



(51) International Patent Classification:

F16C 19/18 (2006.01) *F16C 33/64* (2006.01)
F16C 33/58 (2006.01) *F16C 25/06* (2006.01)

(21) International Application Number:

PCT/EP2014/061356

(22) International Filing Date:

2 June 2014 (02.06.2014)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

PCT/EP2013/062989 21 June 2013 (21.06.2013) EP

(71) Applicant: AKTIEBOLAGET SKF [SE/SE]; S-41550
Göteborg (SE).(72) Inventors: VISSERS, Cornelius Petrus Antonius; Litsers-
straat 67, NL-5275 BT Den Dungen (NL). SCHRAMM,
Edo; Koekoeklaan 18, NL-2566 JS Den Haag (NL). S.,
Rakesh; Plot 2, Bommasandra Ind. Area, Hosur Road,
Bangalore 560099 (IN). PETERS, Gilbert; Kroonstraat
172, NL-6511 DX Nijmegen (NL).(74) Agents: TWEEDLIE, Diane et al.; SKF B.V., Kelvinbaan
16, NL-3439MT Nieuwegein (NL).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

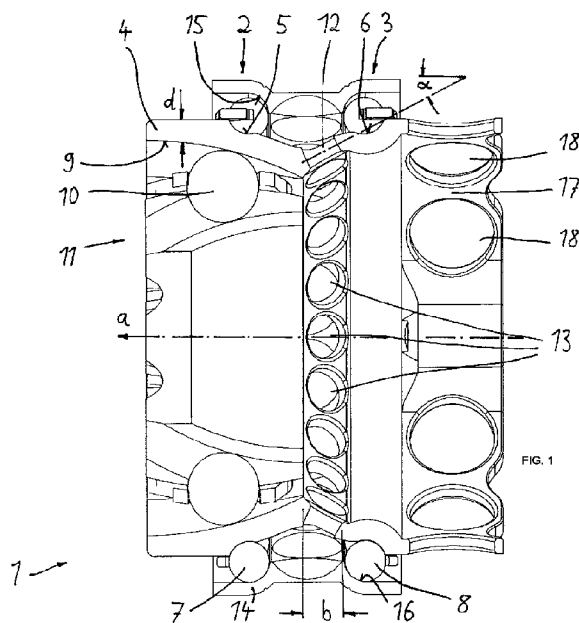
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

[Continued on next page]

(54) Title: BEARING ARRANGEMENT AND METHOD FOR ADJUSTING THE AXIAL PRE-LOAD IN IT



(57) Abstract: The invention relates to a bearing arrangement (1), comprising two roller bearings (2, 3) being axially distanced in an axial direction (a), wherein the bearing inner ring (4) for both roller bearings (2, 3) is made as a one-piece part, wherein the bearing inner ring (4) has two raceways (5, 6) for two rows of roller elements (7, 8) and wherein the bearing inner ring (4) has tracks (9) for the balls (10) of a Constant Velocity Joint (11) at a radial inner section. To provide a compact unit with few parts which can be effectively be adjusted to a desired pre-load the invention proposes that the bearing inner ring (4) has a section (12) extending along an axial distance (b) which is located between the two raceways (5, 6), wherein the section is equipped with means (13) for reducing the stiffness of the material of the bearing inner ring (4). Further- more, the invention relates to a method for adjusting the axial pre-load in such a bearing arrangement.



-
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Bearing Arrangement and Method for Adjusting **the Axial Pre-load in it**

5

Technical Field

10

The invention relates to a bearing arrangement, comprising two roller bearings being axially distanced in an axial direction, wherein the bearing inner ring for both roller bearings is made as a one-piece part, wherein the bearing inner ring has two raceways for two rows of roller elements and wherein the bearing inner ring has tracks for the balls of a Constant Velocity Joint at a radial inner section. Furthermore, the invention relates to a method for adjusting the axial pre-load in such a bearing arrangement.

