Title: ROLLING BEARING WITH TRANSVERSAL GROOVE

Abstract: A rolling bearing consisting of two rings with raceways, along which the rolling elements move, and whose all rolling elements are subjected to a load, wherein one of the races (5,6) has at least one groove or hollow (4) located transversely with respect to the direction of movement of the rolling elements (3).
ROLLING BEARING WITH TRANSVERSAL GROOVE

The present invention relates to a rolling bearing, in which rolling elements such as balls, cylindrical rollers, tapered rollers, needle rollers or spherical rollers move between two raceways.

Rolling bearings which are used as structural elements in machine parts are known. The bearings are included in catalogues of manufacturers of the above-mentioned machine parts, as e.g. in the case of the rolling bearings in the catalogue of SKF – Katalog 6000 PL January 2007. As examples of various types of bearings, one can refer to the descriptions in the Polish patents issued under the following numbers: 159241 161938, 161939, and 179738.

Although the construction of rolling bearings is diversified, each design includes rolling elements, which move between two races. An additional element may be a retainer, which keeps the rolling elements at equal distances from each other, or sealings, etc.

As rolling bearings allow the shaft to rotate and maintain its rotation axis in a fixed position, as well as they transmit loads, they should be characterised by small resistance to motion, stable operation, reliability and resistance to wear, i.e. durability. In order to ensure that energy losses caused by friction and the noise due to vibration of interacting elements are as small as possible, the races of structural elements, which interact with the rolling elements, are ground and then further smoothed. Small differences in dimensions of the rolling elements, however, are the cause of a significant problem, as it is practically impossible to obtain absolute uniformity of dimensions of the rolling elements, which are mass-produced, even if they undergo size selection. For example, a rolling bearing can be equipped with balls, which differ in diameters up to 2 μm. If such a bearing rotates e.g. with the speed of 1000 rpm, the balls can travel distances with a difference of up to 2 mm within 1 minute. Uneven load of the rolling elements in a bearing is yet another cause of propagation of differences in the distance travelled by the rolling elements. In rolling bearings, which transmit only a radial load, the rolling elements which do not take part in transmitting the loads displace, and thus even out the distance. In bearings in which all the rolling elements are subjected to
load, the distance travelled by the rolling elements is evened out owing to the fact that rolling element slips with respect to the race. Slipping takes place only when the forces exerted by the balls on the retainer or the neighbouring ball increased to a value, which exceeds the value of the forces of sliding friction; the bigger load the bearing is subjected to, the higher value of sliding friction occurs. In such a case lubricant for rolling bearings is the component responsible for proper interaction between the elements. Lack of appropriate lubrication is the main cause of bearing wear. Rolling bearings which transmit only radial loads and have retainers made of materials which have small coefficients of friction, can work without lubrication.

Polish patent No. 179738 describes a slewing bearing, having the groove in the inner ring widened in two places, which are located opposite each other with respect to the main axis of the bearing. The bearing described in the mentioned patent is a slewing bearing, usually applied to support slow-speed, highly loaded parts of mobile slewing large-size machines, such as excavators or cranes. The bearing is not mounted on a shaft or in a housing. Instead, it is simply bolted to bearing elements of the machine. The slewing bearing changes its direction of rotation many times during its operation. Its rings and rolling elements are subjected not only to axial and radial loads, as well as significant moment of force from the machine's arm. Such moment load in the bearing axis which is perpendicular to the deflection of the arm causes a change in the direction of the load subjected to the bearing rings as well as the rolling elements. In the axis itself, the load the rings and the rolling elements are subjected to, equals zero. In the view of the above-mentioned situation, unnecessary resistance to motion in the area of the axis is introduced, as direction of the load of the moving rolling elements change. The slewing bearing referred to in the patent No. PL179738 approaches the above-mentioned problem by introducing two opposite places, at which the loading forces the rolling elements and the races are subjected to, change their direction and equal almost zero, and the rolling elements move freely as they are pushed on by the neighbouring balls, owing to a groove in a section of the race. Free movement of the rolling elements at a place, where direction of the ball load and ball rotation plane change, results in a decrease of bearing's resistance to rotation. In the case of slewing bearings, which are characterised by
small rotation speed (5–15 rpm) and repeated change of the load direction, the problem of different distances travelled by the rolling elements is irrelevant.

