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(54) Benævnelse: **Wind turbine comprising a moment bearing**

(56) Fremdragne publikationer:
**US 2014/0199011 A1**
**WO 2011/045146 A1**
**EP 2913547 A1**
**US 8523451 B2**
**US 1949824 A**

(57) Sammendrag:
**The invention relates to a wind turbine comprising a rotor with a hub, a nacelle with a mainframe, and a moment bearing arranged between the hub and mainframe. The moment bearing comprises an inner ring and an outer ring between which at least one row of rotatable bearing elements is arranged. The individual bearing elements are substantially held in place by a cage located between the inner and outer rings. The outer ring further comprises a first and a second shoulder for transferring axial loads in both directions from the bearing elements to the outer ring. The moment bearing further comprises at least a first seal element configured to close off the chamber defined by the inner and outer rings, wherein said first seal element contacts a contact surface on the outer ring. This provides an improved heat transfer where most of the generated heat is transferred to the mainframe.**

**Fortsættes ...**

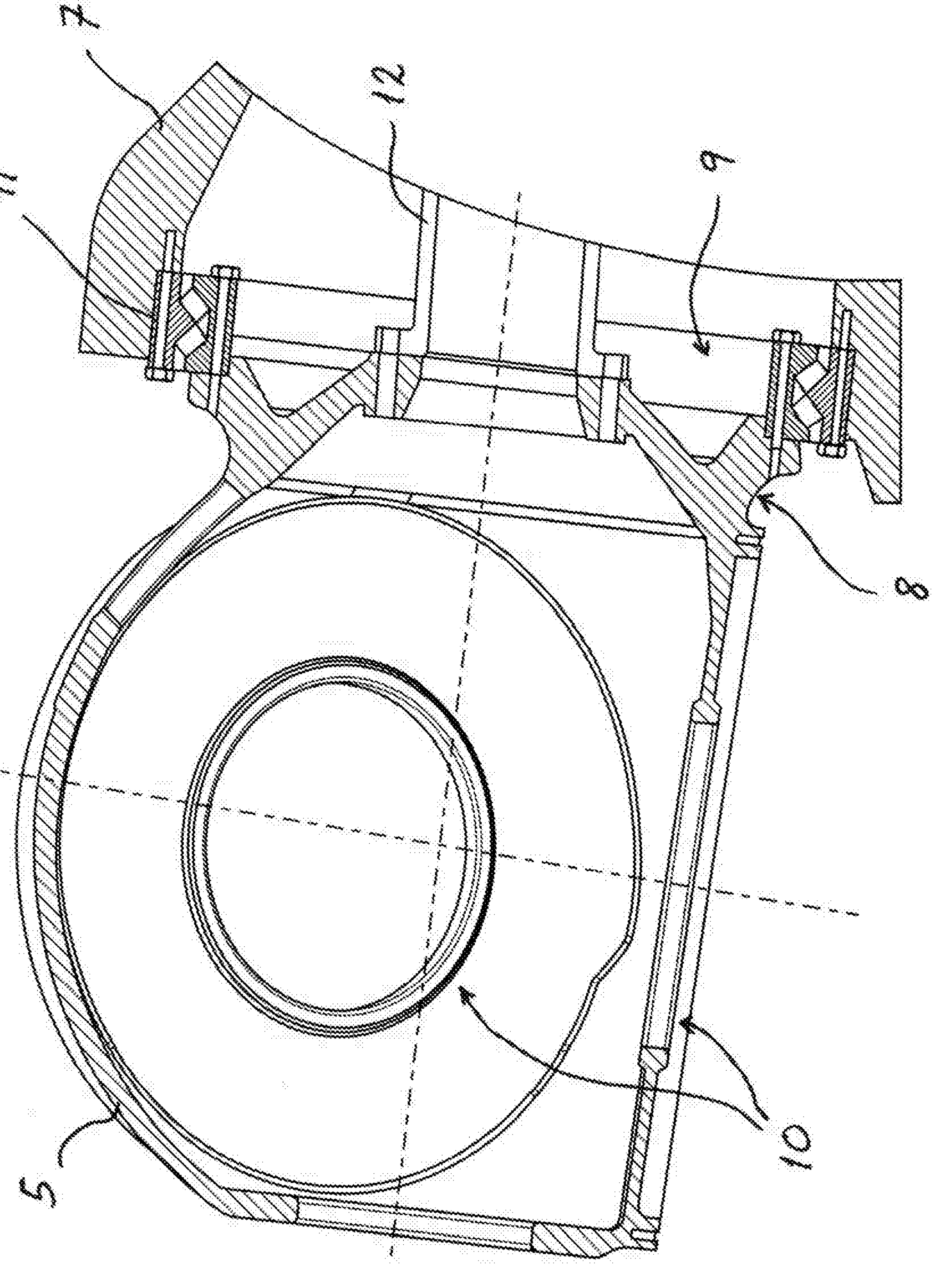


Fig. 2

Wind turbine comprising a moment bearing

## Field of the Invention

The present invention relates to a wind turbine comprising a wind turbine tower, a nacelle arranged relative to the wind turbine tower, a rotor rotatably arranged relative to the nacelle, the rotor comprising a hub with at least a first mounting interface facing the nacelle, the nacelle comprising a mainframe with a second mounting interface facing the rotor, wherein a moment bearing is arranged between the nacelle and the rotor, the moment bearing comprising an inner ring mounted to the first mounting interface and an outer ring mounted to the second mounting interface, the inner ring comprising a first raceway facing the outer ring, the outer ring comprising a second raceway facing the inner ring, wherein a plurality of rotatable bearing elements is arranged between the first raceway and the second raceway.

