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ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

Rolling bearing having at least a flexible ring.

The present invention relates to rolling bearings, in particular rolling bearings having an inner ring and an outer ring with one or more rows of rolling elements, for example balls. The rolling bearings may be, for example, those used in industrial electric motors or in motor vehicle gearboxes.

In such applications, known ISO deep groove ball bearings are usually used. These bearings comprise inner and outer rings of the massive or solid type. A "solid ring" is to be understood as a ring obtained by machining with removal of material (by turning, grinding) from steel tube stock, bar stock, rough forgings and/or rolled blanks.

In such applications, the deep groove ball bearings are mainly loaded radially, often with a relatively weak load compared to the capacity of these bearings. The service life of the deep groove ball bearings is essentially related to the lubrication of the bearing because of the low performance of the lubricant compared to the steel of the solid rings.

German patent application DE 10 2005 033 566 discloses a rolling bearing without clearance in which the outer ring is in two parts. One of the parts of said outer ring is a solid ring. The other part is obtained by stamping sheet metal and delimits, together with a housing holding the two parts of the ring, a space inside which an axially preloaded resilient element is housed.

With such a rolling bearing, in case of an increase of radial loads with regard to the nominal load of the bearing, its service life strongly reduces.

One aim of the present invention is to overcome this drawback.

It is a particular object of the present invention to provide a rolling bearing adapted to take up higher radial loads than the nominal load without decreasing bearing life and which is simple to manufacture and economic.

5 In one embodiment, the rolling bearing comprises an inner ring, an outer ring, at least one row of rolling elements disposed between raceways provided on the rings, and an annular housing inside which at least one of said rings is arranged, said ring being in two parts. Each of the two parts delimits with the housing a closed space. The ratio between the thickness of a guiding portion of each of the two parts of said ring delimiting the raceway and between the outer diameter of the bearing is from 0,7 % to 3 %, and preferably from 1,1 % to 1,9 %.

10 In one embodiment, the ratio between the thickness of each of the guiding portions and the diameter of the rolling elements is from 5,5 % to 22 %, and preferably from 8,5 % to 15 %.

In one embodiment, the closed spaces are empty.

15 Advantageously, the two parts of said ring are identical and symmetrical with respect to a radial plane passing through the centre of the rolling elements.

20 In one embodiment, each of the two parts of said ring comprises an outer axial portion in radial contact with an axial portion of the housing, a radial portion, the guiding portion and an inner axial portion, the closed space being delimited by said portions of the ring and a radial flange of the housing.

In a preferred embodiment, the radial portions of the two parts of said ring are in axial contact with one another.

25 The outer axial portions of the two parts of said ring may be in axial contact with the radial flanges of the housing.

In an embodiment, the inner axial portions of the two parts of said ring are in axial contact with the radial flanges of the housing.

30 In a preferred embodiment, each of the two parts of said ring has a constant thickness. The two parts of said ring may be made of stamped metal sheet or tube.

In one embodiment, the bending strength of each of the two parts of said ring is from is up to 250 MPa.

According to another aspect, it is proposed an electric motor or generator comprising at least one rolling bearing as previously defined.

5 The present invention and its advantages will be better understood by studying the detailed description of a specific embodiment given by way of non-limiting example and illustrated by the appended drawing showing an axial half-section of a rolling bearing according to an example of the invention.

10 As illustrated on the Figure, which illustrate an embodiment of a rolling bearing according to the invention, said bearing comprising an inner ring 1 and an outer ring 2 consisting of two outer parts or half-rings 2a, 2b, a row of rolling elements 3 that consist in the example illustrated of balls, and a cage 4 to hold said rolling elements and disposed between the inner ring 1 and the outer ring 2. The rolling
15 bearing also comprises an annular enclosing ring or housing 5 surrounding the two outer half-rings 2a, 2b.

In this example, the inner ring 1 is designed to be mounted on a rotary member. It thus constitutes the rotating ring of the bearing while the outer ring 2 constitutes the non-rotating ring. The inner ring
20 1 is solid and has a toroidal groove 6 provided on its exterior cylindrical surface 1a and forming a raceway for the rolling elements 3. The radius of curvature of the groove 6 is slightly greater than the radius of the rolling elements. The inner ring 1 may be manufactured by machining or by pressing a steel blank which is then ground and
25 optionally lapped at the raceway in order to give the ring 1 its geometric characteristics and its final surface finish.

