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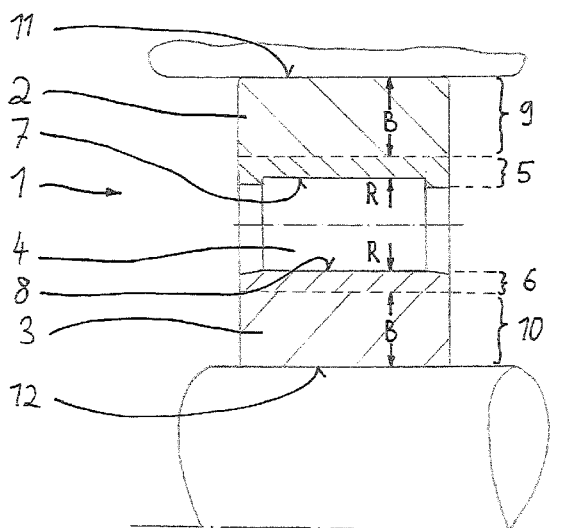
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(54) Title: BEARING WITH FIBER COMPOSITE RINGS



(57) Abstract: The invention relates to a rolling element bearing (1) comprising an outer bearing ring (2) and an inner bearing ring (3), wherein rollers (4) are arranged between the bearing rings (2, 3), wherein each bearing ring (2, 3) has a raceway zone (5, 6) extending along a first extension (R) from the surface of the bearing ring (2, 3) which forms a raceway (7, 8) for the rolling elements (4) and wherein each bearing ring (2, 3) has a base zone (9, 10) extending along a second extension (B) from the surface (11, 12) of the bearing ring (2, 3) which is remote from the raceway (7, 8). To obtain a light but stable design of the bearing, the invention proposes that the bearing rings (2, 3) comprise fiber material, wherein a first fiber material is used for the bearing rings (2, 3) in the first extension (R) and a second fiber material which is different from the first fiber material is used for the bearing rings (2, 3) in the second extension (B).

Fig. 1

Bearing with fiber composite rings

5 Technical Field

The invention relates to a rolling element bearing comprising an outer bearing ring and an inner bearing ring which comprise a fiber composite material. Rolling elements are arranged between the bearing rings, wherein each bearing ring has a raceway zone extending along a first extension from the surface of the bearing ring which forms a raceway for the rolling elements and wherein each bearing ring has a base zone extending along a second extension from the surface of the bearing ring which is remote from the raceway.

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Background

A bearing of this kind is known from WO 2011/020464 A1. Here, a bearing ring is disclosed which consists of a base material. The base material is coated with ceramic material at a surface which forms the raceway for the rollers. The base material is a fiber-reinforced plastic material. Thus, a relatively light bearing ring is provided with a hard surface, so as to obtain a sufficient operating lifetime of the bearing.

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While it becomes thus possible to design the bearing ring with lower weight compared to the classical steel design, it must be said that it is a disadvantage to use the ceramic material because it is relatively heavy.

It is an object of the present invention to propose a rolling element bearing of the kind mentioned above which has a comparable stiffness and durability but which is lighter than the pre-known solution.

5

Summary of the invention

10 A solution according to the invention is characterized in that the bearing rings comprise a fiber material, wherein a first fiber material is used for the bearing rings in the first (radial) extension and a second fiber material which is different from the first fiber material is used for the bearing rings in the second (radial) extension.

15

The bearing rings consist preferably at least partially of wound first and/or second fiber material. The first and/or second fiber material can be wound into a substantially cylindrical shape by using a mandrel.

20 The bearing rings can also comprise plastic material, wherein the first and/or second fiber material is embedded in the plastic material.

The first fiber material is preferably a material with good tribological properties. This means specifically that the first fiber material is preferably
25 aramid, polyethylene (PE) or polytetrafluorethylene (PTFE).

A specific embodiment of the invention proposes that at least two different first fiber materials are selected from of group of aramid, polyethylene (PE) and polytetrafluorethylene (PTFE).