## Background of the Invention

The bearing units used in modern wind turbines today are designed as large and heavy bearing units configured to absorb the various loads generated by the rotor, the generator, the gearbox and other components in the wind turbine. Some wind turbines comprise a moment bearing arranged between the rotor and the nacelle. The moment bearing has an inner diameter of more than one meter and has a weight of several metric tons. Such a moment bearing is designed to mainly transfer moment loads generated by the rotor to the nacelle.

The moment bearing experiences various rigidities in the mainframe as the wind turbine blades rotate relative to the nacelle. As the wind turbine blades rotate relative to the nacelle, they are also subjected to different wind shears which in turn are transferred to the moment bearing. The moment bearing may therefore be preloaded in order to compensate for these dynamical loadings. This ensures that the rollers located between the inner and outer rings of the moment bearing are in contact with the respective raceways, but this also generates a friction torque between the two rings. This, in turn, generates heat in the respective ring causing the ring to expand which may result in a bearing seizure if the moment bearing overheats. One way to solve this problem is to introduce a lubricant into the chamber between the two rings so that a hydrodynamic film is formed on the contact areas between the rollers and the respective rings. However, the lubricant requires regular servicing in order to prevent the roller bearing from overheating and to remove contaminants from the lubricant.

WO 2012/069212 A1 and DE 102012212792 A1 both disclose a roller bearing which comprises two rows of tapered rollers, wherein the tapered rollers are arranged between two shoulders located on the inner ring. In these roller bearings, axial loads are transferred to the inner rings when the rollers contact the shoulders which, in turn, generate heat in the inner ring causing it to heat up. A similar roller bearing is disclosed in WO 2006/099014 A1 which further discloses a grease circulation system connected to the chamber in which the tapered rollers are located. The pressure in the outlet pipes is used to control the circulation of grease which, in turn, allows heat to be removed from the inner ring.

US2014/0199011 disclose a bearing including an inner ring, an outer ring and at least a row of angular contact rollers displaced between raceways provided on the rings, each roller comprising a rolling surface in contact with said raceways and two opposite end faces, the inner and outer rings having guiding faces coming into contact with the end faces of the rollers.

**Object of the Invention**

An object of the invention is to provide alternate moment bearing design that solves the above-mentioned problems.

Another object of the invention is to provide a moment bearing that reduces the risk of a bearing seizure and allows for an improved heat transfer.

**Description of the Invention**

As mentioned above, the invention comprises a wind turbine comprising a wind turbine tower, a nacelle arranged relative to the wind turbine tower, a rotor rotatably arranged relative to the nacelle, the rotor comprising a hub having at least a first mounting interface facing the nacelle, the nacelle comprising a mainframe having a second mounting interface facing the rotor, wherein a moment bearing is arranged between the nacelle and the rotor for transferring moment loads from the rotor to the nacelle, the moment bearing comprising an inner ring mounted to the first mounting interface and an outer ring mounted to the second mounting interface, the inner ring comprising a first raceway facing the outer ring, the outer ring comprising a second raceway facing the inner ring, wherein a plurality of rotatable bearing elements is arranged between the first raceway and the second raceway, wherein at least one shoulder is arranged on said outer ring, the at least one shoulder projects towards the inner ring and is configured to transfer axial loads in at least one axial direction from said plurality of bearing elements to said outer ring.

This provides a moment bearing having an alternative configuration wherein most of the heat generating elements, e.g. the shoulders and outer raceway, are situated on the outer ring, e.g. the outer ring, while the inner ring, e.g. the inner ring, comprises a minimum of heat generating elements, e.g. the inner raceway. This allows for an improved heat transfer as a majority of the generated heat can be transferred to the large mainframe of the nacelle. This allows the mainframe structure to act as a cooling element for cooling the moment bearing during operation which in turn reduces the heat generated in the inner ring.

The moment bearing comprises an inner ring rotatably arranged relative to an outer ring wherein at least one row of rotatable bearing elements is arranged between the inner and outer rings. A cage may be arranged between the inner and outer rings wherein the cage is configured to substantially hold the bearing elements in their respective positions. The inner and outer rings each have a first end facing the rotor and a second end facing the nacelle when mounted. The inner ring comprises a plurality of first mounting elements, e.g. through holes, for mounting to the first mounting interface, e.g. using fastening means in the form of bolts or screws. The outer ring comprises a plurality of second mounting elements, e.g. through holes, for mounting to the second mounting interface, e.g. using fastening means in the form of bolts or screws. This allows the inner ring to be mounted to the hub and the outer ring to be mounted to the mainframe. Moment loads due to the weight of the rotor and the wind acting on the rotor may thus be transferred from the hub to the mainframe via the moment bearing.

The hub further comprises at least two mounting interfaces for mounting at least two wind turbine blades, e.g. via individual pitch bearing systems. The wind turbine further comprises a drive train configured to generate a power output wherein the drive train is rotatably connected to the rotor via a rotation shaft. The rotation shaft may be connected to the moment bearing, e.g. the inner ring, or to a separate mounting interface on the hub. This allows the aerodynamic torque generated by the wind to be transferred to the drive train and transformed to an electrical power output.

According to one embodiment, said at least one shoulder comprises a first shoulder and at least a second shoulder, wherein the plurality of bearing elements is arranged between said first shoulder and said at least second shoulder.

