(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 November 2015 (19.11.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/175182 A1

(51) International Patent Classification:
F16C 19/16 (2006.01) *F16C 33/58* (2006.01)
F16C 33/30 (2006.01)

(21) International Application Number:
PCT/US2015/027203

(22) International Filing Date:
23 April 2015 (23.04.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/991,664 12 May 2014 (12.05.2014) US

(71) Applicant: **SCHAEFFLER TECHNOLOGIES AG & CO. KG** [DE/DE]; Industriestraße 1-3, 91074 Herzogenaurach (DE).

(72) Inventor; and
(71) Applicant : **LEE, Brian** [US/US]; 108 Felix Lane, York, South Carolina 29745 (US).

(72) Inventor: **OHR, Carsten**; 5136 Quail Canyon Drive, Charlotte, North Carolina 28226 (US).

(74) Agent: **GUSHUE, Thomas P.**; Volpe and Koenig, P.C., United Plaza, Suite 1600, 30 S. 17th Street, Philadelphia, Pennsylvania 19103 (US).

(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, 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, ST, 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))*

(54) **Title**: TRIPLE RACE ANGULAR CONTACT BEARING

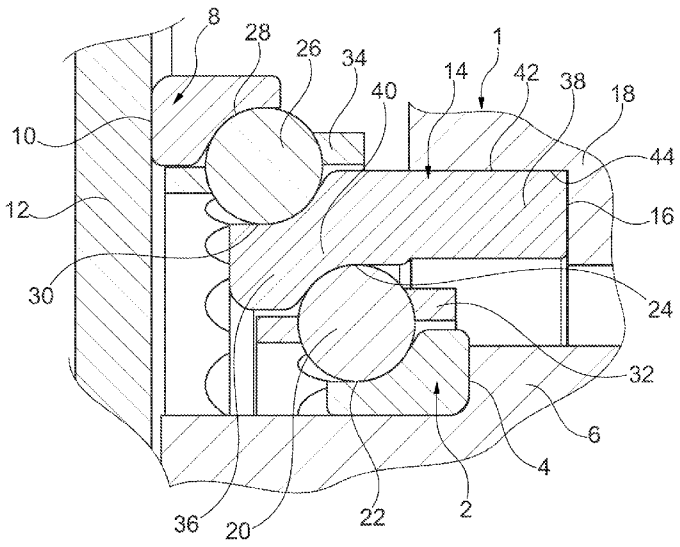


Fig. 1

(57) **Abstract**: A rolling bearing assembly including an intermediate bearing ring is provided. The rolling bearing assembly includes an inner bearing ring including at least one axial end configured to be supported on a first component, and an outer bearing ring including at least one axial end configured to be supported on a second component. The intermediate bearing ring is arranged between the inner bearing ring and the outer bearing ring and includes at least one axial end configured to be supported on a third component. The at least one axial end of the intermediate bearing ring extends in an axial direction past at least one of the at least one axial end of the inner bearing ring or the at least one axial end of the outer bearing ring.

WO 2015/175182 A1

[0001] TRIPLE RACE ANGULAR CONTACT BEARING

[0002] INCORPORATION BY REFERENCE

[0003] The following documents are incorporated herein by reference as if fully set forth: U.S. Provisional Patent Application No. 61/991,664, filed May 12, 2014.

[0004] FIELD OF INVENTION

[0005] The present invention relates to an angular contact rolling bearing assembly, and in particular to an angular contact rolling bearing assembly with an intermediate bearing ring.

[0006] BACKGROUND

[0007] Angular contact rolling bearing assemblies are used in various mechanical applications. One known type of angular contact rolling bearing includes an outer bearing ring, an inner bearing ring, and an intermediate bearing ring defining two races on opposite sides. These angular contact rolling bearing assemblies require the intermediate bearing ring to be captively arranged between the inner and outer bearing rings, and both the inner and outer bearing rings to be supported in machined bores in external components in which the angular contact rolling bearing assembly is being installed. Machining these bores in the external components is time consuming and adds an installation step.