The first fiber material can be embedded in a thermoset or thermoplastic polymer. The polymer is preferably a polyamide. The polyamide can contain a further fiber material, especially glass fiber material.

5

The second fiber material is preferably carbon fiber material. The carbon fiber material can be embedded in a thermoset or thermoplastic polymer. The polymer is preferably a polyamide. The polyamide can contain a further fiber material, especially glass fiber material.

10

A further embodiment of the invention proposes that an intermediate layer is arranged between the raceway zone and the base zone, wherein the intermediate layer comprises fibers of the first fiber material or of the second fiber material or of a third different fiber material. The fibers of the intermediate layer can be wound, as in the case of the raceway zone or base zone, but an angle (e.g. of 5 °) can be provided between the orientation of the fibers in the raceway zone and base zone on the one hand and the fibers of the intermediate zone on the other hand.

20 A further embodiment for ensuring a low weight of the bearing is that the rolling elements are made of a ceramic material, such as silicon nitride.

A bearing according to the present invention can be employed for all kinds of bearings (ball bearings and roller bearings). The carbon fiber (of the base zone) ensures that the bearing can carry high hoop stresses, i. e. the bearing has a high stiffness in the hoop direction. In general, the use of carbon fibers in the base zone delivers a high mechanical stability of the bearing ring; but the tribological properties are not sufficient when using carbon fiber material. Thus, in the raceway zone the mentioned fibers which are employed here

guarantee good tribological properties. Those fibers which are used here preferably do not supply a respective high hoop stiffness, but this is not necessary due to the ability to carry this stress by the base zone. E. g. aramid fibers provide about half the stiffness in the hoop direction compared with the carbon fiber material, but provide a contact stiffness similar to carbon fiber composites (9.5 to 10 GPa).

The proposed filament wound technology is very suitable to replace solutions made from steel in the bearing design.

Thus, the proposed concept suggests to make a filament wound or pulltruded composite bearing ring with the defined arrangement of the two different fiber materials.

The fibers can be placed by winding the fibers onto a mandrel. This can be done with dry fibers or with prepreg.

This means that during the production of the bearing ring by the mentioned winding technology in the case of the outer bearing ring, the raceway zone is produced at first and followed by the base zone. In the case of the inner bearing ring, the base zone is produced at first, followed by the raceway zone which is wound afterwards.

The proposed carbon fibers for the base zone should have a high modulus to be able to carry high hoop stresses. Preferred carbon fibers have an intermediate modulus (IM) or a high modulus (HM).

The fibers in the tribological layer (raceway zone) are preferably oriented in the rolling direction. The raceway fibers have a lower stiffness than the

carbon fibers of the base zone, but possess good anti-wear and fatigue properties. Furthermore, the fibers in the tribological layer preferably display elasticity to transverse compressive loads. Therefore, polymer fibers are preferred here.

5

With respect to resin in which the fibers are embedded, it can be said that it is preferred to have the same resin for both the raceway zone and the base zone.

The raceway zone thickness depends on the actual selection of the carbon
10 fiber, the tribological material in the raceway zone, the contact geometry and the distance between the carbon fibers. It should be as thin as possible, so as to distribute the contact load across several carbon fibers to avoid stress concentrations.

15 Ideally the raceway zone consists of only one layer of polymer fiber, but an optimization between the number of fibers and the size of fiber tow is needed.

A preferred thickness of the raceway zone is between 0.1 mm and 3.0 mm.

20 The maximum contact stress should be reduced below the fatigue limit of the rolling element. The contact stress can be reduced by a lower raceway hardness, which offers an additional beneficial effect.

The proposed roller (or ball) bearing is preferably employed in applications
25 where a very low weight of the bearing is required in combination with high stability and durability.

Brief description of the drawings

The drawing shows an embodiment of the invention. The only figure shows a radial cross section through part of a roller bearing.

5

Detailed description of the invention

10 In the figure a roller bearing 1 – being a cylindrical roller bearing in the present example – is shown. The bearing 1 has an outer bearing ring 2 and an inner bearing ring 3, between which cylindrical rollers 4 are arranged in well-known manner.

