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- (54) Benævnelse: **Tilspidset rullelejeindretning til en direkte drivgenerator af et vindenergianlæg**
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DESCRIPTION

[0001] The present invention relates to a tapered roller bearing arrangement for a direct drive generator of a wind turbine and to a wind turbine comprising the tapered roller bearing arrangement.

[0002] Tapered roller bearings can take large axial forces and are able to sustain large radial forces. Therefore, these bearings are used in large machines, e.g. in wind turbines.

Due to the size of tapered roller bearings employed in such machines, it is a challenging task to ensure optimum lubrication of the bearings.

[0003] EP2233760A1 discloses a tapered roller bearing with lubricating grease inlets arranged at axial sides of the static outer ring of the bearing. The lubricating grease is guided by the tapered rollers to a grease outlet arranged in the rotating inner ring and from there to a grease collecting system. The grease collecting system is firmly connected to the inner ring and rotates with it.

[0004] A drawback of this known tapered roller bearing resides in the structure of the lubricating system that is split into two parts, a first part connected to the static outer ring for lubricating the tapered rollers, and a second part connected to the rotating inner ring for collecting surplus grease. Due to this bulky structure, it is difficult to arrive at a compact bearing arrangement.

[0005] Another drawback is that the grease collecting system rotates together with the rotating ring, wherein any surplus grease is collected in specially adapted containers. Due to this structure, the machine comprising the bearing has to be stopped regularly in order to allow discharging of the containers.

[0006] In large bearing assemblies with a rotating outer ring, it is a challenge to ensure a full grease exchange and to collect the surplus grease. Internally, an arrangement is known where lubricating grease is inlet from the center of the inner ring, guided through the cavity between the inner and the outer ring and collected from the outer ring. However, this requires an expensive grease collecting system. The grease flow is based on the grease pressure in the cavity part located between the rollers and the bearing seal. Therefore, grease pressure is built up in this cavity and grease pressure on the seals causes leakage, increased friction and wear on the seals.

[0007] DE102010051424A1 discloses an alternative tapered roller bearing arrangement, in accordance with the preamble of claim 1, having a lubricant outlet channel provided in a sealing ring fixed onto the inner ring of the tapered roller bearing.

[0008] It is therefore an object of the present invention to provide an improved tapered bearing arrangement for a direct drive generator which allows for efficient lubrication in a cost- and space-saving manner. Another object of the invention is to provide an improved direct drive generator comprising the bearing arrangement and an improved wind turbine.

[0009] The objects are solved by the features of the independent claim 1. Further advantageous developments are subject of the dependent claims.

[0010] The tapered roller bearing arrangement comprises a first inner ring with an inner raceway. The inner raceway has an inner end at a first radial distance from the rotation axis and an outer end at a second radial distance from the rotation axis, wherein the first radial distance is smaller than the second radial distance. The tapered roller bearing arrangement further comprises an outer ring with an outer raceway, wherein the outer ring is arranged around and moveable in relation to the first inner ring. A set of tapered rollers is disposed in a cavity which is arranged between the first inner ring and the outer ring, wherein the tapered rollers are arranged to roll in the cavity between the inner and the outer raceway.

[0011] Further, a grease inlet channel is arranged in the first inner ring. The grease inlet channel is connected to the cavity near the inner end of the inner raceway and used for conducting lubricating grease into the cavity.

[0012] A grease outlet channel is arranged in the first inner ring for draining surplus grease. The grease outlet channel extends through the inner ring from an inlet opening to an outlet opening. The inlet opening of the grease outlet channel is arranged at the axial side of the first inner ring facing the rollers, between the outer end of the inner raceway and the radial outer end of the first inner ring. The outlet opening of the grease outlet channel is arranged at the axial outer side of the first inner ring which is opposite to the roller-facing axial side. Thus, the grease outlet channel runs through the inner ring, from one axial face of the inner ring to the other.

[0013] Both, injection and drain of grease are exclusively effectuated through channels in one and the same ring, here the inner

ring. Thus, compared to the arrangement known from EP2233760, the arrangement allows for draining out surplus grease in a very smart and space-saving manner. Since there is no need to stop the operation of the bearing, the operational costs are significantly reduced.