The aim of the present invention is to design a rolling bearing, in which all the rolling elements are subjected to a load simultaneously, and the problem of different distances travelled by the rolling elements is eliminated or significantly improved.

A rolling bearing, in which all the rolling elements are subjected to a load simultaneously, as in the present invention, is characterised in that there is at least one groove and/or hollow in one of the races created in such a manner that it is transverse with respect to the direction of motion of the rolling elements.

Preferably, the arrangement of the grooves or hollows is different from a multiple of the arrangement of the rolling elements.

Preferably, the groove or hollow is filled with a material, which facilitates the slippage between a rolling element and the races.

Preferably, the material which facilitates the slippage has coefficient of friction which is smaller than the coefficient of friction between the material out of which the raceway is made and the rolling elements.

Preferably, the material which facilitates the slippage can include lead, silver, titanium nitride, diamond-like carbon (DLC), titanium carbide (TiC), polymers used to manufacture bearings, such as polyacetal, polypropylene, polyamide, and polyimide, and most preferably with addition of graphite and/or Teflon.

Preferably, a mechatronic sensor is mounted within the transverse groove or hollow.

Preferably, the rolling elements include balls, cylindrical rollers, tapered rollers, needle rollers and spherical rollers.

The transverse groove or hollow, which is located transversely with respect to the motion of the rolling elements on one of the raceways from the present invention, allows a rolling element to get decoupled from the raceway for a moment, and move due to forces of interactions with the retainer or a neighbouring rolling element, what is a result of differences in diameters of the rolling elements, as well as uneven load the rolling elements of the bearing are subjected to. In the case when the groove or hollow is filled with a material which facilitates the
slippage of the rolling elements along the raceways, the force exerted by the retainer or a neighbouring rolling element, is diminished. The force is necessary for a mutual displacement of all the considered elements.

As the material for filling the groove or hollow, there can be applied an arbitrary polymer used for production of polymer bearings, e.g. a polymer type known by its trade name of Vespel.

Lack of slipping between a rolling element and the raceways in the bearing from the present invention, containing an empty transverse groove or hollow, allows the bearing to work without lubrication. This feature is particularly important for rolling bearings applied in nanotechnology or bearings working in vacuum, whereas application of the filling material facilitates the slippage between a rolling element and the raceways, and increases durability of the bearing even if lubrication is insufficient or is not provided at all.

It is possible to place a mechatronic sensor within the groove or hollow, more particularly in the filling material, which can record information about position and speed of the moving elements. In particular, the mechatronic sensor can record such parameters as shaft or housing vibration, number of rotations, speed, direction of rotation, relative position of the elements, acceleration or deceleration.

The construction design of the present invention is characterised by smaller interaction forces between neighbouring rolling elements or between the rolling elements and the retainer. Displacement of a rolling element in the prepared groove or hallow is not associated with a slippage. Significant advantages resulting from the present invention are evident in the case of deep groove ball bearings that are subjected to axial or angular loads, ball bearings for magnetos, angular contact ball bearings, ball bearings for spindles, four-point contact ball bearings, trust ball bearings, taper roller bearings, cylindrical and spherical roller thrust bearings, angular contact trust ball bearing, needle thrust bearings, tapered roller thrust bearings, so in instances where all the rolling elements are subjected to a load simultaneously.

The subject of the present invention is illustrated in the respective figures, of which Fig. 1 shows a single-row angular contact ball bearing with a retainer viewed in cross- and longitudinal sections, including one empty transverse groove; Fig. 2 shows in a diagram the inner ring of the bearing with an empty transverse
groove; Fig. 3 shows in a diagram the inner ring of the bearing with a transverse
groove filled with a material, and Fig. 4 shows single-row angular contact ball
bearing without a retainer viewed in cross- and longitudinal sections, including
three empty grooves.

The rolling bearing illustrated in Fig. 1 is a single-row angular contact ball
bearing. The bearing is composed of an outer ring 1, an inner ring 2, balls 3 as the
rolling elements and a retainer 8. The rolling elements move along an outer
raceway 5 and inner raceway 6. A transverse groove 4 is created in the inner
raceway 6.

The transverse groove filled 7 or empty 4, is illustrated in detail in diagram
in Fig. 2 and Fig. 3, which show the inner ring of the single-row angular contact
ball bearing.

