may be varied freely within the scope of the claims.

Claims

1. A sealing arrangement for a hydrodynamic machine, wherein the hydrodynamic machine comprises a housing (8), a rotary shaft (9) extending through an opening (8a) of the housing (8), a rotary component (2) arranged in the housing (8) connected to the rotary shaft (9) and a sealing arrangement (15, 16) configured to seal a space between a surface defining the opening (8a) of the housing and the rotary shaft (2), wherein the sealing arrangement comprises a stationary part (15) which is connected to the housing (8) and which comprises a first sealing ring (15a) provided with a first annular sealing surface (15b), and a rotatable part (16) which is connected to the rotary component (2) and which comprises a second sealing ring (16a) provided with a second annular sealing surface (16b) configured to sealingly abut against the first annular sealing surface (15b), and a lubrication passage configured to supply a lubricant to the sealing surfaces (15b, 16b), characterized in that the lubrication passage comprises a lubrication channel (15c) formed in a space between a radially outer part of the annular sealing surfaces (15_{b1}, 16_{b1}) and a radial inner part of the annular sealing surfaces (15_{b2}, 16_{b2}).
2. A sealing arrangement according to claim 1, characterized in that said lubrication channel (15c) is formed as a circular arc.
3. A sealing arrangement according to claim 1 or 2, characterized in that a said lubrication channel (15c) extends almost completely around the annular sealing surfaces (15b, 16b).
4. A sealing arrangement according to claim 1 or 2, characterized in that the lubrication channel (15c) comprises an end portion provided with an inlet hole (15d) where the lubricant enters the lubrication channel (15c) and an opposite end portion with an outlet hole (15e) where the lubricant leave the lubrication channel (15c).
5. A sealing arrangement according to claim 4, characterized in that the inlet hole (15d) and/or the outlet hole (15e) extend through the first sealing ring (15a).
6. A sealing arrangement according to claim 4 or 5, characterized in that the end portions of the lubrication channel (15c) are connected to each other via a lubrication passage (18) having a smaller cross section area than the lubrication channel (15c).

7. A sealing arrangement according to any one of the preceding claims 4 to 6, characterized in that the second sealing ring (16a) rotates in a specific direction of rotation around an axis of rotation (A) of the rotary shaft (9), wherein the lubrication channel (15c) is designed such that the lubricant flows in the lubrication channel (15c) in the same direction of rotation around said axis of rotation (A).
8. A sealing arrangement according to any one of the preceding claims, characterized in that said lubrication channel is defined by a groove (15c) in at least one of the sealing surfaces (15b).
9. A sealing arrangement according to claim 8, characterized in that said lubrication channel is defined by a groove (15c) in the first sealing surfaces (15b) and a flat portion of the second sealing surface (16b).
10. A sealing arrangement according to any one of the preceding claims, characterized in that the sealing arrangement comprises a power member (17) configured to press the sealing surfaces (15b, 16b) against each other, wherein the stationary part (15) of the sealing arrangement comprises said power member (17) and an annular mounting unit (15f) by which the stationary part is releasably mountable in the housing (8).
11. A sealing arrangement according to claim 10, characterized in that the annular mounting unit (15f) comprises an inlet channel (15h) receiving lubricant from a lubrication inlet line (8a) in the housing (8) and an outlet channel (15i) delivering lubricant to a lubrication outlet line (8b) in the housing (8).
12. A sealing arrangement according to any one of the preceding claims, characterized in that the rotatable part (16) of the sealing arrangement comprises an annular support member (16c) which is fixedly arranged on the rotary component (2) and which supports the second sealing ring (16a).
13. A sealing arrangement according to claim 11, characterized in that the second sealing ring (16a) is mounted on the annular support member (16c) via a sealing member (16d).

14. A hydrodynamic machine comprising a sealing arrangement according to any one of the preceding claims wherein the lubricant is coolant.