[0014] Moreover, the tapered roller bearing arrangement allows for both, enhanced lubrication and effective draining out of surplus grease. The grease may be injected near the smaller diameter end of the rollers and drained near the larger diameter end of the rollers. As a result, the grease is forced to pass along the raceway which ensures a full grease exchange.

[0015] Furthermore, since the inlet opening of the grease outlet channel is arranged near the larger diameter end of the rollers, pressure on the sealing, which is arranged between the inner and the outer ring, is avoided or at least reduced. Therefore, the lifetime of the sealing is extended; leakage and friction are reduced.

[0016] According to an embodiment of the invention, the inlet opening of the grease outlet channel is arranged at the outer end of the inner raceway, e.g. at the edge of the inner raceway. Therefore, any surplus grease may be conveyed away directly from the inner raceway instead of being pumped towards the sealing. The flow of the surplus grease through the outlet channel is not based on the global pressure in the bearing but on the pumping effect caused by the movement of the rollers. Therefore, there will be no or only very low pressure on the sealing.

[0017] According to another embodiment of the invention, the inner ring comprises a shoulder having a shoulder portion protruding into the cavity in such a way that the protruding portion abuts onto the larger diameter ends of the tapered rollers. According to this embodiment of the invention, the inlet opening of the grease outlet channel is arranged between this protruding portion and the radial outer end of the inner ring. Therefore, any surplus grease may be conveyed away from the cavity before being further pumped towards the sealing. In this embodiment of the invention, the pumping effect caused by the movement of the rollers is less important than in the embodiment, mentioned before. However, since the inlet opening of the grease outlet channel is arranged in proximity to the larger diameter end of the rollers, the movement of the rollers is also causing a pulsing in the grease that may be used for conveying surplus grease through the grease outlet channel. As a result, the pressure on the sealing is significantly lowered.

[0018] According to a further embodiment of the invention, the grease outlet channel extends in axial direction in relation to the rotation axis of the bearing arrangement and in parallel with said rotation axis. Thus, the length of the outlet channel through the inner ring is reduced to a minimum.

[0019] According to yet a further embodiment of the invention, the grease outlet channel is arranged in an inclined position such that the outlet opening is arranged at a shorter radial distance from the rotation axis than the inlet opening. The inclination of the grease outlet channel supports conveying away the surplus grease. The grease outlet channel may be inclined to the rotation axis by an angle in the range of 35° to 45°, e.g. 40°, in order to facilitate the flow of the surplus grease.

[0020] According to another embodiment of the invention, a circumferential groove is arranged at the side of the first inner ring facing the rollers. Thus, a certain amount of grease may escape from the cavity along this groove and the amount of grease in the bearing finds a balance. The groove may be connected to the inlet opening of the grease outlet channel in such a way that surplus grease may be collected in the groove and transported via the groove to the grease outlet channel.

[0021] According to a further embodiment of the invention, the grease outlet channel comprises two or more grease outlet channels which are arranged radially adjacent, that means at different diameters of the inner ring, and in close proximity to each other. Thereby, the effective flow resistance is reduced and thus a lower pressure is sufficient to convey away the surplus grease.

[0022] According to a further embodiment of the invention, at least two grease outlet channels (70) are arranged in parallel to one another at equally spaced intervals in circumferential direction.

[0023] According to an embodiment of the invention, a second inner ring is axially juxtaposed to the first inner first ring, wherein the second inner ring comprises an inner raceway having an inner end at a first radial distance from the rotation axis and an outer end at a second radial distance from the rotation axis. The first radial distance is smaller than the second radial distance. The outer ring is arranged around and moveable in relation to the second inner ring and comprises a further outer raceway.

A further set of tapered rollers having a smaller diameter end and a larger diameter end is moveable disposed between the inner raceway of the second inner ring and the further outer raceway. The grease inlet channel is arranged to also feed grease into the cavity near the inner end of the second inner raceway. Alternatively, a further grease inlet channel could be arranged in the second inner ring for feeding grease to the smaller diameter end of the tapered rollers.