20

Background

Bearing arrangements of the kind mentioned above are known in the art. **EP 0 181 654 B1** shows such a design, where the one-piece inner ring of a two-row roller bearing is equipped at its radial inner surface with the tracks of a Constant Velocity Joint (CVJ). A similar solution is shown in **GB 2 088 489 A**. Also here, a compact bearing arrangement is provided by incorporating the

25

tracks of the CVJ into an inner circumference of the bearing inner ring. Other designs are shown in **GB 2 145 481 A** and in **GB 2 150 987 A**.

It is thereby quite complicated and laborious to adjust the axial pre-load in the
5 two roller bearings to a specific defined level. Especially the requirement to the precision of the manufactured parts is very high to obtain a desired pre-load after assembly of the bearing arrangement.

Thus, it is an object of the present invention to propose a bearing ar-
10 rangement of the generic kind which allows to effectively adjust the two bearings to a desired pre-load. Simultaneously, it should become possible to provide a compact unit with few parts.

15

Summary of the invention

A solution according to the invention is characterized in that the bearing
inner ring has a section extending along an axial distance which is located be-
20 tween the two raceways, wherein the section is equipped with means for reducing the stiffness of the material of the bearing inner ring.

Such means for reducing the stiffness of the material of the bearing inner ring
in the section can be a plurality of recesses which are distributed around the
25 circumference of the bearing inner ring. Preferably, the recesses are bores, which are machined into the section. The recesses are preferably distributed around the circumference of the bearing inner ring equidistantly.

The section has preferably a substantial straight extension in a radial cross section, wherein the section extends under an angle to the axial direction. Preferably this angle is between 10° and 30°.

- 5 Also, the bearing outer ring for both roller bearings is preferably made as a one-piece part, wherein the bearing outer ring has two raceways for the two rows of roller elements.

The maximum of the radial thickness of the bearing inner ring is preferably at
10 most 200 % of the minimum of the radial thickness of the bearing inner ring along its axial extension. That is, the bearing inner ring is preferably made of a quite homogeneous tube section without specific thick portions. Thus, massive sections are avoided.

- 15 The bearing inner ring is preferably free of any flange element. For the purpose of connection of adjacent machine parts (wheel, brake disc, etc.) it is suggested according to a preferred embodiment of the invention that the bearing inner ring has a cylindrical end section for connecting those adjacent machine parts. Specifically, the cylindrical end section can have a plurality of
20 holes around its circumference, wherein the holes are preferably distributed around the circumference of the cylindrical end section equidistantly. Furthermore, the holes can have a circular shape.

The Constant Velocity Joint can be for example of the Rzeppa kind or of the
25 tripod kind. A Rzeppa joint consists of a spherical inner with six grooves in it, and a similar enveloping outer shell; each groove guides one ball. Typical Rzeppa joints allow 45° to 48° of articulation. The tripod joints are normally used at the inboard end of car driveshafts. This joint has a three-pointed yoke attached to the shaft, which has barrel-shaped roller bearings on the ends.

These fit into a cup with three matching grooves, attached to the differential. A typical tripod joint has up to 50 mm of plunge travel and 26° of angular articulation.

- 5 The bearing arrangement is preferably part of a wheel bearing unit of a vehicle.

The method for adjusting the axial pre-load in a bearing arrangement of the kind mentioned above comprises – according to the invention – the steps of:

10

- a) providing the bearing inner ring with a section extending along an axial distance which is located between the two raceways, wherein the section is equipped with means for reducing the stiffness of the material of the bearing inner ring;

15

- b) carrying out a plastically deformation of at least a part of the section, so that the effective distance between the two raceways is changed.

- 20 The proposed design has different advantages:

Since the inner bearing ring is made as a one-piece part, there is no (weak) parting-line along the axial extension of the bearing inner ring. The bearing inner ring can be designed with a quite thin wall thickness. This saves weight.

25

Since the CVJ is placed inside the inner ring, it can have a quite larger diameter. Furthermore, a certain degree of freedom is given to place the CVJ at a desired location within the inner side of the bearing inner ring.