15. A vehicle comprising a hydrodynamic machine according to claim 16.

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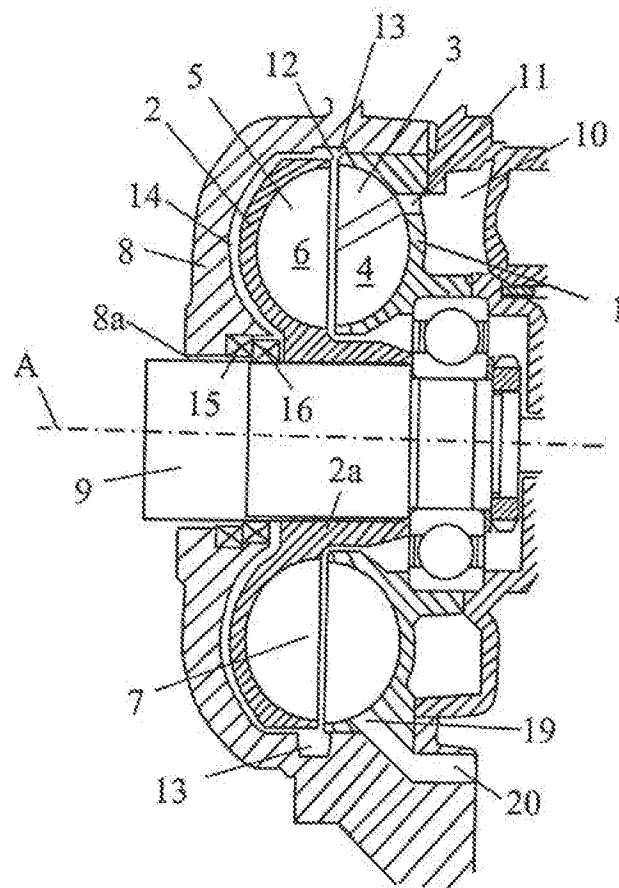