The moment bearing comprises at least one shoulder configured to absorb loads in at least one axial direction wherein this at least one shoulder projects outwards from an inner surface on the outer ring. A first shoulder and a second shoulder may be arranged on the inner surface of the outer ring. The first and second shoulders may define the end stops of the outer raceway, e.g. the second raceway, which acts as a contact surface for the side surface of the bearing elements. The first and second shoulders may each comprise a contact surface for contacting an end surface of the bearing elements. The shoulder, e.g. the first or second shoulder, may be an annular shoulder extending along the inner surface of the outer ring. This allows axial loads in both directions to be transferred from the bearing elements to the outer ring during operation.

The inner ring comprises an outer surface in which the inner raceway, e.g. the first raceway, is formed. No shoulders may be arranged on the outer surface which, in turn, minimises the heat generated in the inner ring. This, in turn, reduces the expansion or deformation of the inner ring and, thus, the risk of a bearing seizure.

The first and outer rings may both be formed by a single ring piece. Alternatively, one ring, e.g. the inner or outer ring, may be formed by at least two ring pieces which may be jointed together while the other ring may be formed by a single ring piece. Alternatively, both the inner and outer rings may be formed by at least two ring pieces which may be jointed together. The at least two ring pieces may form two opposite facing end surfaces which are brought into contact with each other during assembly. Said end surfaces may be machined, e.g. in a metal lathe, and then brought together for preloading the moment bearing before mounting. The spacing between these end surfaces may be sealed off by suitable sealing means, e.g. a sealant, or seal elements, e.g. a deformable element.

According to one embodiment, said plurality of bearing elements comprises a first row of bearing elements and at least a second row of bearing elements, said first row of bearing elements being arranged relative to said at least second row of bearing elements.

The moment bearing comprises at least one row of bearing elements wherein the individual bearing elements are positioned relative to each other. A first row of bearing elements and at least a second row of bearing elements may be arranged relative to each other. Alternatively, the moment bearing may comprise three, four, or more rows of bearing elements. The individual rows of bearing elements may be arranged in one or more pairs. Each pair may be positioned in a face-to-face arrangement, a back-to-back arrangement, or a tandem arrangement. This allows radial and axial loads to be transferred from the rotor to the nacelle. This also allows the axial and radial loads to be distributed over one or more pairs of bearing elements.

According to one embodiment, said bearing elements are roller elements, and at least one of said first and second raceways defines at least one line contact for contacting said roller elements, wherein said at least one line contact intersects a rotation axis of the moment bearing in at least one intersection point.

The bearing elements may be shaped as roller elements having two opposite facing end surfaces connected via a side surface. One or both end surfaces act as contact surfaces for contacting the shoulder, e.g. the first and second shoulders, during operation. The side surface may be shaped to form a cone-shaped contact surface, a spherical-shaped contact surface, logarithmic contact surface, or another suitable contact surface. The two end surfaces may have the same diameter or different diameters. The first and second raceways may be shaped to follow the contours of this side surface. This allows the bearing elements to be shaped as tapered or spherical roller elements.

The first and second raceways may define a first and a second line contact extending in an axial direction of the moment bearing. The moment bearing has a central rotational axis which also defines the axial direction. The moment bearing further defines a radial direction extending perpendicular relative to the axial direction. The side surface of the bearing element may further define a third and a fourth line contact extending in the axial direction. The individual line contacts may intersect the rotation axis of the moment bearing in one or more intersection points. In example, the individual line contacts may intersect the rotation axis in the same intersection point. The rotation axis and each line contact form a contact angle which, in turn, is used to determine the amount of the axial and radial forces capable of being transferred to the mainframe.

According to one embodiment, said moment bearing further comprises at least one first seal element arranged on at least one of said inner and outer rings, the at least one first seal element is configured to seal off a chamber defined by at least the first and outer rings.

The inner and outer surfaces of the first and outer rings and the first and second ends define a chamber or spacing in which the bearing elements are arranged. This chamber or spacing may be closed off by means of first sealing elements located at either sides of the moment bearing. The first seal element may be configured as a replaceable seal, such as a labyrinth seal, a contact seal, a lamellar seal, a V-shaped seal, a lip seal having one, two, three, or more lips, or another suitable seal element. Other types of replaceable seal elements may be used to close off the chamber or spacing.

The first seal element may be arranged at or near the first and second ends respectively. The first seal element may be mounted to one or both rings of the moment bearing using fastening means, such as bolts or screws, or a mechanical coupling, such as tracks and grooves. The first seal element may optionally comprise one or more stiffening elements for providing stiffness to the first seal element.

According to a special embodiment, said at least one first seal element is arranged on the inner ring and extends towards the outer ring.

The first seal element may in example be mounted to at least the inner ring, e.g. on the end surface or the outer surface, wherein the first seal element extends towards the outer ring. The first seal element may comprise a free end contacting the outer ring, e.g. the corresponding end surface, the inner surface, or another shoulder arranged on the outer ring. This allows any heat generated in the outer ring at this contact area to be transferred to the mainframe of the nacelle. This, in turn, further reduces the heat generated in the inner ring and, thus, further reduces the risk of the moment bearing failing.

According to another special embodiment, said chamber is partly or fully filled with a lubricant.