A further grease outlet channel with an inlet opening and an outlet opening is arranged within the second inner ring. The inlet

opening is arranged at the axial side of the second inner ring which faces the rollers, wherein the inlet opening is arranged between the outer end of the inner raceway and the radial outer end of the second inner ring. The outlet opening is arranged at an axial outer side of the second inner ring. This axial outer side is situated opposite to the axial side of the second inner ring facing the rollers.

[0024] By arranging two rows of tapered rollers between one or more inner rings and one or more outer rings, the bearing arrangement may sustain even larger axial and radial forces.

[0025] In a further embodiment of the invention, the first inner ring and the second inner ring are formed integrally, thus avoiding mechanical interconnections between the first and the second inner ring. Besides, the outer ring may be composed of two distinct rings which facilitate the mounting of the bearing arrangement.

[0026] In a further embodiment of the invention, the one or more inner rings, the outer ring, or the inner and the outer rings are composed of a plurality of segments in circumferential direction. The segmentation of the rings allows for replacing damaged bearing parts easily.

[0027] In yet a further embodiment of the invention, the tapered roller bearing arrangement is comprised in a direct drive generator, wherein a rotor of the direct drive generator is connected to the outer ring for rotation therewith and a stator of the generator is connected to the first inner ring. By using the tapered roller bearing arrangement in conjunction with a direct drive generator, surplus grease may be drained out in a smart and space-saving manner. As a result, there is no need to stop the operation of the generator for cleaning the grease collecting means. This is advantageous for reducing operating costs of wind turbines, especially offshore wind turbines.

[0028] A method example for lubricating such a tapered roller bearing arrangement comprises the steps of feeding grease via the grease inlet channel into the cavity, guiding the grease through the cavity to the inlet opening of the grease outlet channel, and draining surplus grease from the cavity through the grease outlet channel.

[0029] In the following, the invention will be described by way of example in more detail with reference to the drawings, wherein the drawings show preferred configurations and do not limit the scope of the invention.

[0030] FIG 1 shows schematically a sectional view of a part of the bearing arrangement according to an embodiment of the invention.

[0031] FIG 2 shows schematically a sectional view of a part of the bearing arrangement according to another embodiment of the invention.

[0032] FIG 2a shows schematically an enlarged sectional view of a detail of FIG 2

[0033] Referring to **FIG 1**, the tapered roller bearing arrangement 100 comprises a first inner ring 20 and an outer ring 30, wherein the outer ring 30 is arranged around and moveable in relation to the first inner ring 20.

[0034] The bearing arrangement 100 comprises furthermore a first set of tapered rollers 10 disposed in a cavity 60 between the first inner ring 20 and the outer ring 30. The tapered rollers 10 are arranged to roll between a raceway 21 of the first inner ring 20 and a raceway 31 of the outer ring 30. In the following, the raceway 21 of the first inner ring 20 is referred to as inner raceway 21 and the raceway 31 of the outer ring 30 is referred to as outer raceway 31.

[0035] Preferably, but not necessarily, the tapered rollers 10 are held in positions circumferentially spaced at equal intervals by a cage 80. Besides, a sealing 40 is arranged between the first inner ring 20 and the outer ring 30.

[0036] The inner raceway 21 is tapered in relation to the rotation axis R of the bearing arrangement 100 and has an inner end 21a and an outer end 21b. Thereby, the inner end 21a is arranged at a smaller diameter of the inner ring 20 and the outer end 21b is arranged at a larger diameter of the inner ring 20. Thus, in relation to the rotation axis R of the bearing arrangement 100, the radial distance of the outer end 21b is larger than the radial distance of the inner end 21a.

[0037] A grease inlet channel 50 is arranged in the first inner ring 20, running in radial direction. It could also be arranged partly in axial direction or in any other direction as long as it is connected to the cavity 60 near the inner end 21a of the inner raceway 21. The grease inlet channel 50 is used for feeding lubricating grease into the cavity 60 near the smaller diameter end 10a of the

tapered rollers 10. The movement of the rollers 10 conducts the grease along the raceways 21, 31 towards the larger diameter end 10b of the rollers. Any surplus grease is finally conducted towards the cavity part between the larger diameter end 10b of the rollers and the sealing 40. Thereby, the pressure in this cavity part would normally be increased.