Fig 1

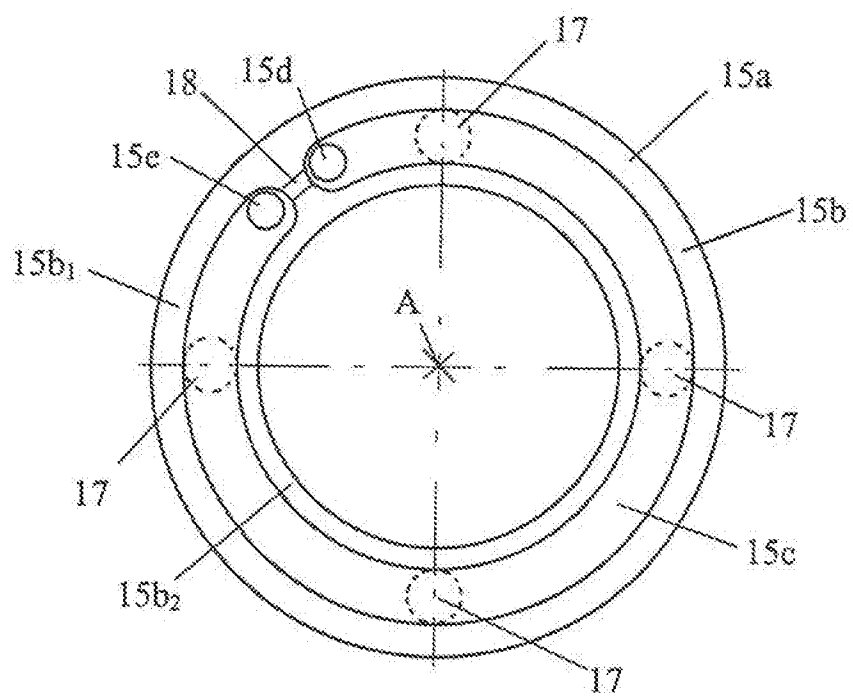


Fig 2

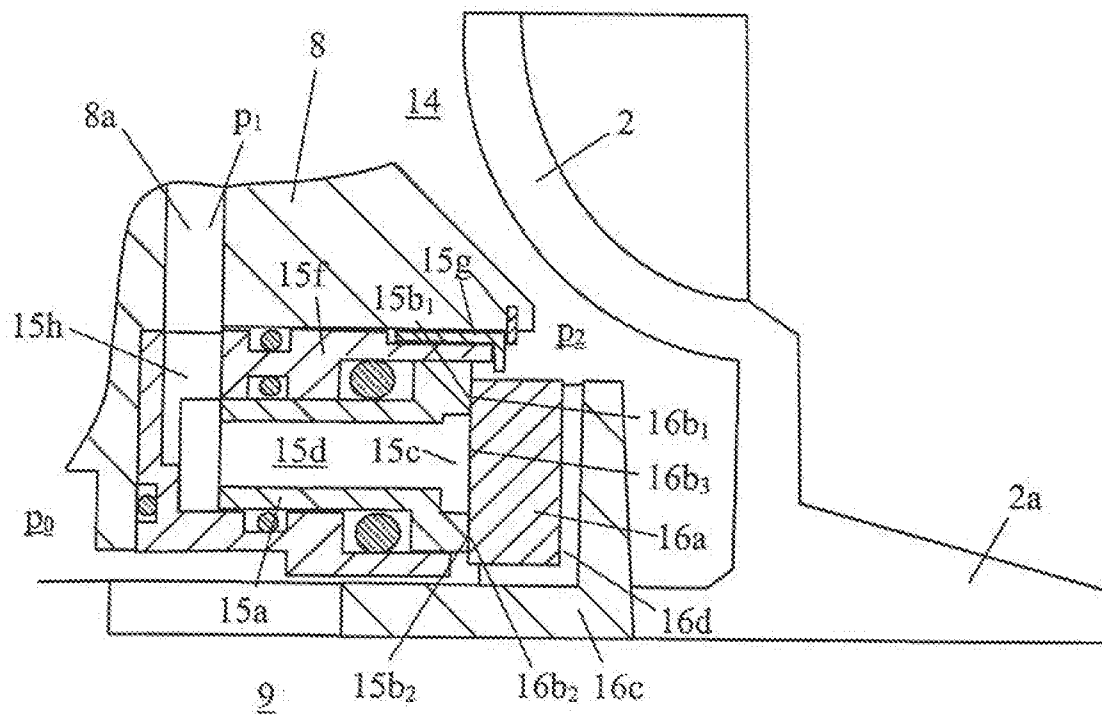


Fig 3

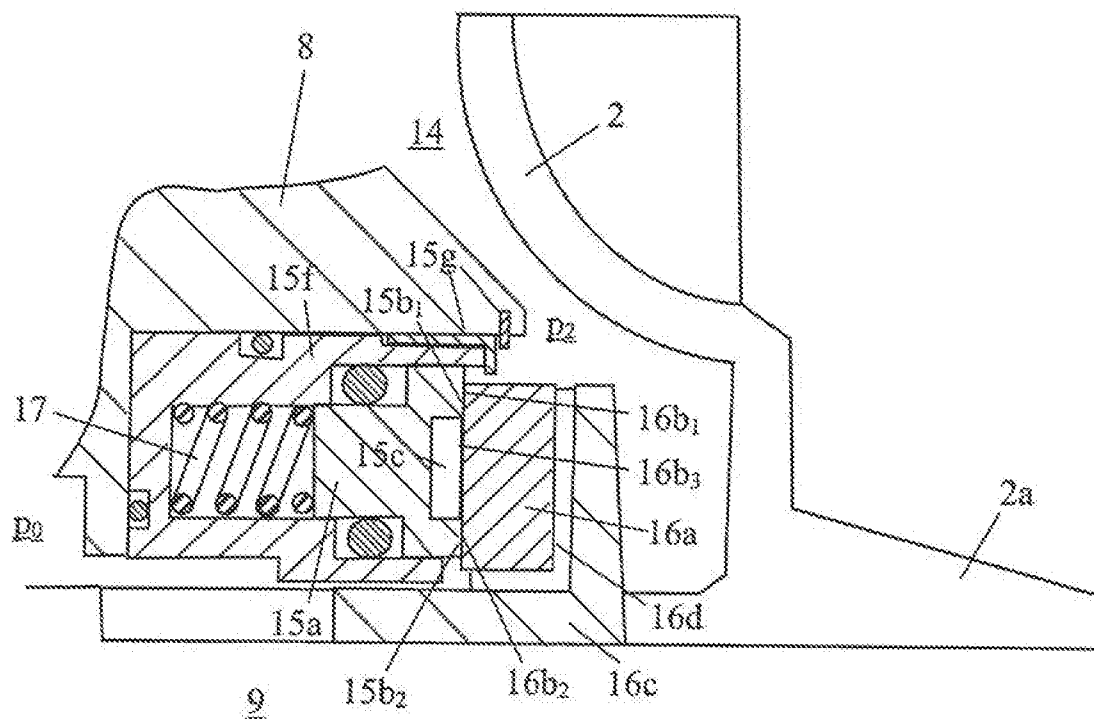


Fig 4

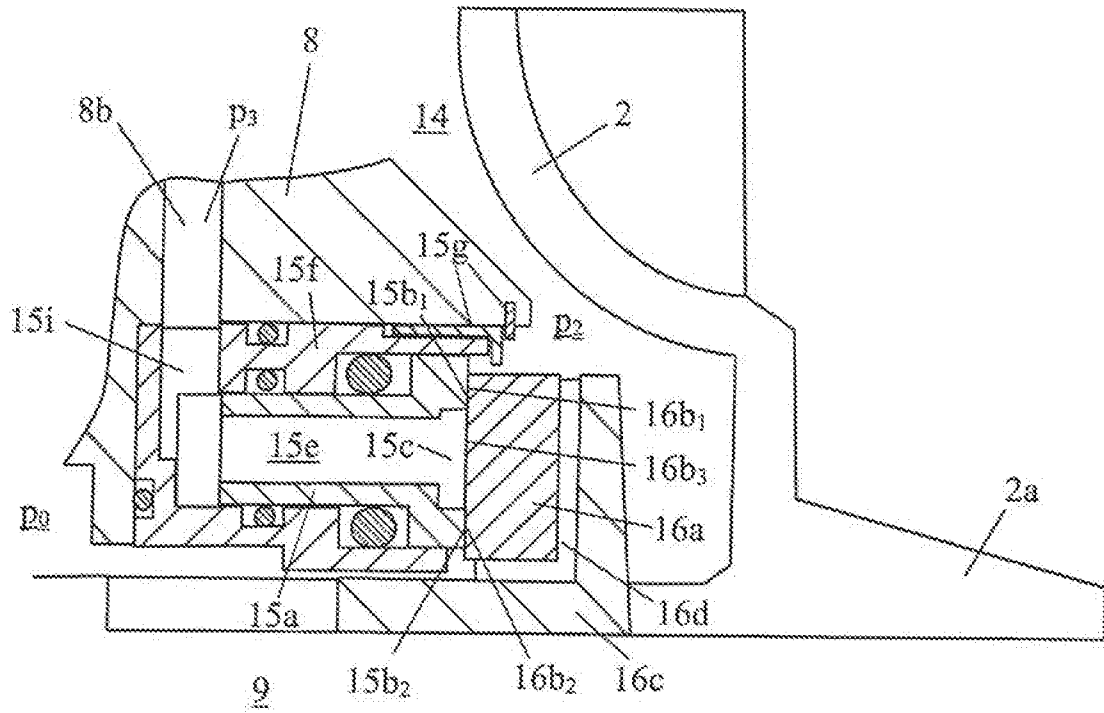


Fig 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2016/050261

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B60T, F01C, F03B, F04B, F04C, F04D, F16D, F16J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3917289 A (IVANOV VIKTOR VASILIEVICH ET AL), 4 November 1975 (1975-11-04); figures 2-3; column 1, lines 5-11; column 3, line 46 - column 4, line 15; column 4, lines 35-43; column 5, lines 40-53 --	1-15
A	US 4489951 A (KATAOKA TADASHI ET AL), 25 December 1984 (1984-12-25); figures 1,11; column 1, line 44 - column 2, line 63 --	1-15
A	US 20140241887 A1 (NEUENSCHWANDER PETER ET AL), 28 August 2014 (2014-08-28); figure 3; paragraphs [0033]-[0039] -- -----	1-15

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

* Special categories of cited documents:

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

17-05-2016

Date of mailing of the international search report

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Name and mailing address of the ISA/SE

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Continuation of: second sheet

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B60T 10/02 (2006.01)

F16D 57/04 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2016/050261

US	3917289 A	04/11/1975	SU	406481 A1	05/12/1974
US	4489951 A	25/12/1984	NONE		
US	20140241887 A1	28/08/2014	CA	2852164 A1	10/05/2013
			CN	103906936 A	02/07/2014
			DE	102011085681 A1	08/05/2013
			EP	2773877 A1	10/09/2014
			HK	1199084 A1	19/06/2015
			JP	2014533342 A	11/12/2014
			KR	20140083051 A	03/07/2014
			SG	11201401938 A	30/10/2014
			WO	2013064638 A1	10/05/2013