[0008] Another known type of angular contact rolling bearing requires two separate bearing sub-assemblies, each sub-assembly including an inner bearing ring and an outer bearing ring with rolling elements therebetween. These angular contact rolling bearing assemblies are more expensive to manufacture than assemblies including a multi-race intermediate bearing rings due to the increased number of components. These assemblies are also heavier and require more space than other assemblies with a multi-race

intermediate bearing ring because they include four bearing rings instead of three bearing rings.

[0009] SUMMARY

[0010] Briefly stated, a rolling bearing assembly including an intermediate bearing ring that is configured to be mounted to an external component is provided. The rolling bearing assembly includes an inner bearing ring including at least one axial end configured to be supported on a first component. An outer bearing ring is provided that includes at least one axial end configured to be supported on a second component. The intermediate bearing ring includes at least one axial end configured to be supported on a third component. The at least one axial end of the intermediate bearing ring extends in an axial direction past at least one of the at least one axial end of the inner bearing ring or the at least one axial end of the outer bearing ring. A first row of rolling elements is supported between the inner bearing ring and the intermediate bearing ring. The inner bearing ring includes a radially inner race on which the first row of rolling elements run, and the intermediate bearing ring includes a radially outer race on which the first row of rolling elements run. A second row of rolling elements is supported between the outer bearing and the intermediate bearing ring. The outer bearing ring includes a radially outer race on which the second row of rolling elements run, and the intermediate bearing ring includes a radially inner race on which the second row of rolling elements run.

[0011] BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The foregoing Summary and the following detailed description will be better understood when read in conjunction with the appended drawings, which illustrate a preferred embodiment of the invention. In the drawings:

[0013] Figure 1 is cross-sectional view through a rolling bearing including an intermediate bearing ring installed in an assembly in accordance with a preferred embodiment of the invention.

[0014] Figure 2 is a cross-sectional view through the rolling bearing assembly shown in Figure 1 in an uninstalled state.

[0015] Figure 3 is an exploded view of the rolling bearing assembly of Figures 1 and 2.

[0016] Figure 4 is cross-sectional view through the rolling bearing of Figures 1-3 installed in a differential assembly.

[0017] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Certain terminology is used in the following description for convenience only and is not limiting. The words "front," "rear," "upper" and "lower" designate directions in the drawings to which reference is made. The words "radially inwardly" and "radially outwardly" refer to directions radially toward and away from an axis of the part being referenced. "Axially" refers to a direction along the axis of a shaft or other part. A reference to a list of items that are cited as "at least one of a, b, or c" (where a, b, and c represent the items being listed) means any single one of the items a, b, or c, or combinations thereof. The terminology includes the words specifically noted above, derivatives thereof and words of similar import.

[0019] Referring to Figures 1-4, a rolling bearing assembly 1 according to the present invention is shown. The rolling bearing assembly 1 includes an inner bearing ring 2 including at least one axial end 4 configured to be supported on a first component 6. An outer bearing ring 8 includes at least one axial end 10 configured to be supported on a second component 12. An intermediate bearing ring 14 includes at least one axial end 16 configured to be supported on a third component 18. The at least one axial end 16 of the intermediate bearing ring 14 extends in an axial direction past at least one of

the at least one axial end 4 of the inner bearing ring 2 or the at least one axial end 10 of the outer bearing ring 8.

[0020] As shown in Figure 2, the axial end 16 of the intermediate bearing ring 14 preferably extends past the axial end 4 of the inner bearing ring 2. In one preferred configuration, the axial end 16 of the intermediate bearing ring 14 preferably extends past the axial end 4 of the inner bearing ring 2 by a distance (d) that is sufficient to allow mounting of the intermediate bearing ring 14 on the third component 18 that is separate and apart from the first and second components 6, 12. Depending on the application, the axial end 16 of the intermediate bearing ring 14 can extend a greater or shorter distance past the axial end 4 of the inner bearing ring 2. One of ordinary skill in the art recognizes the opposite axial end of the intermediate bearing ring 14 could extend past the axial end 10 of the outer bearing ring 8 in an alternate embodiment of the present invention. The axial end of the intermediate bearing ring 14 that extends past the axial end of either the inner bearing ring 2 or the outer bearing 8 provides a mounting portion for installation in the third component. As shown in Figure 1, a radially outer surface 42 of the second portion 38 of the intermediate bearing ring 14 is configured to be supported on a radially inner surface 44 of the third component 18. In another configuration, a radially inner surface of the first portion 36 of the intermediate bearing ring can be configured to be supported on a radially outer surface of the third component 18.