The rolling bearing presented in Fig. 4 is a single-row angular contact ball
bearing. The bearing is composed of an outer ring 1, an inner ring 2 with maximal
number of the rolling elements in a form of balls 3, and there is no retainer. The
rolling elements move along an outer raceway 5 and an inner raceway 6. Three
transverse grooves 4 are created in the inner raceway 6.

To eliminate or significantly reduce the problems caused by the differences
in dimensions of the rolling elements 3, a groove/grooves or hallow/hollows 4 is/are
created in the outer raceway 6 or the inner raceway 5.

As the inner ring 2 of the bearing rotates, it makes all the rolling elements 3 travel
on the outer raceway 6 or the inner raceway 5. The transverse groove/grooves 4 allow/allows the rolling element to move without a slippage, provided that there
occur forces resulting from interactions between the rolling elements 3, or between
one of the rolling elements 3 and the retainer. In the bearing with a groove/grooves
4 which is/are filled with the material 7 having a reduced coefficient of friction, the
rolling elements 3 can easily slip, what results in a decrease of the values of the
forces resulting from the interaction between the rolling elements or between the
retainer 8 and a rolling element.
Claims

1. A rolling bearing consisting of two rings with raceways, along which the rolling elements move, and whose all rolling elements are subjected to a load, wherein one of the races (5,6) has at least one groove or hollow (4) located transversely with respect to the direction of movement of the rolling elements (3).

2. The bearing of Claim 1 wherein the transverse groove or hollow (4) is filled with a material (7), which facilitates the slippage between the rolling elements (3) and the races (5,6).

3. The bearing of Claim 2 wherein the material which facilitates the slippage has a coefficient of friction which is smaller than the coefficient of friction between the rolling elements (3) and the material the raceway (5,6) is made of.

4. The bearing of Claim 2 or 3 wherein the material which facilitates the slippage can be lead, silver, titanium nitride, diamond-like carbon, titanium carbide or polymers used to manufacture bearings.

5. The bearing of Claim 4 wherein the applied polymer is polyacetal, polypropylene, polyamide or polyimide.

6. The bearing of Claim 4 or 5 wherein polymer with addition of graphite and/or Teflon is used.

7. The bearing of Claim 1 wherein arrangement of the grooves or hollows (4) is different from multiple of the arrangement of the rolling elements (3).

8. The bearing of Claim 1 or 2 wherein the rolling elements refer to balls, spherical rollers, tapered rollers, needle rollers or cylindrical rollers.

9. The bearing of Claim 1 or 2 wherein a mechatronic sensor is mounted within the transverse groove or hollow (4).

10. The bearing of Claim 9 wherein the mechatronic sensor is mounted within the material filling the transverse groove (4).
Fig. 4
### A. CLASSIFICATION OF SUBJECT MATTER

INV. F16C19/52  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

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>EP 0 375 938 A1 (OMET SRL [IT]) 4 July 1990 (1990-07-04)</td>
<td>1-6,8</td>
</tr>
<tr>
<td></td>
<td>column 2, line 11 - line 34 column 2, line 46 - line 52 figure 1</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>US 1 334 027 A (AUGUST FORSBERG ERIK) 16 March 1920 (1920-03-16) page 2, line 59 - page 3; figures 1,3,4</td>
<td>1,7</td>
</tr>
</tbody>
</table>

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

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

*"X"* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

*"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.

*"S"* document member of the same patent family

Date of the actual completion of the international search: 16 May 2011

Date of mailing of the international search report: 24/05/2011

Name and mailing address of the ISA/European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016

Authorized officer: Schlossarek, M
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>JP 7 197937 A (ISHIMOTO NAOKI) 1 August 1995 (1995-08-01) abstract; figures 3,4</td>
<td>1</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>US 1334027</td>
<td>16-03-1920</td>
<td>NONE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 2006336103 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2639786 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 101360927 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2007082532 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1977126 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2334821 T3</td>
</tr>
<tr>
<td>JP 7197937</td>
<td>01-08-1995</td>
<td>NONE</td>
</tr>
<tr>
<td>US 2010002974</td>
<td>07-01-2010</td>
<td>WO 2008029528 A1</td>
</tr>
</tbody>
</table>