The cage 4 comprises a plurality of open cavities 7 bounded by external retaining claws 8. The cavities 7 are advantageously spherical with a diameter slightly greater than that of the rolling elements 3 so
30 as to receive and hold the latter. The cavities 7 are made around the periphery of an annular body of the cage 4, leaving a heel 9 opposite the openings of the cavities 7. These openings bounded in each case by two opposing claws 8 have a width slightly smaller than the diameter of the rolling elements 3. The rolling elements 3 are snap-fitted by

moving the claws 8 apart elastically. Alternatively, the cage may have other means than cavities 7 and claws 8 for retaining the rolling elements. The cage 4 can be made of moulded plastic or of metal.

5 In this embodiment, the two parts 2a and 2b of the outer ring 2 are identical and symmetrical with respect to the radial plane of symmetry of the bearing passing through the centre of the rolling elements 3 in order to reduce the manufacturing costs. As an alternative, it is also possible to foresee parts 2a, 2b non-symmetric. These two outer half-rings 2a, 2b may advantageously be manufactured
10 by cutting and stamping a metal sheet, the pieces obtained then being hardened by heat treatment. Each of the two half-rings 2a, 2b has a constant thickness. The raceways may then be ground and/or lapped in order to give them their geometric characteristics and their definitive surface finish. Since the two half-rings 2a, 2b are identical in this
15 example, only one of them, having the reference "a", will be described here, it being understood that the identical elements of the other half-ring 2b have the reference "b".

The half-ring 2a of the outer ring 2 comprises an outer cylindrical axial portion 11a, an annular radial portion 12a, a toroidal
20 portion 13a and an inner cylindrical axial portion 14a. The radial portion 12a is connected to the outer axial portion 11a and to the toroidal portion 13a. The toroidal portion 13a delimits a toroidal raceway 15a for the rolling elements 3. The toroidal portion 13a forms a guiding portion for the rolling elements 3. The radius of curvature of
25 the raceway 15a is slightly greater than the radius of the rolling elements 3. The toroidal portion 13a is also connected to the inner axial portion 14a. The toroidal portion 13a extends axially towards the outside of the rolling bearing with the inner axial portion 14a. The two outer half-rings 2a, 2b are positioned with the radial faces 16a, 16b of
30 the radial portions 12a, 12b in axial contact with one another, approximately in the radial plane of symmetry of the rolling bearing and the rolling elements 3. Alternatively, it might be possible to foresee an axial clearance between the radial portions 12a, 12b of the

half-rings 2a, 2b in order to obtain an internal preload for the rolling bearing.

5 The housing 5, which is advantageously made of stamped metal sheet, comprises two radial flanges 17a, 17b and an outer axial portion 17c connected to the two radial flanges 17a, 17b so as to surround the two half-rings 2a, 2b and to hold them against one another in the axial direction. The half-rings 2a, 2b are centred in the axial portion 17 of the housing 5 by radial contact between the two axial portions 11a, 11b and the bore of the axial portion 17c. The outer radial faces 18a, 18b which form the annular edges of the two outer axial portions 11a, 10 11b are respectively in axial contact with the radial flanges 17a, 17b of the housing 5. The outer radial faces 19a, 19b which form the annular edges of the two inner axial portions 14a, 14b are respectively in axial contact with the radial flanges 17a, 17b. The two radial 15 flanges 17a, 17b extend radially inwards towards the outer cylindrical surface 1a of the inner ring 1. The inner edges 20a, 20b leave a radial clearance with respect to said cylindrical surface 1a. The outer radial face of each flange 17a, 17b lies in a radial plane containing a radial face of the inner ring 1.