[0021] In one preferred configuration, the axial end 16 of the intermediate bearing ring 14 is fixed to the third component 18 by a press fit. This allows the inner bearing ring 2 and outer bearing ring 8 to be supported by the intermediate bearing ring 14. In another preferred configuration, the axial end 16 of the intermediate bearing ring 14 is fixed to the third component 18 by welding. One of ordinary skill in the art recognizes from the present disclosure that other mounting configurations, *e.g.* a flange formed on the intermediate bearing ring 14 and a complementary recess on the third

component 18, can be used to install the rolling bearing assembly 1 with external components.

[0022] A first row of rolling elements 20 is supported between the inner bearing ring 2 and the intermediate bearing ring 14. The inner bearing ring 2 includes a radially inner race 22 on which the first row of rolling elements 20 run. The intermediate bearing ring 14 includes a radially outer race 24 on which the first row of rolling elements 20 run. A second row of rolling elements 26 is supported between the outer bearing ring 8 and the intermediate bearing ring 14. The outer bearing ring 8 includes a radially outer race 28 on which the second row of rolling elements 26 run. The intermediate bearing ring 14 includes a radially inner race 30 on which the second row of rolling elements 26 run. Each row of rolling elements 20, 26 is preferably comprised of spherical rolling elements. In a preferred configuration, a first cage 32 supports the first row of rolling elements 20, and a second cage 34 supports the second row of rolling elements 26.

[0023] As shown in Figure 1, the radially inner race 30 of the intermediate bearing ring 14 is defined on a first portion 36 of the intermediate bearing ring 14, and the radially outer race 24 of the intermediate bearing ring 14 is defined on a second portion 38 of the intermediate bearing ring 14. In a preferred configuration, the first and second portions 36, 38, of the intermediate bearing ring 14 axially overlap at a transition portion 40. This overlap between the first portion 36 and the second portion 38, and the radially inner race 30 and the radially outer race 24, reduces the overall installation space required for the assembly 1.

[0024] As shown in Figure 4, the rolling bearing assembly 1 can be installed in a differential assembly 50. The configuration shown in Figure 4 is the same as Figures 1-3, except the rolling bearing assembly 1 is installed in the differential assembly 50 and the first component is an output shaft 6', the second component is a carrier plate 12', and the third component is a transmission housing 18'. One of ordinary skill in the art recognizes the

rolling bearing assembly 1 can be adapted to be installed in various applications, while retaining the features described above.

[0025] Having thus described the present invention in detail, it is to be appreciated and will be apparent to those skilled in the art that many physical changes, only a few of which are exemplified in the detailed description of the invention, could be made without altering the inventive concepts and principles embodied therein. It is also to be appreciated that numerous embodiments incorporating only part of the preferred embodiment are possible which do not alter, with respect to those parts, the inventive concepts and principles embodied therein. The present embodiment and optional configurations are therefore to be considered in all respects as exemplary and/or illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all alternate embodiments and changes to this embodiment which come within the meaning and range of equivalency of said claims are therefore to be embraced therein.