[0038] In order to minimize the pressure on the sealing 40, the inlet opening 70a of a grease outlet channel 70 is arranged at the roller-facing axial side of the first inner ring 20 between the outer end 21b of the inner raceway and the radial outer end 23 of the first inner ring 20. By the movement of the rollers 10, surplus grease is pumped into the grease outlet channel 70 prior reaching the sealing 40. The grease outlet channel 70 is running through the first inner ring 20 and may be configured as a bore hole.

[0039] In the bearing arrangement 100 shown in FIG 1, the grease outlet channel 70 runs from one axial side of the inner ring 20 to the other and extends in axial direction in relation to the rotation axis R. The inlet opening 70a is arranged at the outer end 21b of the inner raceway 21, preferably at the edge of the inner raceway 21. The edge of the inner raceway 21 may also be referred to as the very outer end of the inner raceway 21. Although it is preferred to position the inlet opening of the grease outlet channel 70 at the edge of the inner raceway 21, it may also be arranged near the edge of the inner raceway 21.

[0040] The outlet opening 70b of the grease outlet channel 70b is arranged at the opposite axial side of the first inner ring 20, herein referred to as axial outer side. The axial outer side of the first inner ring 20 is located opposite to the roller-facing axial side of the inner ring 20.

[0041] In order to further facilitate the grease transport from the cavity 60 to the axial outer side of the first inner ring 20, the grease outlet channel 70 could also be inclined to the rotation axis R of the bearing arrangement 100). Besides, the grease outlet channel 70 could comprise several grease outlet channels arranged next to each other.

[0042] As shown in FIG 1, the bearing arrangement 100 may comprise a circumferential groove 22 arranged at the roller-facing side of the first inner ring 2. The groove 22 is connected to the inlet opening 70a of the grease outlet channel 70 and thus the groove is in fluid connection with the inner raceway 21. Surplus grease may be collected in the groove 22 and transported via the groove 22 to the grease outlet channel 70.

[0043] With the groove 22 in the corner between the larger diameter end of the inner raceway 21 and the shoulder 24 or the protruding portion of the shoulder 25, a certain amount of grease may escape into and flow along the groove 22. Thus, not all the grease will be pumped out. With a high amount of grease pushed, in flow direction of the grease, in front of the rollers 10, some grease will be pressed out through the grease outlet channel 70. As a result, the amount of grease in the bearing arrangement 100 will automatically find a balance.

[0044] Two or more grease outlet channels (70) may be distributed in parallel to one another at equally spaced intervals in circumferential direction. Preferably, four grease outlet channels (70) are comprised within the inner ring, wherein their outlet openings (70b) are circumferentially distributed and equidistantly spaced at the axial outer side of the inner ring 20.

[0045] Tapered roller bearings often comprise two rows of tapered rollers in the form of two single-row bearings arranged juxtaposed to each other or in the form of a two-row bearing, as shown in FIG 1.

[0046] Thus, the tapered bearing arrangement 100 may optionally comprise a second inner ring 20', wherein the first and second inner rings 20, 20' are formed integrally or as two distinct rings. The two distinct rings may be firmly connected to each other.

[0047] As shown in FIG 1, the second inner ring 20' is arranged axially juxtaposed to the first inner 20. An inner raceway 21' is formed on the second inner ring 20', wherein the inner raceway 21' is a tapered raceway. That means it has an inner end 21a' at a first radial distance from the rotation axis R of the bearing arrangement and an outer end 21b' at a second radial distance from the rotation axis R, wherein the first radial distance is smaller than the second radial distance.

[0048] The outer ring 30 is arranged around and moveable in relation to both the first inner ring 20 and the second inner ring 20', and comprises a further outer raceway 32 which is also a tapered raceway.

[0049] A further set of tapered rollers 10', having a smaller diameter end 10a' and a larger diameter end 10b', is disposed between the inner raceway 21' of the second inner ring 20' and the further outer raceway 32. The tapered rollers 10' are arranged to roll between the raceway 21' of the second inner ring 20' and the further outer raceway 32.