With regard to the assembly method the following is noted: The bearing arrangement is assembled by placing the bearing inner ring out of center inside the bearing outer ring, i. e. excentrically. This creates space to place the balls of both raceways into their space between the inner and outer bearing ring.

5 Once all balls are inseted, they are distributed around the circumference of the bearing and located by means of a cage which it then mounted. By doing so a certain degree of pre-load is established.

Additional pre-load can be realized by deforming the inner ring at a predefined area, i. e. in the mentioned section which is reduced in stiffness.

10

This area, i. e. the section, is located between the two raceways of the two roller bearings. Due to the means for weakening (bores) it is quite easy and possible to deform the section and thus the bearing inner ring plastically. By

15 deforming this area radially inward or outward it is possible to increase the preload of the two ball rows.

The bearing inner ring does not contain a flange as usual in pre-known solution of wheel bearings, which flange normally carries the wheel and brake disc. Instead, an axial extending cylindrical end section with holes is provided

20 for mounting the wheel and brakedisc. By doing so it is possible to use classical bearing seals on both sides of the bearing arrangement; also those bearing seals can be mounted from both sides. If there would be a flange, this would not be possible. Also, the bearing cage can thus be mounted from both

25 sides of the bearing arrangement.

Thus, a high level of part integration becomes possible by the proposed solution. The number of parts is reduces. This causes also beneficially a quite lightweight construction.

Furthermore, a degree of freedom is created with respect to the placement of the CVJ inside of the bearing inner ring.

- 5 Ordinary seals can be used and easily mounted. The seals and the cages can be mounted from both sides of the bearing arrangement.

10 **Brief description of the drawings**

The drawing shows an embodiment of the invention. The only figure shows a radial cross section of a bearing arrangement which is a part of a vehicle and which is used for supporting a wheel of the vehicle.

15

Detailed description of the invention

- 20 Normally, driven wheels in vehicles comprise a separate wheel bearing and a separate driveshaft. Those components are connected by means of some kind of spline. The wheel bearing consists normally a stationary outer bearing ring connected to the suspension of the vehicle; furthermore, it has a rotating inner bearing ring which is connected to the wheel and to the driveshaft. The inner
- 25 bearing ring can comprise two halves, a flange and a Small Inner Ring (SIR), both containing a raceway. The SIR is fixed to the flange, for example by orbital forming.

In order to save weight, to integrate the functionality and to reduce the number of parts and machining procedures, the following design is proposed according to the invention which comes up with a wheel bearing with integrated Continuous Velocity Joint (CVJ). Here, preferably both the bearing inner ring
5 and the bearing outer ring are made as a one-piece part. The bearing inner ring comprises two raceways on the outer diameter and CVJ tracks on the inside of the bearing inner ring. The CVJ can be of any type, e. g. of the Rzeppa kind or of the tripod kind.

10 Specifically, the following design is proposed:

The bearing arrangement 1 comprises two roller bearings 2 and 3. In the embodiment both roller bearings 2, 3 are angular contact ball bearings. The bearing inner ring 4 has two raceways 5 and 6 for the roller elements 7 and 8
15 which are balls in the present case. Thus, the bearing inner ring 4 is made as a one-piece element which comprises the two raceways 5, 6 for both rows of balls 7, 8.

Similar, the bearing outer ring 14 has two raceways 15 and 16 for the balls 7, 8.
20 Also, the bearing outer ring 14 is a one-piece element which comprises the two raceways 15, 16 for both rows of balls 7, 8.

The bearing inner ring 4 is also designed to have tracks 9 for the balls 10 of a Constant Velocity Joint (CVJ) 11. The tracks 9 are arranged at the radial inner
25 circumference of the bearing inner ring 4, while the raceways 5, 6 are arranged at the radial outer circumference of the bearing inner ring 4 which has generally a tube-shaped design.

While the bearing inner ring 4 extends in an axial direction a it has a section 12 which has a certain axial extension or distance b. As can be seen in the figure this section 12 has in the depicted radial cross section a substantial straight form, which is arranged under an angle α relatively to the axial direction a. The angle α is about 20° in the embodiment.