The chamber or spacing may be partly or fully filled with a lubricant, such as oil, grease, or another suitable lubricant, for reducing the friction between the bearing elements and the raceways. The lubricant may be supplied to the chamber or spacing during assembly of the moment bearing and optionally topped up before, during or after mounting the moment bearing.

The moment bearing may further comprise at least one inlet and at least one outlet configured to be coupled to a lubrication system, wherein said at least one inlet and at least one outlet are in fluid communication with the chamber or spacing. This allows the lubricant to be circulated between the moment bearing and the lubrication system in order to remove contaminates from the lubricant and further to remove heat from the moment bearing.

The moment bearing may alternatively or additionally comprise one or more integrated temperature sensors arranged relative to the inner and/or outer ring, wherein said temperature sensors are configured to be coupled to a control unit, e.g. a wind turbine control unit or an external control unit. This allows the control unit to monitor the temperature in the moment bearing during operation and optionally generate an event signal if the temperature exceeds or drops below one or more thresholds.

According to yet another special embodiment, said moment bearing further comprises at least one second seal element arranged on at least one of said inner and outer rings, the at least one second seal element is arranged relative to the at least one first seal element.

The moment bearing may comprise at least one second seal element arranged at or near one or both ends of the moment bearing. The second seal element may be positioned between the first seal element and the bearing elements. Alternatively, the first and second seal elements may be integrated to form a single seal unit. The second seal element may be a labyrinth seal, a multi-stage seal, or another suitable second seal element. This further allows the chamber or spacing to be sealed off. This also allows the lubricant to act as the innermost seal element for sealing off the chamber or spacing.

According to one embodiment, said moment bearing further comprises a cage having a plurality of through holes, wherein the plurality of bearing elements is positioned in said plurality of through holes.

The bearing elements in each row may be positioned in a cage wherein the cage comprises a plurality of individual through holes or spaces in which the individual bearing elements are arranged. The inner dimensions of each through holes substantially correspond to the outer dimensions of the bearing elements. The bearing element may be configured as a solid or hollow element capable of rotating around an internal rotation axis. Alternatively, the bearing element may be rotatably positioned on a rotation shaft extending through the bearing element, wherein this rotation shaft is connected to the cage. The cage may be freely arranged inside the chamber or spacing, or be connected to one or both rings.

The bearing elements, the cage, the inner ring, and the outer ring may be made of any suitable material or composite. In example, the inner and outer rings may be made of metal, such as brass, bronze, or steel, or another suitable material. In example, the bearing elements may be made of metal, such as steel, or another suitable material. In example, the cage may be made of metal, such as brass or steel, polymeric materials, or another suitable material.

According to one embodiment, said moment bearing comprises a first bearing unit and at least a second bearing unit, wherein said first bearing unit and said at least second bearing unit are arranged in a paired configuration.

The moment bearing may be configured as a single bearing unit wherein the individual bearing elements are arranged in one, two, three, four, or more rows as described above. One or both rings may be formed by a single ring piece or multiple ring pieces as described above. This allows the moment bearing to transfer combined radial and axial loads from the rotor to the nacelle.

The moment bearing may instead be configured as two, three, four, or more bearing units, wherein each individual bearing unit comprises an inner and an outer ring and a plurality of bearing elements arranged between the first and outer rings. This allows each bearing unit to be adjusted individually or in synchronous. This also allows each bearing unit to be configured to transfer loads in at least one radial and/or axial direction.

In one exemplary configuration, the moment bearing may be configured as a double row bearing unit, e.g. a double row tapered roller bearing. By arranging the shoulder, e.g. the first and second shoulders, on the outer ring and optionally allowing the seal element, e.g. the first seal element, to slide along the inner surface of the outer ring, the moment bearing can be thermally balanced and, thus, reduces the risk of the inner ring overheating and, thereby, causing a bearing seizure or bearing failure.

**Description of the Drawing**

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

- Fig. 1 shows an exemplary wind turbine,
- Fig. 2 shows an exemplary rotor and nacelle with a moment bearing arranged in between, and
- Fig. 3 shows an exemplary embodiment of the moment bearing according to the invention.

In the following text, the figures will be described one by one, and the different parts and positions seen in the figures will be numbered with the same numbers in the different figures. Not all parts and positions indicated in a specific figure will necessarily be discussed together with that figure.

**Position number list**

1. Wind turbine
2. Wind turbine tower
3. Nacelle
4. Rotor
5. Hub
6. Wind turbine blades
7. Mainframe
8. First mounting interface
9. Second mounting interface
10. Mounting interface for wind turbine blades
11. Moment bearing
12. Rotation shaft
13. Inner ring
14. Outer ring
15. First mounting elements
16. Second mounting elements
17. First raceway
18. Second raceway
19. Chamber
20. Bearing elements, roller elements
21. First shoulder
22. Second shoulder
23. Cage
24. First seal element
25. Chamber
26. Second seal element

27. First row of bearings elements

28 Second row of bearings elements

**Detailed Description of the Invention**

Fig. 1 shows an exemplary embodiment of a wind turbine 1 according to the invention, comprising a wind turbine tower 2 arranged on a foundation. The foundation is here shown as an onshore foundation, but also an offshore foundation may be used. A nacelle 3 is arranged on the wind turbine tower 2, e.g. via a yaw bearing system. A rotor 4 is rotatably arranged relative to the nacelle 3 and comprises a hub 5 mounted to at least two wind turbine blades 6, e.g. via a pitch bearing system.