[0050] . The grease inlet channel 50 may be arranged to also feed grease into the cavity 60 near the inner end 21a' of the

second inner raceway 21'. Alternatively, two separate inlet channels 50 could be arranged in the two inner rings 20, 20' to feed the two rows of tapered rollers 10, 10' with lubricating grease.

[0051] Moreover, a further grease outlet channel 70' is arranged within the second inner ring 20' for conveying used grease away from the outer edge of the further raceway 21'. The further grease outlet channel 70' is running from one axial side of the second inner ring 20' to its opposite axial side, referred to as axial outer side.

[0052] The further grease outlet channel 70' has an inlet opening 70a' and an outlet opening 70b'. The inlet opening 70a' is arranged at the axial side of the second inner ring 20' facing the rollers 10', at the outer end 21b' of the inner raceway 21'. The outlet opening 70b' of the further grease outlet channel 70' is arranged at the axial outer side of the second inner ring 20'. This axial outer side is located opposite to the axial side of the second inner ring 20' facing the rollers 10'.

[0053] As described above, the bearing arrangement 100, shown in FIG 1, comprises an outer ring 30 having two outer raceways 31, 32 as well as a first inner ring 20 and a second inner ring 20' that are firmly connected to each other, e.g. by screw connections. Alternatively, the first and second inner ring 20, 20' may be formed integrally and/or the outer ring 30 may comprise two distinct outer rings that are firmly connected to each other. Besides, each of the rings (20, 20', 30) may be segmented in circumferential direction.

[0054] FIG 2 shows another embodiment of the invention. The embodiment shown in FIG 2 differs from the embodiment shown in FIG 1 in that the inlet opening 70a of the grease outlet channel 70 is spaced apart from the outer end 21b of the inner raceway 21 but still between the outer end 21b of the inner raceway and the radial outer end 23 of the first inner ring 20. This difference is best seen from FIG 2a showing just the related section of the bearing arrangement 100.

[0055] The first inner ring 20 comprises a shoulder 24. The shoulder has, preferably, a shoulder portion 25 protruding into the cavity 60 in such a way that the protruding portion 25 abuts onto the larger diameter ends 10b of the tapered rollers 10. The inlet opening 70a of the grease outlet channel 70 is arranged between the outer end of the inner raceway 21b and the radial outer end 23 of the first inner ring 20. Preferably, it is arranged between the protruding portion of the shoulder 25 and the radial outer end 23 of the first inner ring 20.

[0056] The grease outlet channel 70 is inclined in relation to the rotation axis R such that the outlet opening 70b is arranged at a shorter radial distance from the rotation axis than the inlet opening 70a. That means that the grease outlet channel 70 is inclined towards the rotation axis.

[0057] The inclination angle of the grease outlet channel 70 is, preferably, in the range of 35° to 45°, e.g. about 40°.

[0058] Although, an inclined grease outlet channel 70 is preferred in this embodiment, the grease outlet channel 70 could also run in axial direction, in parallel with the rotation axis R.

[0059] As shown in FIG 2 and FIG 2a, the grease outlet channel 70 may comprise at least two grease outlet channels 70, 71, 72, 73 which are arranged next to each other. The grease outlet channels 70, 71, 72, 73 may be arranged radially adjacent to one another. Alternatively, a single grease outlet channel 70 could run through the first inner ring having a diameter which is large enough to substitute for the at least two grease outlet channels 70, 71, 72, 73. The at least two grease outlet channels 70, 71, 72, 73 may all be inclined in relation to the rotation axis, preferably, by the same inclination angle such that they run in parallel with one another.

[0060] According to a further embodiment of the invention (not shown), the outer ring 30 is firmly connected to a rotor of a direct drive generator for rotation therewith, and the one or more inner rings 20, 20' are firmly connected to a stator of the direct drive generator.