15 Each of the bearing rings 2, 3 has a raceway for the rollers 4. The outer bearing ring 2 has an outer raceway 7, the inner bearing ring 3 has an inner raceway 8.

Both bearing rings 2, 3 consist of two separate zones.

20

I. e. in a radially outer region of the outer bearing ring 2 a base zone 9 extends along a first extension B in radial direction. The base zone 9 abuts at its radially inner end to a raceway zone 5, which extends along a second extension R in radial direction. The raceway zone 5 has the outer raceway 7 at
25 its inner circumference. The radially outer circumference of the outer bearing ring 2 has a cylindrical surface 11 which is arranged in a bore of a housing element.

Similarly, in a radially inner region of the inner bearing ring 3, a base zone 10 extends along a first extension B in radial direction. The base zone 10 abuts at its radially outer end to a raceway zone 6, which extends along a second extension R in radial direction. The raceway zone 6 has the inner raceway 8 at its outer circumference. The radially inner circumference of the inner bearing ring 3 has a cylindrical surface 12; this surface encircles a shaft.

Both bearing rings 2, 3 are produced by winding a fiber material around a mandrel. According to the invention, two different fiber materials are used. The base zones 9 and 10 are produced by using a carbon fiber. Raceway zones 5 and 6 are produced by using an aramid fiber.

Thus, the raceway zones 5 and 6 have good tribological properties due to the use of the aramid fiber. In distinction, the base zones 9 and 10 have poor tribological properties (which are not required here) but have a high mechanical stability due to the use of the carbon fiber. The bearing ring is thus able to carry high hoop stresses.

Especially when used with ceramic rollers 4, a very light and stable roller bearing is obtained.

Reference Numerals:

5	1	Roller bearing
	2	Outer bearing ring
	3	Inner bearing ring
	4	Rollers (balls)
	5	Raceway zone
10	6	Raceway zone
	7	Raceway
	8	Raceway
	9	Base zone
	10	Base zone
15	11	Surface
	12	Surface
	R	First extension
20	B	Second extension

Patent Claims:

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1. Rolling element bearing (1) comprising an outer bearing ring (2) and an inner bearing ring (3), wherein rollers (4) are arranged between the bearing rings (2, 3), wherein each bearing ring (2, 3) has a raceway zone (5, 6) extending along a first radial extension (R) from the surface of the bearing ring (2, 3) which forms a raceway (7, 8) for the rolling elements (4) and wherein each bearing ring (2, 3) has a base zone (9, 10) extending along a second radial extension (B) from the surface (11, 12) of the bearing ring (2, 3) which is remote from the raceway (7, 8) for the rolling elements (4),

15

characterized in that

- the bearing rings (2, 3) comprise a fiber material, wherein a first fiber material is used for the bearing rings (2, 3) in the first extension (R) and a second fiber material, which is different from the first fiber material, is used for the bearing rings (2, 3) in the second extension (B).

25

2. Rolling element bearing according to claim 1, characterized in that the bearing rings (2, 3) consist at least partially of wound first and/or second fiber material.

3. Rolling element bearing according to claim 2, characterized in that the first and/or second fiber material is wound into a substantially cylindrical shape.

5

4. Rolling element bearing according to one of claims 1 to 3, characterized in that the bearing rings (2, 3) further comprise plastic material, wherein the first and/or second fiber material is embedded in the plastic material.

10

5. Rolling element bearing according to one of claims 1 to 4, characterized in that the first fiber material is a material with good tribological properties.

15

6. Rolling element bearing according to claim 5, characterized in that the first fiber material is aramid.

20

7. Rolling element bearing according to claim 5, characterized in that the first fiber material is polyethylene (PE).

- 25 8. Rolling element bearing according to claim 5, characterized in that the first fiber material is polytetrafluorethylene (PTFE).

9. Rolling element bearing according to one of claims 6 to 8, characterized in that at least two different first fiber materials are selected from of group of aramid, polyethylene (PE) and polytetrafluorethylene (PTFE).