The wind turbine blades 6 are here shown as full-span wind turbine blades, but also partial-pitchable wind turbine blades may be used. The partial-pitchable wind turbine blade comprises an inner blade section and an outer blade section, wherein a pitch bearing system is arranged between the two blade sections.

Fig. 2 shows an exemplary embodiment of the rotor 4 and the nacelle 3. Here, only the hub 5 of the rotor 4 and a mainframe 7 of the nacelle 3 are shown for illustrative purposes. The hub 5 comprises a first mounting interface 8 facing the nacelle 3 and the mainframe 7 comprises a second mounting interface 9 facing the rotor 3. The hub 4 further comprises at least two other mounting interfaces 10 facing in a direction of the rotor 3. The individual mounting interfaces 10 is configured to be mounted to a corresponding mounting interface (not shown) on the respective wind turbine blades 6.

The first mounting interface 8 is configured to be mounted to the mainframe 7 via a moment bearing 11. The moment bearing 11 is configured to at least transfer moment loads from the rotor 4 to the nacelle 3, e.g. the mainframe 7. The first mounting interface 8 is further configured to be mounted to a rotation shaft 12 which in turn is connected to a drive train (not shown) arranged in the nacelle 3. The drive train is configured to transform the aerodynamic torque generated by the wind acting on the rotor 4 to an electrical power output.

Fig. 3 shows an exemplary embodiment of the moment bearing 11 where the hub 5 and the mainframe 7 have been omitted for illustrative purposes. The moment bearing

11 comprises an inner ring 13 and an outer ring 14 arranged relative to the inner ring 13. The inner ring 13 comprises a plurality of first mounting elements 15 in the form of through holes for mounting to the first mounting interface 8 using fastening means (shown in fig. 2) in the form of bolts. The outer ring 14 comprises a plurality of second mounting elements 16 in the form of through holes for mounting to the second mounting interface 9 using fastening means (shown in fig. 2) in the form of bolts.

The inner ring 13 comprises a first raceway 17 facing the outer ring 14 and the outer ring 14 comprises a second raceway 18 facing the inner ring 13. The inner and outer rings 13, 14 are spaced apart to form a chamber 19 in which a plurality of rotatable bearing elements 20 are arranged. The bearing elements 20 are here shown as roller elements having a side surface defining a line contact for contacting the first and second raceways 17, 18 respectively. The outer ring 14 further comprises a first shoulder 21 and a second shoulder 22 projecting towards the inner ring 13. The first and second shoulders 21, 22 act as stop elements for the bearing elements 20 and are configured to transfer axial loads in both axial directions from the bearing elements 20 to the outer ring 14. This enables heat generated due to friction between the bearing elements 20 and the respective shoulders 21, 22 to be transferred directly to the mainframe 7 via the outer ring 14.

The bearing elements 20 are positioned in a back-to-back arrangement wherein the individual bearing elements 20 are arranged in two rows as shown in fig. 3. The bearing elements 20 are here shown as tapered roller elements wherein the respective line contacts intersect a rotation axis (indicated by dotted lines in fig. 2) of the moment bearing 11.

The individual bearing elements 20 in each row are optionally positioned in corresponding through holes of a cage 23. The cage 23 is configured to substantially hold the bearing elements 20 in place relative to each other.

A first seal element 24 is arranged at either axial ends of the moment bearing 11 for sealing off the chamber 19. The chamber 19 is optionally partly or fully filled with a suitable lubricant, such as oil or grease. The first seal element 24 is mounted to the inner ring 13 and contacts the outer ring 14. The first seal element 24 is here shown as a deformable sealing lip partly supported by a stiffening element. This further enables heat generated due to friction between the first seal element 24 and the outer ring 14 to be transferred directly to the mainframe 7.

A second seal element 26, e.g. a labyrinth seal, is optionally arranged inside the chamber 19 at or near the respective ends of the moment bearing 11. The second seal element 26 is here arranged relative to the first seal element 24 and acts as an inner-most seal element.

**Patentkrav**

1. Vindturbine (1) omfattende et vindturbinetårn (2), en maskinkabine (3) arrangeret i forhold til vindturbinetårnet (2), en rotor (4) arrangeret roterbart i forhold til maskinkabinen (3), idet rotoren (4) omfatter et nav (5) med mindst en første montageflade (8) vendende mod maskinkabinen (3), hvor maskinkabinen (3) omfatter en hovedramme (7) med en anden montageflade (9) vendende mod rotoren (4), hvori et momentoptagende leje (11) er arrangeret mellem maskinkabinen (3) og rotoren (4) til overføring af momentbelastninger fra rotoren (4) til maskinkabinen (3), hvor det momentoptagende leje (11) omfatter en inderring (13) monteret på den første montageflade (8) og en yderring (14) monteret på den anden montageflade (9), hvor inderringen (13) omfatter en første løbebane (17) vendende mod yderringen (14), idet yderringen (14) omfatter en anden løbebane (18) vendende mod inderringen (13), hvori en flerhed af roterbare lejeelementer (20) er arrangeret mellem den første løbebane (17) og den anden løbebane (18), hvori mindst en skulder (21, 22) er arrangeret på yderringen (14), idet den mindst ene skulder (21, 22) rager frem mod inderringen (13) og er konfigureret til at overføre aksialbelastninger i mindst en aksialretning fra flerheden af lejeelementer (20) til yderringen (14), **kendetegnet ved** at det momentoptagende lejes (11) yderring (14) omfatter en første skulder (21) og mindst en anden skulder (22), hvori det momentoptagende leje (11) omfatter en første række lejeelementer (20) arrangeret mellem den første skulder (21) og den mindst ene anden skulder (22).

