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(54) Rolling element bearing having improved wear characteristics

Wälzlager mit verbesserten Verschleisseigenschaften

Palier à éléments roulants avec résistance à l'usure améliorée

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(73) Proprietor: **SKF Engineering & Research Centre B.V.**
3430 DT Nieuwegein (NL)

(72) Inventors:
- **Gabelli, Antonip**
  NL-3402 GP Ijselstein (NL)
- **Veenhuizen, Piter Abraham**
  NL-5051 AE Goirle (NL)
- **de Vries, Gerardus**
  NL-3432 GJ Nieuwegein (NL)

(74) Representative: **de Bruijn, Leendert C.**
Nederlandsch Octrooibureau
P.O. Box 29720
2502 LS Den Haag (NL)

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Description

[0001] The invention is related to a rolling element bearing, according to the preamble of claim 1.

[0002] Such rolling element bearing is disclosed in US-A-3764188. Said bearing comprises a number of balls which consist of a plastic material, in combination with normal steel balls. The plastic material is gradually transferred onto the races of the rings and onto the other balls so as to preclude the surface coating thereof from wearing through.

[0003] During rotation of the bearing, the rolling elements roll over the races of the rings. Any contaminations, for instance small wear particles, which are on the races or the rolling elements become compressed between these elements. Hard wear particles, for instance small steel particles which have come off of one of the components of the bearing or have entered from the outside, resist such compression and lead to the formation of minute indentations in both the races and the rolling elements.

[0004] It has been found that in particular the indentations in the races have a negative influence on the useful bearing life. Also, they lead to increased noise during running due to unsmooth running and increased play, caused by wear of the raceway surfaces.

[0005] These indentations take a craterlike shape, whereby a small central hole is surrounded by a ridge of material that has been pushed upwardly and projects above the raceway. Conversely, the rolling elements are indented as well. Due to the cyclic character of the load exerted by the rolling elements, crack formation and fatigue may occur in the rings at the location of high stress concentration usually located just under the ridge of a dent.

[0006] Although it has already been proposed to protect the bearings against such detrimental contamination particles by providing seals and filters, nevertheless the ingress thereof cannot always be totally prevented and therefore the formation of indentations cannot excluded.

[0007] The object of the invention is to alleviate these problems. This object is achieved by the features of the second part of claim 1.

[0008] Any indentations, in particular projecting parts thereof, which are formed by solid contamination particles upon compression between the race in question and a rolling element of about the same hardness, are now compressed as soon as a rolling element with a substantially higher hardness overrolls them. Thereby, said smooth character of the raceways is restored. Only small holes are left, which do not have a reduced or no negative influence on the running properties of the bearing. In these small holes minute quantities of lubricating oil are collected, which help the lubrication of the rolling element in case of oil starvation. Also, the stress concentration and thus the risk of crack formation and wear is basically reduced. Furthermore, the bearing will run more quietly.

[0009] Although any material with adequate hardness properties (Vickers hardness at 5 kg load higher than 13 GPa and modulus of elasticity (Young's modulus) higher than 280 GPa) could be applied, preferably at least one of the rolling elements consists of a ceramic material i. e. engineering ceramic materials: silicon nitride including sialons, silicon carbide and aluminium oxide, or cermets such as cemented carbides. Normally, the other rolling elements consist of steel with about the same mechanical properties as the steel used in the rings.

[0010] Rolling element bearings wherein all rolling elements consist of ceramic material are already known. Having regard to the fact that in these bearings all rolling elements exert the same compressing action on the races, the development of such indentations with high ridges is prevented.

[0011] However, due to the higher hardness and stiffness properties of these rolling elements, the stresses induced in the rings are also higher thus leading to a reduced life or capacity for such types of bearings.

[0012] In the latter bearings, most of the rolling elements are made in steel; thus the deformation is shared equally between the contacting bodies leading to lower stress and preservation of the dynamic capacity of the bearing.

[0013] Most preferably, the ceramic material is siliconnitride.