20 Each of the outer half-rings 2a, 2b delimits, with the housing 5, an annular closed space 21a, 21b. More specifically, the closed space 21a is delimited by the outer axial portion 11a, the radial portion 12a, the toroidal portion 13a and the inner axial portion 14a, and facing these portions, a part of the radial flange 17a of the housing 5. The 25 closed spaces 21a, 21b are empty, i.e. no lubricant or other means is contained in these spaces. Lubricant is foreseen into the radial space between the inner ring 1 and the outer half-rings 2a, 2b inside which are housed the rolling elements 3.

30 The various elements of the rolling bearing are assembled as follows. Once the rolling elements 3 have been inserted in the cavities 7 of the cage 4 and the whole has been fitted on the inner ring 1, the two half-rings 2a, 2b are positioned around the row of rolling elements 3. The housing 5 has, at this stage of the assembly process, an L-shaped structure with an outer cylindrical portion forming the axial

portion 17c being connected to a radial portion forming one of the radial flanges, for example the flange 17b. The housing thus created is then fitted over the two half-rings 2a, 2b. Once the two outer half-rings 2a, 2b have been put in place in the L-shaped structure of the housing 5, the outer cylindrical portion of the housing 5 is folded over on the side opposite the radial flange 17b to form the second radial flange 17a opposite the first and to hold the two half-rings 2a, 2b against one another by way of their respective outer axial portions 11a, 11b and their inner axial portions 14a, 14b. Once the assembly process is complete, the housing 5 and the two outer half-rings 2a, 2b delimit annular closed empty volumes or spaces 21a, 21b.

According to an analysis made by the applicant, it was found that osculation variation of the rolling bearing is obtained with a ratio between the thickness of each of the toroidal portions 13a, 13b of the two outer half-rings 2a, 2b and the outer diameter of the housing 5 from to 0,7 % to 3 %, and preferably from 1,1 % to 1,9 %.

The applicant has determined that, with such a range, due to rolling elements load distribution inside the rolling bearing, each of the raceways 15a, 15b of the toroidal portions 13a, 13b deforms around the rolling elements 3 and osculation is reduced. The rolling bearing load capacity becomes higher thanks to this phenomenon. Accordingly, the surface of the raceways 15a, 15b of the outer half-rings 2a, 2b becomes larger and the contact pressure exerted on said raceways by the rolling elements 3 becomes lower with regard to a conventional massive outer solid which deforms much less. Surface stresses are then reduced and surface fatigue life is increased.

Otherwise, in case of higher radial loads than the nominal load of the rolling bearing applied on the rolling bearing, the raceways 15a, 15b of the outer half-rings 2a, 2b are deformed and better envelop the rolling elements 3. Thus, the rolling bearing can take up higher radial loads without decreasing bearing life. With the above-mentioned ratio between the thickness of the toroidal portions 13a, 13b of the half-rings 2a, 2b and the outer diameter of the rolling bearing, the flexibility of said rings gives smaller osculation and a self-adaptive

interaction between the raceways and the rolling elements when the radial loads increase. Thus, each of the outer half-rings 2a, 2b has an adaptive osculation design which enables to reduce the impact of an increase of radial loads applied on the rolling bearing. As previously mentioned, the two half-rings 2a, 2b have a constant thickness. The ratio between the thickness of the half-rings 2a, 2b and the outer diameter of the rolling bearing is from 0,7 % to 3 %, and preferably from 1,1 % to 1,9 %. The ratio between the thickness of each of the guiding portions 13a, 13b and the diameter of the rolling elements 3 is from 5,5 % to 22 %, and preferably from 8,5 % to 15 %. For instance, for a rolling bearing with a housing having an outer diameter equal to 130 mm and rolling elements 3 having a diameter equal to 17,462 mm, the thickness of the half-rings 2a, 2b may be comprised between 1,48 to 2,6 mm, and preferably equal to 2 mm. The bending strength of each of the two half-rings 2a, 2b may be up to 250 MPa. The strain strength of each of said two half-rings 2a, 2b is 0,01 % of the deformation before plastic deformation.