2. Vindturbine ifølge krav 1, **kendetegnet ved** at det momentoptagende leje (11) yderligere omfatter en første række (27) lejeelementer (20) og mindst en anden række (28) lejeelementer (20a), hvilken første række (27) lejeelementer (20) er arrangeret i forhold til den mindst ene anden række (28) lejeelementer (20).

3. Vindturbine ifølge krav 1 eller 2, **kendetegnet ved** at lejeelementerne (20) er rulleelementer, og at mindst en af første og andre løbebaner (17, 18) definerer mindst en kontaktlinje for kontakt med rulleelementerne (20), hvori den mindst ene kontaktlinje skærer en rotationsakse af det momentoptagende leje (11) i mindst et skæringspunkt.

4. Vindturbine ifølge ethvert af krav 1 til 3, **kendetegnet ved** at det momentoptagende leje (11) yderligere omfatter mindst et første tætningselement (24, 26) arrangeret på

mindst en af inder- og yderringene (13, 14), hvor det mindst ene første tætningselement (24, 26) er konfigureret til at aftætne et kammer (19) defineret af mindst de indre og ydre ringe (13, 14).

5. Vindturbine ifølge krav 4, **kendetegnet ved** at det mindst ene første tætningselement (24, 26) er arrangeret på inderringen (13) og strækker sig mod yderringen (14).

6. Vindturbine ifølge krav 4 eller 5, **kendetegnet ved** at kammeret (19) er delvist eller helt fyldt med et smøremiddel.

7. Vindturbine ifølge ethvert af krav 4 til 6, **kendetegnet ved** at det momentoptagende leje (11) yderligere omfatter mindst et andet tætningselement (26) arrangeret på mindst en af inder- og yderringene (13, 14), hvor det mindst ene andet tætningselement (26) er arrangeret i forhold til det mindst ene første tætningselement.

8. Vindturbine ifølge ethvert af krav 1 til 7, **kendetegnet ved** at det momentoptagende leje (11) yderligere omfatter et bur (23) med en flerhed af gennemgående huller, hvori flerheden af lejeelementer (20) er placeret i de flere gennemgående huller.

9. Vindturbine ifølge ethvert af krav 1 til 8, **kendetegnet ved** at det momentoptagende leje (11) omfatter en første lejeenhed og mindst en anden lejeenhed, hvori den første lejeenhed og den mindst ene anden lejeenhed er arrangeret parvist.