[0014] In order to avoid unbalances in the rotating bearing, at least two rolling elements consisting of a harder material are provided which are regularly spaced in circumferential direction.

[0015] The invention will further be explained with reference to an embodiment shown in the figures.

[0016] Figure 1 shows a partly side view of an outer ring, having indentations, of a bearing with normal rolling elements.

[0017] Figure 2 shows a partly view of the outer ring, having small holes, in a bearing comprising at least one stiffer or harder rolling element.

[0018] The outer ring 1 of a rolling element bearing, the other parts of which have not been shown, has a raceway 2 over which the rolling elements may roll. Any solid contamination particles which get caught on the surface of the rolling elements and the raceway 2, will lead to the crater-like indentations, comprising a small hole 4 surrounded by a ridge or projecting part 5.

[0019] In turn, these projecting parts 5 will lead to stress concentration and to indentations in the rolling elements themselves.

[0020] The presence of such indentations in both the rings and the rolling elements of the bearing lead to early fatigue and crack formation. Also higher vibrations and a noisy running of the bearing are obtained.

[0021] According to the invention, at least one of the rolling elements is of substantially harder or stiffer nature, e.g. is made of a ceramic or cemented carbides. Such rolling element, when overrolling the indentations

3, will compress at least the protruding parts 5 thereof, as shown in figure 2.

[0022] In this figure 2, an outer ring 6 is shown, of which the projecting parts have been compressed down, giving rise to lands 7 which correspond to the normal, non-damaged surface 8 of the ring 6. The holes which are formed by the indentations are left over.

[0023] The risk of fatigue and therefore crack formation and wear in ring of a bearing having at least 1 stiffer or harder rolling element is considerably lower than in the normal bearings. The presence of the small holes 4 leads to a better lubricating of the raceway 8 and the rolling elements. In the holes 4 minute amounts of oil 9 are collected, which give better lubricating characteristics.

Claims

1. Rolling element bearing, comprising an outer ring and an inner ring which enclose a bearing space containing rolling elements which are movable in one and the same raceway, said rings consisting of steel and at least one of the rolling elements consisting of a material which is different from the material of the other rolling elements, said other rolling elements consisting of steel, characterised in that said at least one of the rolling elements consists of a material which is harder or stiffer than the steel material of said other rolling elements, resulting in a higher hardness of said at least one rolling element with respect to the other rolling elements.

2. Bearing according to claim 1, wherein the Vickers hardness measured at 5 kg load of at least one of the rolling elements is higher than 13 GPa

3. Bearing according to claim 1 or 2, wherein the modulus of elasticity of at least one of the rolling elements is higher than 280 GPa.

4. Bearing according to claim 1, 2 or 3, wherein at least one of the rolling elements consists of an engineering ceramic material or cermets, and the other rolling elements consist of steel.

5. Bearing according to claim 4, wherein the ceramic material is silicon nitride, sialons, silicon carbide, aluminium oxide or cemented carbides.

6. Bearing according to claim 1, 2, 3, 4 or 5, wherein at least two rolling elements consisting of a harder material are provided which are regularly spaced in circumferential direction.

Patentansprüche

1. Wälzkörperlager, das einen Außenring und einen Innenring aufweist, die einen Lagerraum einschließen, der Wälzkörper enthält, die in ein und demselben Laufring beweglich sind, wobei die Ringe aus Stahl bestehen und zumindest einer der Wälzkörper aus einem Material besteht, das sich von dem Material der anderen Wälzkörper unterscheidet, wobei die anderen Wälzkörper aus Stahl bestehen, **dadurch gekennzeichnet,**
daß zumindest einer der Wälzkörper aus einem Material besteht, das härter oder steifer ist als das Stahlmaterial der anderen Wälzkörper, was zu einer höheren Härte des zumindest einen Wälzkörpers in Bezug auf die anderen Wälzkörper führt.

2. Lager nach Anspruch 1, wobei die Vickershärte, gemessen bei einer Last von 5 kg zumindest eines Wälzkörpers höher als 13 GPa ist.