[0061] A method for lubricating the tapered roller bearing arrangement 100, comprises the steps of feeding grease via the grease inlet channel 50 into the cavity 60 and guiding the grease through the cavity 60 to the inlet opening 70a, 70a' of the grease outlet channel 70, 70'. Thereby, the grease is pumped by the movement of the rollers 10, 10', and if present, the movement of a cage towards the inlet opening of the grease outlet channel 70a, 70a' and from there to the outlet opening 70b, 70b' of the grease outlet channel 70, 70'. At the grease outlet opening 70b, 70b', the grease may be collected by grease cups, tubes, hoses or similar grease collecting means which may in turn be connected to one or more containers.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

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P a t e n t k r a v

1. Tilspidset rullelejeindretning (100) til en direkte drivgenerator af et vind-energianlæg, omfattende

5 - en første indvendig ring (20) med en indvendig løbebane (21), hvor den indvendige løbebane (21) har en indvendig ende (21a) i en første radial afstand fra rotationsaksen (R) af lejeindretningen og en udvendig ende (21b) i en anden radial afstand fra rotationsaksen (R), hvor den første radiale afstand er mindre end den anden radiale afstand;

10 - en udvendig ring (30) med en udvendig løbebane (31), hvor den udvendige ring (30) er anbragt omkring og er bevægelig i forhold til den første indvendige ring (20);

- et sæt af tilspidsede ruller (10), der er anbragt i et hulrum (60), der befinder sig mellem den første indvendige ring (20) og den udvendige ring (30), hvor de tilspidsede ruller (10) er indrettede til at rulle i hulrummet mellem den ind-
15 vendige (21) og den udvendige løbebane (31);

- en smøreindgangskanal (50), der er anbragt i den første indvendige ring og forbundet til hulrummet (60) i nærheden af den indvendige ende (21a) af den indvendige løbebane (21) for at lede smørefedt ind i hulrummet (60); og

20 **kendetegnet ved, at:**

- en smøreudgangskanal (70) er anbragt i den første indvendige ring (20) til afledning af overskydende fedt, hvor smøreudgangskanalen (70) har en indgangsåbning (70a) og en udgangsåbning (70b),

25 - indgangsåbningen (70a) er anbragt ved en aksial side, der vender mod rullerne, af den første indvendige ring (20) mellem den udvendige ende (21b) af den indvendige løbebane (21) og den radiale udvendige ende (23) af den første indvendige ring (20), og

- udgangsåbningen (70b) er anbragt ved en aksial udvendig side af den første indvendige ring (20), over for den aksiale side, der vender mod rullerne,

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2. Tilspidset rullelejeindretning (100) ifølge krav 1, hvor indgangsåbningen (70a) af smøreudgangskanalen (70) er anbragt ved den udvendige ende (21b) af den indvendige løbebane (21).

35 3. Tilspidset rullelejeindretning (100) ifølge krav 1,

- hvor de tilspidsede ruller (10) har en ende med mindre diameter (10a) og en ende med større diameter (10b),
- hvor den indvendige ring (20) omfatter en skulder (24) med et skulderparti (25), der rager ind i hulrummet (60) på en sådan måde, at det fremadragende parti (25) ligger an mod enderne med større diameter (10b) af de tilspidsede ruller (10), og
- hvor indgangsåbningen (70a) af smøreudgangskanalen (70) er anbragt mellem det fremadragende parti (25) og den radiale udvendige ende (23) af den indvendige ring (20).

4. Tilspidset rullelejeindretning (100) ifølge et af de foregående krav,

- hvor smøreudgangskanalen (70) strækker sig i aksial retning i forhold til rotationsaksen af lejeindretningen (100) og parallelt med rotationsaksen (R).

5. Tilspidset rullelejeindretning (100) ifølge et af kravene 1-3,

- hvor smøreudgangskanalen (70) er skrå i forhold til rotationsaksen (R), således at udgangsåbningen (70b) er anbragt i en kortere radial afstand fra rotationsaksen (R) end indgangsåbningen (70a).

6. Tilspidset rullelejeindretning (100) ifølge krav 5,

- hvor smøreudgangskanalen (70) er skrå til rotationsaksen (R) med en vinkel i området fra 35° til 45°.