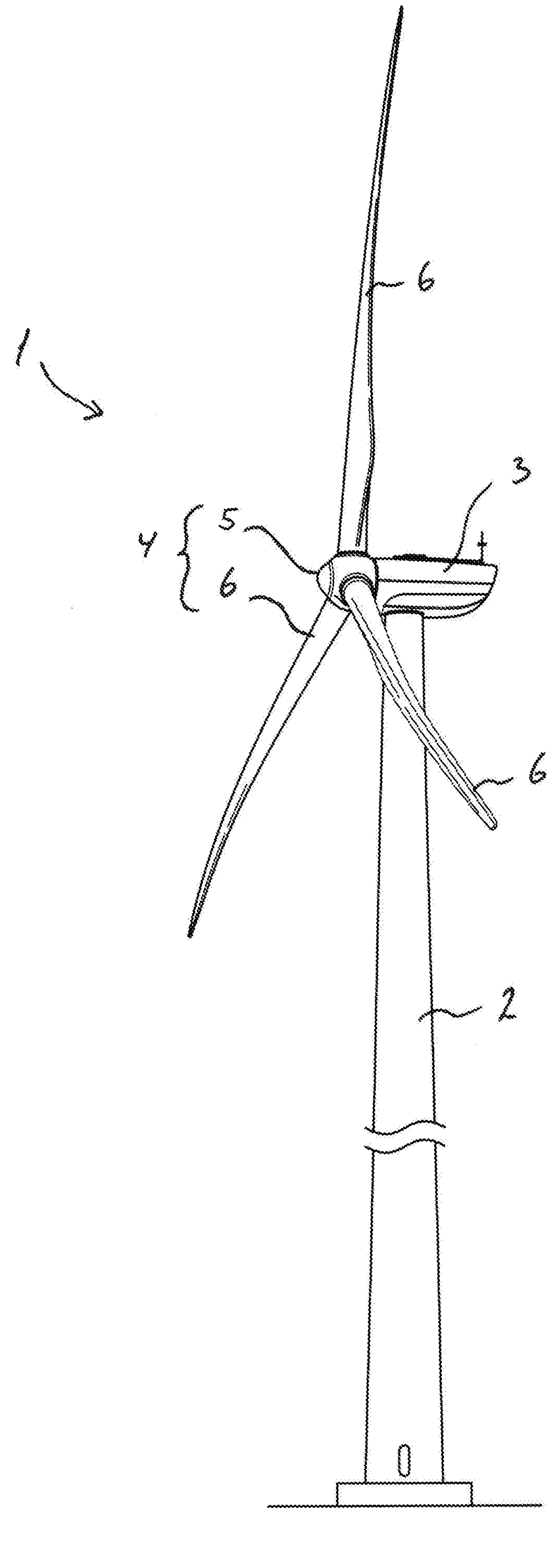


Fig. 1

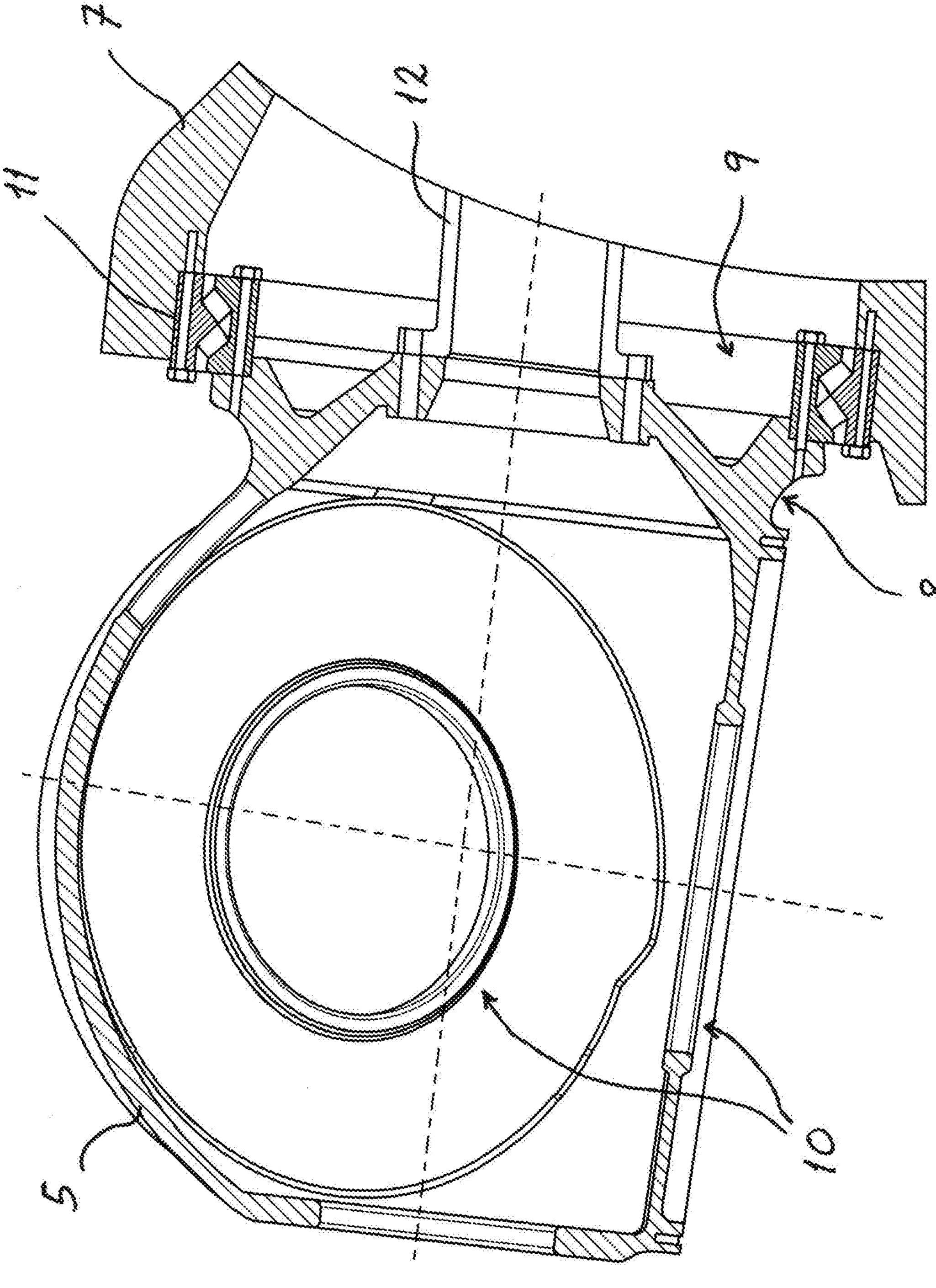


Fig. 2

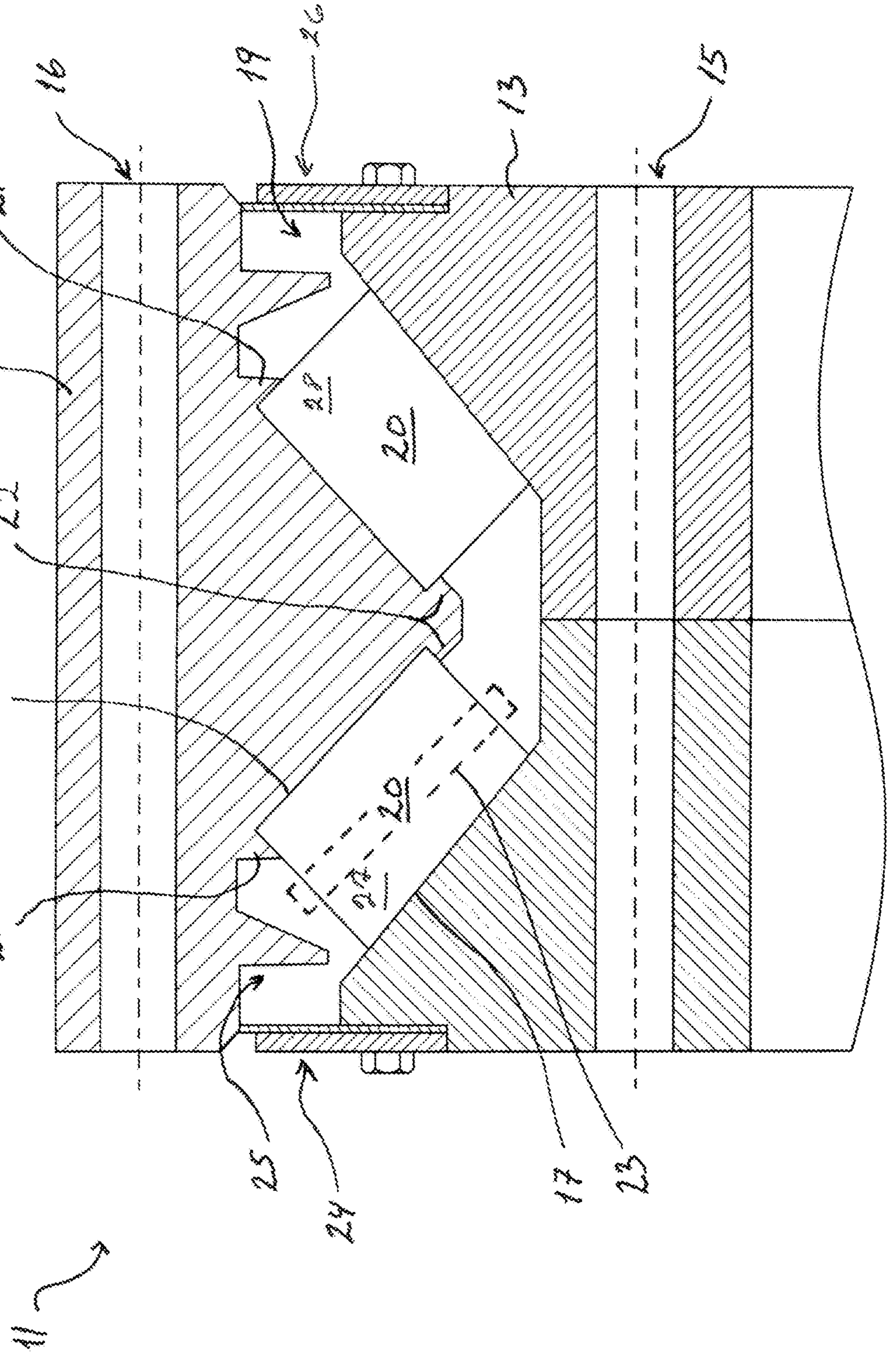


Fig. 3

DANISH PATENT AND TRADEMARK OFFICE

| SEARCH REPORT - PATENT | Application No. PA 2016 70106 |
|---|---|

1. ☐ Certain claims were found unsearchable (See Box No. I).

2. ☐ Unity of invention is lacking prior to search (See Box No. II).

A. CLASSIFICATION OF SUBJECT MATTER

***F16C 33/60*** (2006.01); ***F03D 80/70*** (2016.01)

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&CPC&FICLA: F03D, F16C

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

DK, NO, SE, FI: IPC-classes as above.

Electronic database consulted during the search (name of database and, where practicable, search terms used)

EPODOC, WPI, FULL TEXT: ENGLISH

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant for claim No. |
|---|---|---|
| X | US 2014/0199011 A1 (MAGNY, JEAN-BAPTISTE et al.) 17 July 2014.<br>See abstract, sections [0002], [0004], [0023], [0036], [0044] and figures 1 - 4. | 1 - 10 |
| X<br>A | WO 2011/045146 A1 (SCHAEFFLER TECHNOLOGIES GMBH) 21 April 2011.<br>See abstract, p. 16, lin. 15 - 17 and figs. 6 and 11. | 1, 3, 4, 9;<br>2, 5 - 8, 10 |
| X<br>A | EP 2913547 A1 (NTN CORPORATION) 02 September 2015.<br>See abstract, section [0002] and fig. 2. | 1, 2;<br>3 - 10 |

☒ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" Document defining the general state of the art which is not considered to be of particular relevance.

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"E" Earlier application or patent but published on or after the filing date.