3. Lager nach Anspruch 1 oder 2, wobei der Elastizitätsmodul zumindest eines Wälzkörper höher als 280 GPa ist.

4. Lager nach Anspruch 1, 2 oder 3, wobei zumindest einer der Wälzkörper aus einem technischen keramischen Werkstoff oder aus Cermets und die anderen Wälzkörper aus Stahl bestehen.

5. Lager nach Anspruch 4, wobei der keramische Werkstoff Siliciumnitrid, Sialone, Siliciumcarbid, Aluminiumoxid oder Sinterhartmetalle ist.

6. Lager nach Anspruch 1, 2, 3, 4 oder 5, wobei zumindest zwei aus einem härteren Material bestehende Wälzkörper bereitgestellt werden, die in umfänglicher Richtung mit einem regelmäßigen Abstand angeordnet sind.

Revendications

1. Palier à éléments roulants, comprenant une bague interne et une bague externe qui délimitent un espace du palier contenant des éléments roulants qui sont mobiles sur une seule et même piste de roulement, ces bagues étant réalisées en acier et l'un au moins des éléments roulants étant réalisé en un matériau qui est différent du matériau des autres éléments roulants, ces autres éléments roulants étant réalisés en acier, caractérisé en ce que l'un au moins des éléments roulants est réalisé en un matériau qui est plus dur ou plus rigide que l'acier des autres éléments roulants, ce qui se traduit par une dureté plus élevée du ou des éléments roulants précités par rapport aux autres éléments roulants.

2. Palier suivant la revendication 1 caractérisé en ce que la dureté Vickers, mesurée sous une charge de 5 kg, de l'un au moins des éléments roulants est supérieure à 13 GPa.

3. Palier suivant l'une quelconque des revendications 1 ou 2 caractérisé en ce que le module d'élasticité de l'un au moins des éléments roulants est supérieur à 280 GPa.

4. Palier suivant l'une quelconque des revendications 1,2 ou 3 caractérisé en ce que l'un au moins des éléments roulants est constitué en un matériau céramique de la technique ou en cermets tandis que les autres éléments roulants sont réalisés en acier.

5. Palier suivant la revendication 4 caractérisé en ce que le matériau céramique est constitué par le nitrure de silicium, les sialons, le carbure de silicium, l'oxyde d'aluminium ou des carbures cémentés.

6. Palier suivant l'une quelconque des revendications 1,2,3,4 ou 5 caractérisé en ce qu'au moins deux éléments roulants, réalisés en un matériau plus dur, sont prévus et sont régulièrement espacés dans la direction circonférentielle.

Fig-1

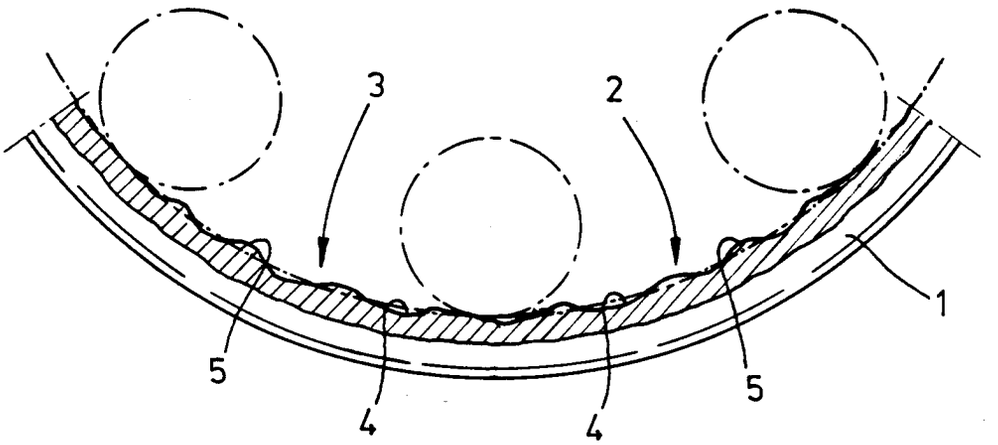

Fig-2