[0026] List of reference elements

[0027] 1. Rolling bearing assembly

[0028] 2. Inner bearing ring

[0029] 4. Axial end of inner bearing ring

[0030] 6. First component

[0031] 6'. Output shaft

[0032] 8. Outer Bearing Ring

[0033] 10. Axial end of outer bearing ring

[0034] 12. Second component

[0035] 12'. Carrier plate

[0036] 14. Intermediate bearing ring

[0037] 16. Axial end of intermediate bearing ring

[0038] 18. Third component

[0039] 18'. Transmission housing

[0040] 20. First row of rolling elements

[0041] 22. Radially inner race on inner bearing ring

[0042] 24. Radially outer race on intermediate bearing ring

[0043] 26. Second row of rolling elements

[0044] 28. Radially outer race on outer bearing ring

[0045] 30. Radially inner race on intermediate bearing ring

[0046] 32. First cage

[0047] 34. Second cage

[0048] 36. First portion of intermediate bearing ring

[0049] 38. Second portion of intermediate bearing ring

[0050] 40. Transition portion of intermediate bearing ring

[0051] 42. Radially outer surface of second portion of intermediate bearing ring

[0052] 44. Radially inner surface of third component

[0053] 50. Differential assembly

* * *

CLAIMS

What is claimed is:

1. A rolling bearing assembly comprising:

an inner bearing ring including at least one axial end configured to be supported on a first component;

an outer bearing ring including at least one axial end configured to be supported on a second component;

an intermediate bearing ring including at least one axial end configured to be supported on a third component, wherein the at least one axial end of the intermediate bearing ring extends in an axial direction past at least one of the at least one axial end of the inner bearing ring or the at least one axial end of the outer bearing ring;

a first row of rolling elements supported between the inner bearing ring and the intermediate bearing ring, the inner bearing ring includes a radially inner race on which the first row of rolling elements run, and the intermediate bearing ring includes a radially outer race on which the first row of rolling elements run; and

a second row of rolling elements supported between the outer bearing ring and the intermediate bearing ring, the outer bearing ring includes a radially outer race on which the second row of rolling elements run, and the intermediate bearing ring includes a radially inner race on which the second row of rolling elements run.

2. The rolling bearing assembly of claim 1, further comprising a first cage for supporting the first row of rolling elements, and a second cage for supporting the second row of rolling elements.

3. The rolling bearing assembly of claim 1, wherein the radially inner race of the intermediate bearing ring is defined on a first portion of the intermediate bearing ring, and the radially outer race of the intermediate bearing ring is defined

on a second portion of the intermediate bearing ring, and the first and second portions of the intermediate bearing ring axially overlap at a transition portion of the intermediate bearing ring.

4. An assembly including the first, second, and third components, and the rolling bearing assembly of claim 1, wherein the at least one axial end of the intermediate bearing ring is fixed to the third component.

5. The assembly of claim 4, wherein the at least one axial end of the intermediate bearing ring is fixed to the third component by a press fit.

6. The assembly of claim 4, wherein the at least one axial end of the intermediate bearing ring is fixed to the third component by welding.

7. A differential assembly including the first, second, and third components, and the rolling bearing assembly of claim 1, wherein the first component is an output shaft, the second component is a carrier plate, and the third component is a transmission housing.

8. The differential assembly of claim 7, wherein the first and second components are supported via the intermediate bearing ring on the third component.