This section 12 is equipped with means 13 for reducing the stiffness of the section. More specifically, holes 13 are machined into the section 12 which are arranged equidistantly around the circumference of the bearing inner ring 4. Depending on the distance of the holes 12 in circumferential direction and the diameter of the same the remaining stiffness can be adjusted. In general, the remaining stiffness is chosen in such a way that it is guaranteed that the forces during the operation of the bearing arrangement 1 do not lead to a plastic deformation of the bearing inner ring 4.

But the weakened design allows to adjust the axial pre-load in the bearing arrangement 1 during assembly of the same. For doing so, radial forces are applied to the section 12 after the two roller bearings 2, 3 are completely mounted. By a plastic deformation of the section 12 and more specifically by a radial deformation of the same the effective distance between the two raceways 5 and 6 can be modified and thus the effective axial pre-load in the bearing arrangement can be adjusted.

For plastic deformation a (not depicted) tool can press from the radial inner side of the bearing inner ring 4 radially outwards onto the section to deform the same.

As can be seen the radial thickness d of the whole bearing inner ring 4 is not varying very much, compared with the pre-known solutions as mentioned

above. Preferably, the maximal radial thickness of the bearing inner ring 4 is about 200 % or less than the minimal radial thickness of the bearing inner ring 4 along its axial extension.

- 5 As can be seen, the bearing inner ring 4 is free from any flange element. Instead, the bearing inner ring 4 comprises a cylindrical end section 17 which is substantially tube-shaped. In the cylindrical end section holes 18 are machined which serve for fixing further components like the wheel and/or the brake disk.

Reference Numerals:

5	1	Bearing arrangement
	2	Roller bearing
	3	Roller bearing
	4	Bearing inner ring
	5	Raceway
10	6	Raceway
	7	Roller element
	8	Roller element
	9	Track
	10	Ball
15	11	Constant Velocity Joint (CVJ)
	12	Section
	13	Means for reducing the stiffness (recesses / holes)
	14	Bearing outer ring
	15	Raceway
20	16	Raceway
	17	Cylindrical end section
	18	Hole
	a	Axial direction
25	b	Axial distance
	d	Radial thickness
	α	Angle

Patent Claims:

5

1. Bearing arrangement (1), comprising two roller bearings (2, 3) being axially distanced in an axial direction (a), wherein the bearing inner ring (4) for both roller bearings (2, 3) is made as a one-piece part, wherein the bearing inner ring (4) has two raceways (5, 6) for two rows of roller elements (7, 8) and wherein the bearing inner ring (4) has tracks (9) for the balls (10) or roller elements of a Constant Velocity Joint (11) at a radial inner section,

10

characterized in that

15

the bearing inner ring (4) has a section (12) extending along an axial distance (b) which is located between the two raceways (5, 6), wherein the section is equipped with means (13) for reducing the stiffness of the material of the bearing inner ring (4).

20

2. Bearing arrangement according to claim 1, characterized in that the means (13) for reducing the stiffness of the material of the bearing inner ring (4) in the section (12) are a plurality of recesses which are distributed around the circumference of the bearing inner ring (4).

25

3. Bearing arrangement according to claim 2, characterized in that the recesses (13) are bores.
- 5 4. Bearing arrangement according to claim 2 or 3, characterized in that the recesses (13) are distributed around the circumference of the bearing inner ring (4) equidistantly.
- 10 5. Bearing arrangement according to one of claims 1 to 4, characterized in that the section (12) has a substantial straight extension in a radial cross section, wherein the section (12) extends under an angle (α), preferably between 10° and 30° , to the axial direction (a).
- 15 6. Bearing arrangement according to one of claims 1 to 5, characterized in that the bearing outer ring (14) for both roller bearings (2, 3) is made as a one-piece part, wherein the bearing outer ring (14) has two raceways (15, 16) for the two rows of roller elements (7, 8).
- 20 7. Bearing arrangement according to one of claims 1 to 6, characterized in that the maximum of the radial thickness (d) of the bearing inner ring (4) is at most 200 % of the minimum of the radial thickness (d) of the bearing inner ring (4) along its axial extension.
- 25 8. Bearing arrangement according to one of claims 1 to 7, characterized in that the bearing inner ring (4) is free of any flange element.