7. Tilspidset rullelejeindretning (100) ifølge et af de foregående krav,

- hvor en omkredsriille (22) er anbragt ved den side, der vender mod rullerne, af den første indvendige ring (20) til opsamling af overskydende fedt, og
- hvor omkredsriillen (22) er forbundet til indgangsåbningen (70a) af smøreudgangskanalen (70) på en sådan måde, at overskydende fedt kan opsamles i rillen (22) og transporteres via rillen (22) til smøreudgangskanalen (70).

8. Tilspidset rullelejeindretning (100) ifølge et af de foregående krav,

- hvor smøreudgangskanalen (70) omfatter mindst to smøreudgangskanaler (70, 71, 72, 73), som er anbragt ved siden af hinanden ved forskellige diametre af den indvendige ring (20).

9. Tilspidset rullelejeindretning (100) ifølge et af de foregående krav,

- hvor mindst to smøreudgangskanaler (70) er anbragt indbyrdes parallelt i intervaller med lige stor indbyrdes afstand i omkredsretning.

10. Tilspidset rullelejeindretning ifølge et hvilket som helst af de foregående krav, endvidere omfattende

- en anden indvendig ring (20'), der er aksialt sammenstillet med den første indvendige ring (20), hvor den anden indvendige ring (20') omfatter en indvendig løbebane (21') med en indvendig ende (21a') i en første radial afstand fra rotationsaksen (R) af lejeindretningen og en udvendig ende (21b') i en anden radial afstand fra rotationsaksen (R), hvor den første radiale afstand er mindre end den anden radiale afstand;

- hvor den udvendige ring (30) er anbragt omkring og er bevægelig i forhold til den anden indvendige ring (20') og omfatter en yderligere udvendig løbebane (32);

- et yderligere sæt af tilspidsede ruller (10') med en ende med mindre diameter (10a') og en ende med større diameter (10b'), det yderligere sæt af tilspidsede ruller (10') er anbragt mellem den indvendige løbebane (21') af den anden indvendige ring (20') og den yderligere udvendige løbebane (32), hvor rullerne (10') er indrettede til at rulle mellem løbebanen (21') af den anden indvendige ring (20) og den yderligere udvendige løbebane (32);

- hvor smøreindgangskanalen (50) er indrettet til også at forsyne fedt til hulrummet (60) i nærheden af den indvendige ende (21a') af den anden indvendige løbebane (21'); og

- en yderligere smøreudgangskanal (70'), der er anbragt i den anden indvendige ring (20'), hvor den yderligere smøreudgangskanal (70') har en indgangsåbning (70a') og en udgangsåbning (70b'),

indgangsåbningen (70a') er anbragt ved den aksiale side, der vender mod rullerne, af den anden indvendige ring (20') mellem den udvendige ende (21b') af den indvendige løbebane (21') og den radiale udvendige ende (23') af den anden indvendige ring (20'), og

- hvor udgangsåbningen (70b') af den yderligere smøreudgangskanal (70') er anbragt ved en aksial udvendig side af den anden indvendige ring (20'), over for den aksiale side, der vender mod rullerne, af den anden indvendige ring (20').

11. Tilspidset rullelejeindretning (100) ifølge krav 10,

- hvor enten den første indvendige ring (20') og den anden indvendige ring (20') er udformet i ét stykke, eller den udvendige ring (30) består af to adskilte ringe, eller begge, den første indvendige ring (20') og den anden indvendige ring (20') er udformet i ét stykke, og den udvendige ring (30) består af to adskilte ringe.

5

12. Tilspidset rullelejeindretning (100) ifølge et af de foregående krav,

- hvor den første indvendige ring (20), den anden indvendige ring (20') og/eller den udvendige ring (30) består af en flerhed af segmenter i omkredsretning.

10

13. Direkte drivgenerator til et vindenergianlæg, omfattende en tilspidset rullelejeindretning (100) ifølge et af de foregående krav,

- hvor en rotor af den direkte drivgenerator er fast forbundet med den udvendige ring (30) til rotation dermed, og hvor en stator af generatoren er fast forbundet til den første indvendige ring (20).