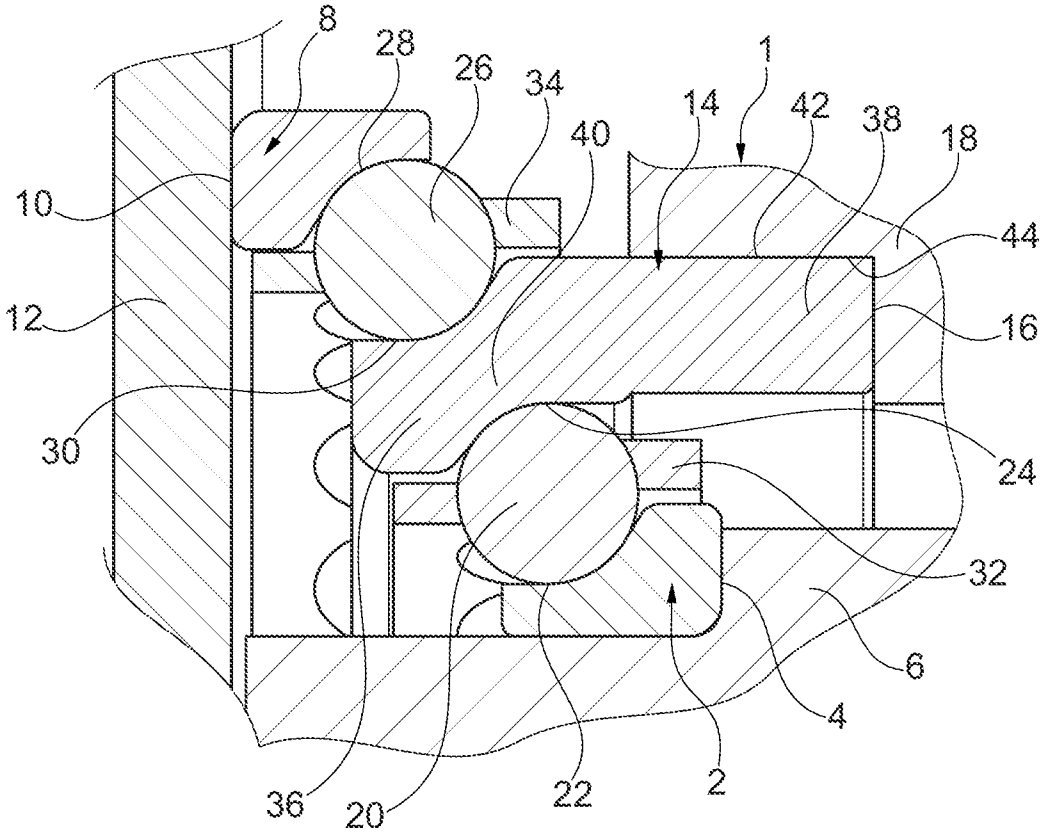


Fig. 1

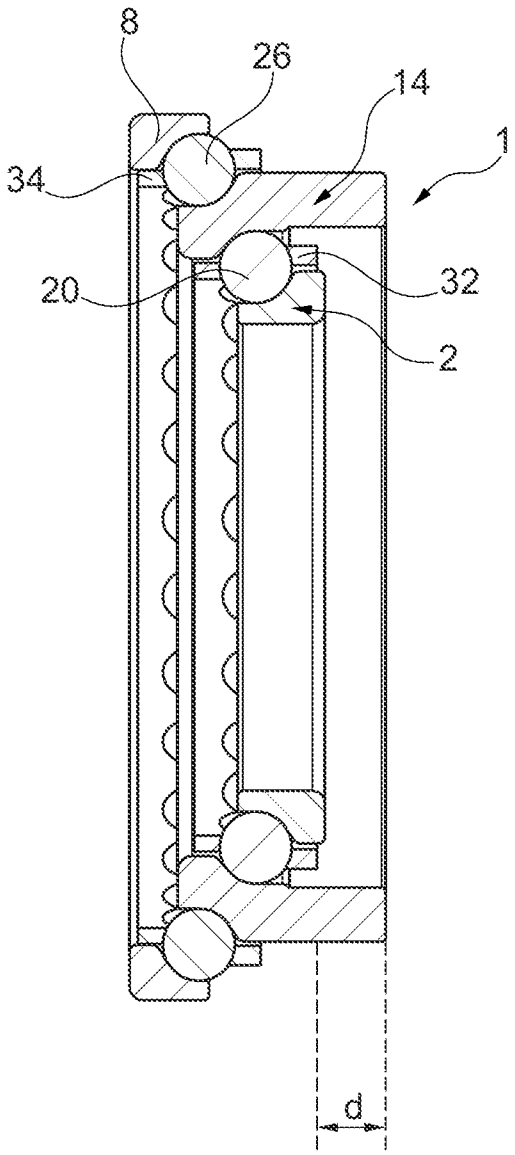


Fig. 2

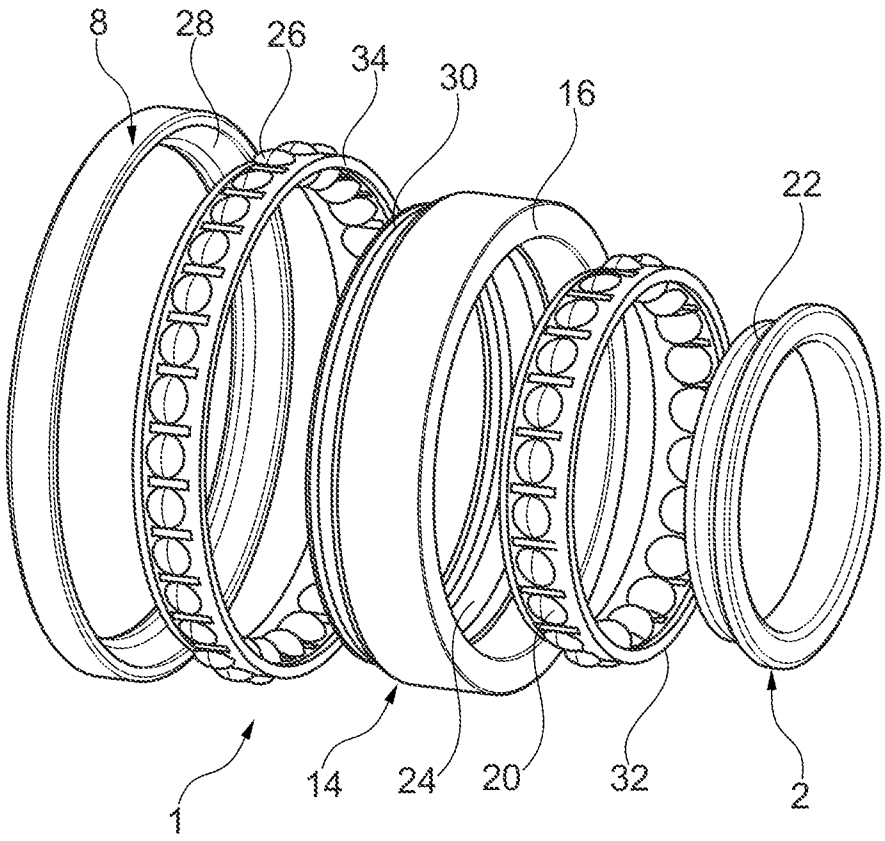


Fig. 3

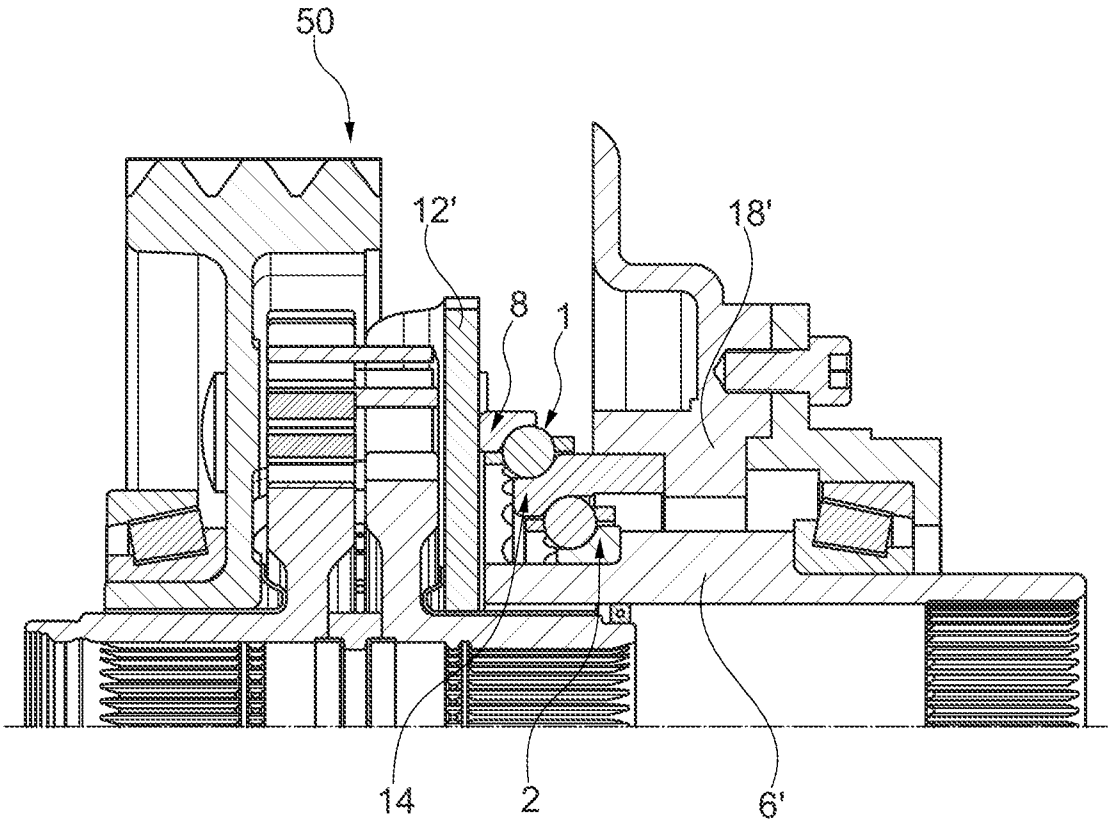


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/027203

A. CLASSIFICATION OF SUBJECT MATTER

F16C 19/16(2006.01)i, F16C 33/30(2006.01)i, F16C 33/58(2006.01)i

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 19/16; F16C 19/38; F16C 19/24; B21D 53/10; F16C 19/00; F16C 19/34; F16C 33/30; F16C 33/58

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: roll, row, triple, race, intermediate, ring, bearing and cage

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012-0141058 A1 (RADINGER et al.) 07 June 2012 See abstract, paragraphs [0063]-[0075], claim 15 and figures 2-4.	1-8
A	US 2008-0089629 A1 (SEO et al.) 17 April 2008 See abstract, paragraphs [0048]-[0061], claims 1-7 and figures 1-4.	1-8