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"O" Document referring to an oral disclosure, use, exhibition or other means.

"P" Document published prior to the filing date but later than the priority date claimed.

"T" Document not in conflict with the application but cited to understand the principle or theory underlying the invention.

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Date of completion of the search report

28 September 2016

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| SEARCH REPORT - PATENT | | Application No. PA 2016 70106 |
|---|---|---|
| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant for claim No. |
| X<br>A | US 8523451 B2 (OZU, TAKUYA et al.) 03 September 2013.<br>See abstract and figs. 5A and 15. | 1, 2;<br>3 - 10 |
| A | US 1949824 A (BUCKWALTER, TRACY V.) 06 March 1934.<br>See claims 1 - 6 and figs. 1, 3 and 4. | 1 - 10 |

| SEARCH REPORT - PATENT | Application No.<br>PA 2016 70106 |
|---|---|

**Box No. I  Observations where certain claims were found unsearchable**

This search report has not been established in respect of certain claims for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched, namely:

2. ☐ Claims Nos.:
because they relate to parts of the patent application that do not comply with the prescribed requirements to such an extent that no meaningful search can be carried out, specifically:

3. ☐ Claims Nos.:
because of other matters.

**Box No. II  Observations where unity of invention is lacking prior to the search**

The Danish Patent and Trademark Office found multiple inventions in this patent application, as follows:

| SEARCH REPORT - PATENT | Application No. PA 2016 70106 |
|---|---|

**SUPPLEMENTAL BOX**

Continuation of Box [.]