9. Bearing arrangement according to one of claims 1 to 8, characterized in that the bearing inner ring (4) has a cylindrical end section (17) for connecting adjacent machine parts.
10. Bearing arrangement according to claim 9, characterized in that the cylindrical end section (17) has a plurality of holes (18) around its circumference, wherein the holes (18) are preferably distributed around the circumference of the cylindrical end section (17) equidistantly.
11. Bearing arrangement according to claim 10, characterized in that the holes (18) have a circular shape.
12. Bearing arrangement according to one of claims 1 to 11, characterized in that the Constant Velocity Joint (11) is of the Rzeppa kind.
13. Bearing arrangement according to one of claims 1 to 11, characterized in that the Constant Velocity Joint (11) is of the tripod kind.
14. Bearing arrangement according to one of claims 1 to 13, characterized in that it is part of a wheel bearing unit of a vehicle.

15. Method for adjusting the axial pre-load in a bearing arrangement (1), comprising two roller bearings (2, 3) being axially distanced in an axial direction (a), wherein the bearing inner ring (4) for both roller bearings (2, 3) is made as a one-piece part, wherein the bearing inner ring (4) has two raceways (5, 6) for two rows of roller elements (7, 8) and wherein the bearing inner ring (4) has tracks (9) for the balls (10) or roller elements of a Constant Velocity Joint (11) at a radial inner section,

characterized in that

the method comprises the steps of:

- a) providing the bearing inner ring (4) with a section (12) extending along an axial distance (b) which is located between the two raceways (5, 6), wherein the section is equipped with means (13) for reducing the stiffness of the material of the bearing inner ring (4);
- b) carrying out a plastically deformation of at least a part of the section (12), so that the effective distance between the two raceways (5, 6) is changed.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/061356

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16C19/18 F16C33/58 F16C33/64 F16C25/06
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 F16D

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)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 100 43 799 A1 (DAIMLER CHRYSLER AG [DE]) 14 March 2002 (2002-03-14) column 3, lines 40-55 paragraph [0025]; figures -----	1, 15
A	EP 0 892 187 A2 (NSK LTD [JP]) 20 January 1999 (1999-01-20) page 14, lines 5-10 page 15, lines 43-44; figure 14 -----	1, 2, 6, 7, 12, 14, 15
A	EP 0 181 654 B1 (SKF IND TRADING & DEV [NL]) 17 May 1989 (1989-05-17) cited in the application column 3, lines 42-82; figure 2 -----	1, 12, 15
A	EP 2 527 676 A1 (IMO HOLDING GMBH [DE]) 28 November 2012 (2012-11-28) paragraph [0030]; figures -----	1, 15



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

"E" earlier application or patent 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

"&" document member of the same patent family

Date of the actual completion of the international search

20 October 2014

Date of mailing of the international search report

31/10/2014

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

Béguin-Adriaenssens

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/061356

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 10043799	A1	14-03-2002	NONE
EP 0892187	A2	20-01-1999	DE 69828467 D1 10-02-2005 DE 69828467 T2 16-02-2006 DE 69833340 T2 12-10-2006 EP 0892187 A2 20-01-1999 EP 1326027 A1 09-07-2003 US 6368223 B1 09-04-2002
EP 0181654	B1	17-05-1989	DE 3570214 D1 22-06-1989 EP 0181654 A1 21-05-1986 JP S61103009 A 21-05-1986 NL 8403209 A 16-05-1986 US 4668111 A 26-05-1987
EP 2527676	A1	28-11-2012	DK 2527676 T3 26-08-2013 EP 2527676 A1 28-11-2012 ES 2421481 T3 03-09-2013