A	US 2011-0069917 A1 (YAMADA et al.) 24 March 2011 See abstract, paragraphs [0174]-[0183], claims 1-3 and figures 1-4.	1-8
A	US 2010-0202721 A1 (FUKUDA et al.) 12 August 2010 See abstract, paragraphs [0064]-[0069], claims 5, 6 and figures 1-9	1-8
A	US 2011-0255820 A1 (CASPALL et al.) 20 October 2011 See abstract, paragraphs [0034]-[0051], claim 1 and figures 2-4.	1-8

☐ 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	Date of mailing of the international search report
13 July 2015 (13.07.2015)	**14 July 2015 (14.07.2015)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
RHEE, Jun Ho
Telephone No. +82-42-481-8288

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/027203

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012-0141058 A1	07/06/2012	CN 102472317 A	23/05/2012
		DE 102009037571 A1	17/02/2011
		EP 2464879 A1	20/06/2012
		EP 2464879 B1	10/09/2014
		US 8646982 B2	11/02/2014
		WO 2011-018314 A1	17/02/2011
US 2008-0089629 A1	17/04/2008	EP 1830084 A1	05/09/2007
		EP 1830084 A4	24/11/2010
		EP 1830084 B1	04/06/2014
		JP 2006-151030 A	15/06/2006
		JP 2006-153051 A	15/06/2006
		JP 2006-153052 A	15/06/2006
		JP 2006-153054 A	15/06/2006
		US 8029195 B2	04/10/2011
		WO 2006-057310 A1	01/06/2006
US 2011-0069917 A1	24/03/2011	CN 102046497 A	04/05/2011
		CN 102046497 B	24/09/2014
		JP 05545210 B2	09/07/2014
		US 8702312 B2	22/04/2014
		WO 2009-144785 A1	03/12/2009
US 2010-0202721 A1	12/08/2010	EP 2003351 A1	17/12/2008
		JP 04862458 B2	25/01/2012
		JP 2007-278324 A	25/10/2007
		US 8371759 B2	12/02/2013
		WO 2007-116869 A1	18/10/2007
US 2011-0255820 A1	20/10/2011	GB 201111079 D0	10/08/2011
		GB 2492368 A	02/01/2013