In the disclosed embodiment, the outer ring 2 comprises two half-rings 2a, 2b and the inner ring 1 is of the solid type. Alternatively, it might be possible to have the outer ring solid while the inner ring would consist of two half-rings produced in a similar way to the half-rings 2a, 2b of the disclosed embodiments. The two half-rings of the inner ring would be mounted inside a housing. The arrangement is identical to that of the embodiment illustrated, but with the elements inverted. In another embodiment, it could also be possible to have a rolling bearing in which the inner ring and the outer ring each comprise two half-rings enclosed in a housing as previously described. In such an embodiment, the rolling bearing has four closed empty spaces.

Although the present invention has been illustrated on the basis of a rolling bearing having a single row of balls, it should be understood that the invention can be applied to bearings using several rows of rolling elements, without major modifications. The invention

can also be applied to different types of ball bearings, such as angular contact bearings, or else to self-aligning bearings.

CLAIMS

1. Rolling bearing comprising an inner ring (1), an outer ring (2), at least one row of rolling elements (3) disposed between raceways (6, 15a, 15b) provided on the rings, and an annular housing (5) inside which at least one of said rings is arranged, said ring being in two parts (2a, 2b), characterized in that each of the two parts of said ring delimits with the housing a closed space (21a, 21b), and in that the ratio between the thickness of a guiding portion (13a, 13b) of each of the two parts (2a, 2b) delimiting the raceway (15a, 15b) and between the outer diameter of the bearing is from 0,7 % to 3 %, and preferably from 1,1 % to 1,9 %.

2. Rolling bearing according to claim 1, wherein the ratio between the thickness of each of the guiding portions (13a, 13b) and the diameter of the rolling elements (3) is from 5,5 % to 22 %, and preferably from 8,5 % to 15 %.

3. Rolling bearing according to claim 1 or 2, wherein the closed spaces (21a, 21b) are empty.

4. Rolling bearing according to any of the preceding claims, wherein the two parts (2a, 2b) of said ring are identical and symmetrical with respect to a radial plane passing through the centre of the rolling elements (3).

5. Rolling bearing according to any of the preceding claims, wherein each of the two parts (2a, 2b) of said ring comprises an outer axial portion (11a, 11b) in radial contact with an axial portion (17c) of the housing, a radial portion (12a, 12b), the guiding portion (13a, 13b) and an inner axial portion (14a, 14b), the closed space (21a, 21b) being delimited by said portions of the ring and a radial flange (17a, 17b) of the housing.

6. Rolling bearing according to claim 5, wherein the radial portions (12a, 12b) of the two parts of said ring are in axial contact with one another.

7. Rolling bearing according to claims 5 or 6, wherein the outer axial portions (11a, 11b) of the two parts of said ring are in axial contact with the radial flanges (17a, 17b) of the housing.