15

14. Vindenergianlæg, omfattende den tilspidsede lejeindretning (100) ifølge et hvilket som helst af kravene 1 til 12 eller en direkte drivgenerator ifølge krav 13.

20

DRAWINGS

FIG 1

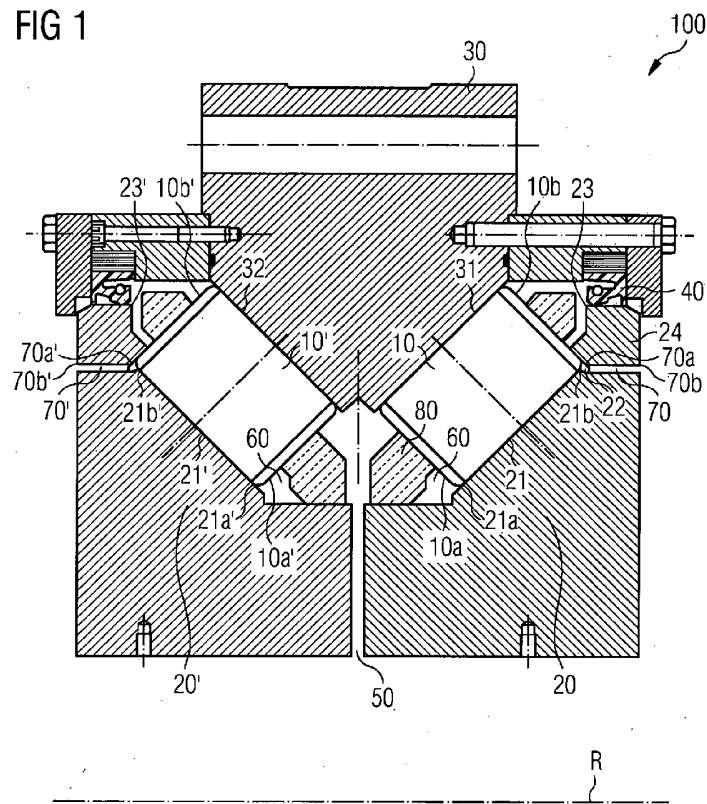


FIG 2

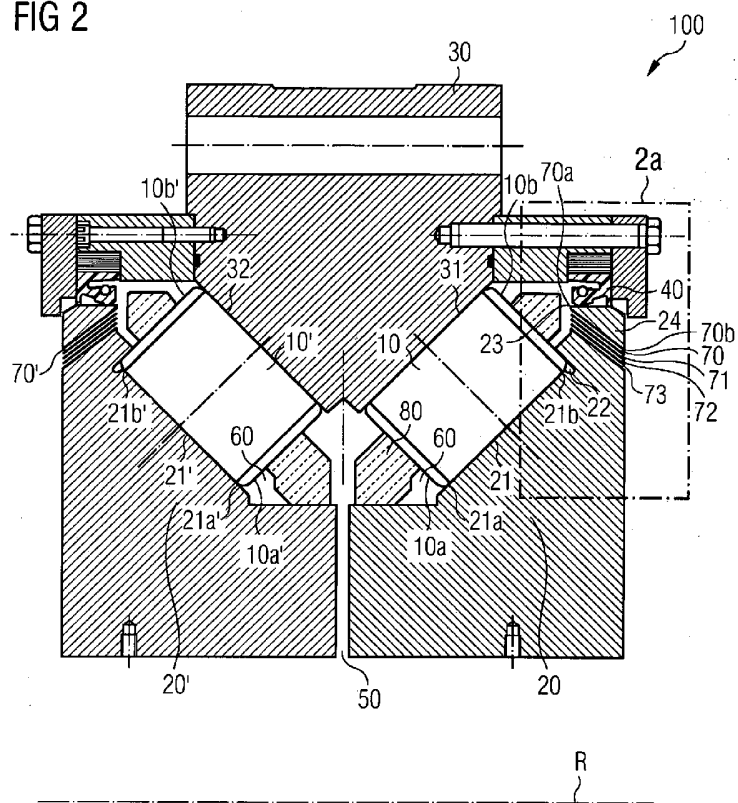


FIG 2a