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10. Rolling element bearing according to one of claims 6 to 9, characterized in that the first fiber material is embedded in a thermoset or thermoplastic polymer.

10

11. Rolling element bearing according to claim 10, characterized in that the polymer is polyamide.

- 15 12. Rolling element bearing according to claim 10 or 11, characterized in that the polyamide contains fiber material, especially glass fiber material.

- 20 13. Rolling element bearing according to one of claims 1 to 12, characterized in that the second fiber material is carbon fiber material.

- 25 14. Rolling element bearing according to claim 13, characterized in that the carbon fiber material is embedded in polyamide (PA), especially in polyamide PA 6.6.

15. Rolling element bearing according to one of claims 1 to 14, characterized in that an intermediate layer is arranged between the

raceway zone (5, 6) and the base zone (9, 10), wherein the intermediate layer comprises fibers of the first fiber material or of the second fiber material or of a third different fiber material.

5

16. Roller bearing according to one of claims 1 to 15, characterized in that the rolling elements (4) are made of a ceramic material.

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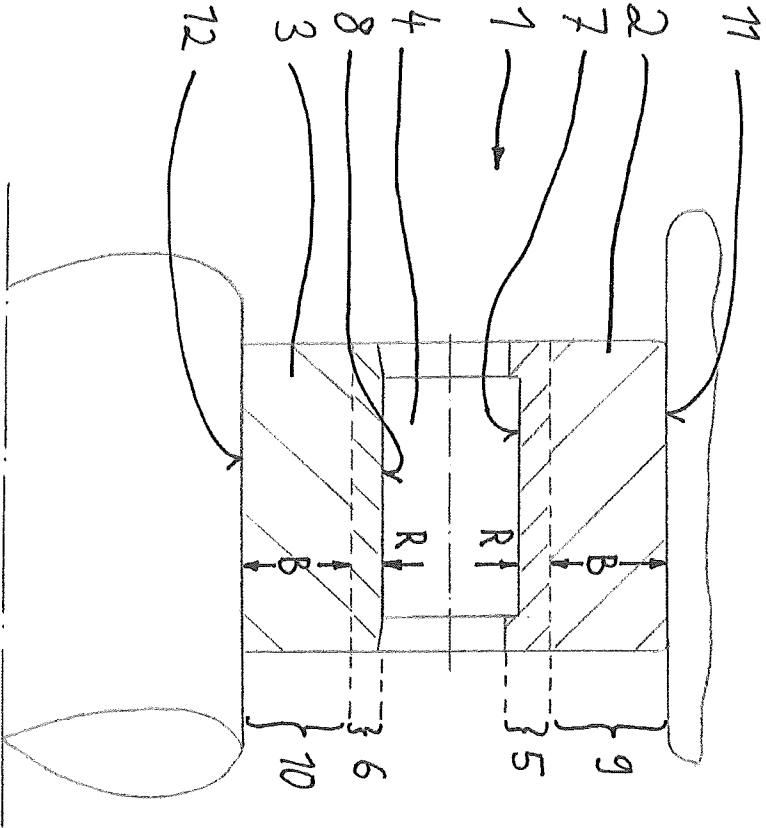


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/059371

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16C33/62
ADD.

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)
F16C

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10 2004 035212 A1 (INA SCHAEFFLER KG [DE]) 16 February 2006 (2006-02-16) paragraph [0019] - paragraph [0028] figure	1,2,5, 7-9,12, 13
A	WO 2011/020464 A1 (SCHAEFFLER TECHNOLOGIES GMBH [DE]; BECKER KLAUS [DE]; STEINHAUER FRANK) 24 February 2011 (2011-02-24) the whole document	1-6,8,9, 12,13



Further documents are listed in the continuation of Box C.



See patent family annex.

* 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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"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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102004035212 A1	16-02-2006	NONE	

WO 2011020464 A1	24-02-2011	DE 102009038418 A1	24-02-2011
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