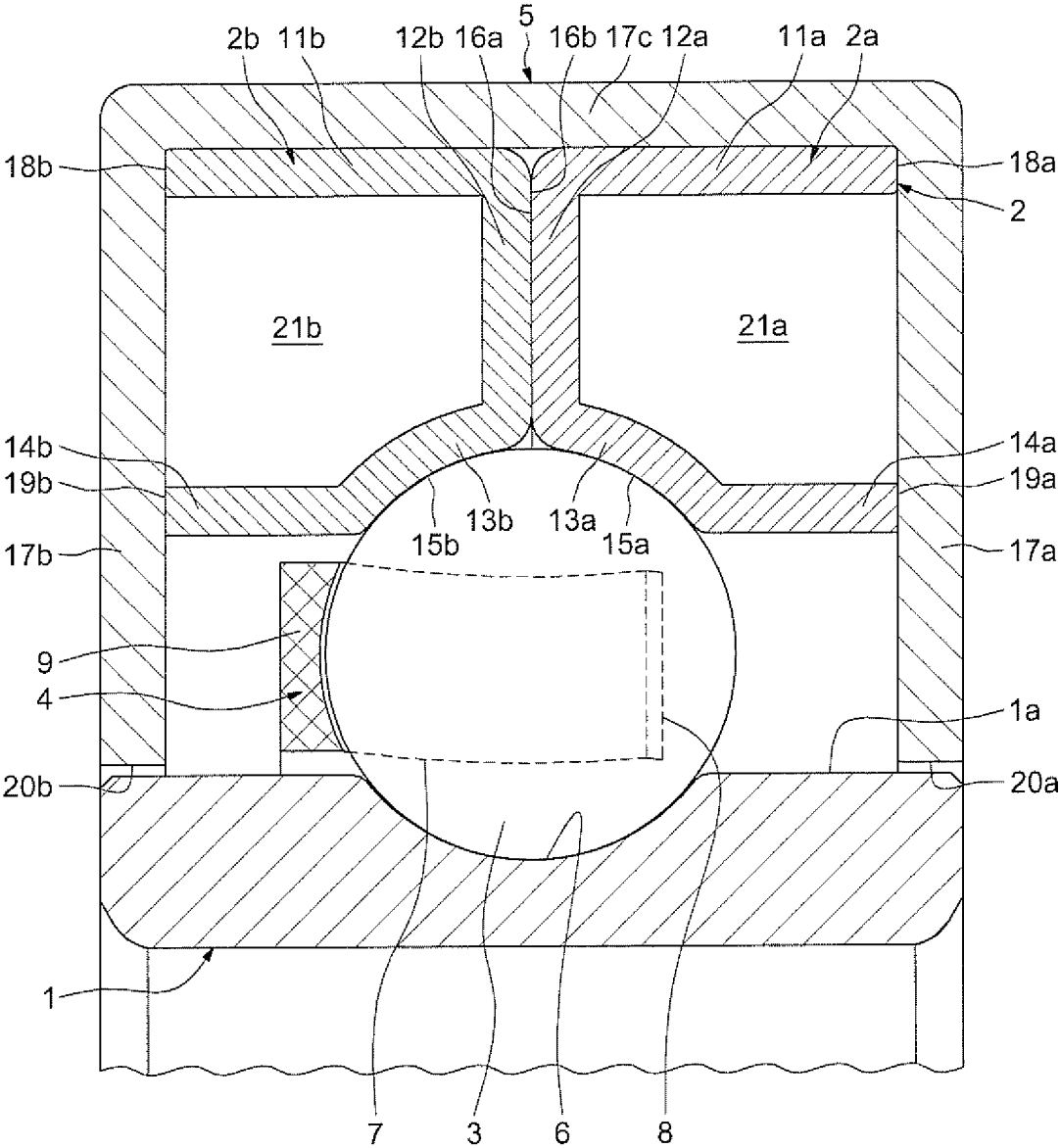
5 8. Rolling bearing according to any of the preceding claims 5 to 7, wherein the inner axial portions (14a, 14b) of the two parts of said ring are in axial contact with the radial flanges (17a, 17b) of the housing.

10 9. Rolling bearing according to any of the preceding claims, wherein each of the two parts (2a, 2b) of said ring has a constant thickness.

10. Rolling bearing according to any of the preceding claims, wherein the two parts (2a, 2b) of said ring are made of stamped metal sheet or tube.

15 11. Rolling bearing according to any of the preceding claims, wherein the bending strength of each of the two parts (2a, 2b) of said ring is up to 250 MPa.

12. Electric motor or generator comprising at least one rolling bearing according to any of the preceding claims.



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. F16C33/60
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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 1 111 621 A (COMPTOIR GENERAL DU ROULEMENT) 2 March 1956 (1956-03-02) column 2, line 12 - column 3, line 12 column 1, line 7 - line 16 figure 1	1-11
X	US 2010/327686 A1 (GARDELLE JEAN-LUC [FR] ET AL) 30 December 2010 (2010-12-30) paragraph [0041] - paragraph [0044] paragraph [0001] figure 2	1,2,4-7, 9-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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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.

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2011/053031

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010/127989 A1 (SKF AB [SE]; CORDIER STEPHANE [FR]; LAPINTE JULIEN [FR]; LIVERATO YVES) 11 November 2010 (2010-11-11) page 1, line 5 - line 9 page 4, line 23 - page 5, line 28 figure 1 -----	1,2, 4-10,12
X	GB 19741 A A.D. 1913 (SCHATZ JOHN WILLIAM [US]) 12 February 1914 (1914-02-12) page 1, line 28 - page 2, line 15 page 2, line 42 - line 46 figures 3,5,7 -----	1-4,6,7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/053031

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