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- (71) Applicant: THE TIMKEN COMPANY [US/US]; 4500 Mt. Pleasant St. NW, North Canton, Ohio 44720 (US).
- (72) Inventors: WERNER, Brian; 3209 Ivory Road NW, Carrollton, OH 44615 (US). HANNON, William; 1936 Stoney Hill Drive, Hudson, OH 44236 (US).
- (74) Agents: HONGSERMEIER, Jayson, L. et al.; Michael Best & Friedrich LLP, 100 East Wisconsin Avenue, Suite 3300, Milwaukee, WI 53202-4108 (US).
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(54) Title: BEARING CAGE AND ASSEMBLY WITH LUBRICATION STIMULANT

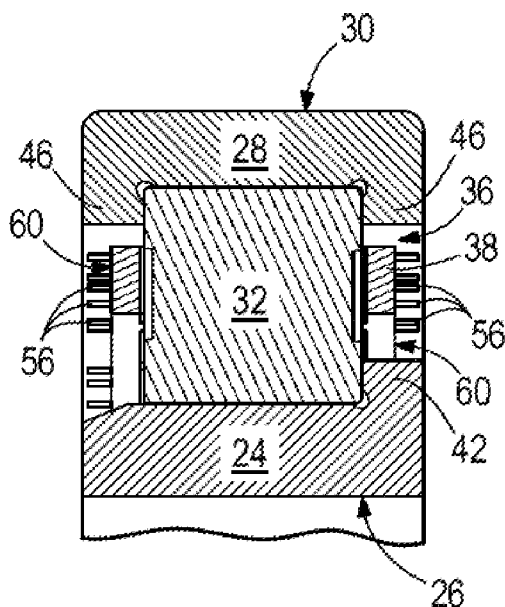


FIG. 2A

(57) Abstract: A bearing assembly includes an inner ring, an outer ring, and a plurality of rolling elements situated between the inner and outer rings. The plurality of rolling elements (32) facilitates relative rotation between the inner and outer rings about an axis. A cage (36) is situated between the inner and outer rings, and the cage includes a pair of axial end flanges (38) and a plurality of bridges extending between the axial end flanges. At least one of the pair of axial end flanges of the cage includes an array of axially outwardly extending fingers (56) configured to distribute lubricant from a quantity of lubricant during operation.

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SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, **Published:**
GW, KM, ML, MR, NE, SN, TD, TG).

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

BEARING CAGE AND ASSEMBLY WITH LUBRICATION STIMULANT**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/902,397, filed November 11, 2013, the entire contents of which are incorporated by reference herein.

BACKGROUND

[0002] The present invention relates to bearing assemblies, and more particularly to a bearing assembly including a bearing cage configured to stimulate lubricant flow and coverage during operation.

[0003] The majority of bearings have no means to disperse and direct lubricant flow to critical areas, such as metal-on-metal sliding between the ring(s) and the axial ends of the rollers, within the bearing chamber. For some special applications, extensive bearing ring modification is carried out to accommodate an active lubricant spray system to ensure a wetted environment. Although this ensures a minimum level of oil on the critical surfaces to prevent boundary lubrication and stave off wear, the required manufacturing is complicated and costly.

SUMMARY

[0004] In one aspect, the invention provides a bearing assembly including an inner ring, an outer ring, and a plurality of rolling elements situated between the inner and outer rings. The plurality of rolling elements facilitates relative rotation between the inner and outer rings about an axis. A cage is situated between the inner and outer rings, and the cage includes a pair of axial end flanges and a plurality of bridges extending between the axial end flanges. At least one of the pair of axial end flanges of the cage includes an array of axially outwardly extending fingers configured to distribute lubricant from a quantity of lubricant during operation.

[0005] In another aspect, the invention provides a cage for use in a rolling element bearing assembly. The cage includes a pair of ring-shaped axial end flanges and a plurality of bridges extending between the pair of axial end flanges. Rolling element pockets are defined between each adjacent pair of bridges. At least one of the pair of axial end flanges

includes an array of axially outwardly extending fingers configured to distribute lubricant from a quantity of lubricant during operation.

[0006] In yet another aspect, the invention provides a method of lubricating a rolling element bearing assembly during use. A cage positioned between inner and outer rings and having a plurality of rolling element pockets is rotated about an axis. During rotation of the cage, an array of fingers extending axially outwardly from the cage pass through a quantity of lubricant and distribute lubricant to improve wetting of remote portions of the bearing assembly.

[0007] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1 is a front view of a bearing assembly according to one aspect of the invention.

[0009] Fig. 2 is a cross-sectional view, taken along line 2-2 of the bearing assembly of Fig. 1.

[0010] Fig. 2A is an enlarged view of a portion of the bearing assembly as shown in Fig. 2.

[0011] Fig. 3 is a cross-sectional view, taken along line 3-3 of the bearing cage of Fig. 4.

[0012] Fig. 4 is a front view of a bearing cage of the bearing assembly of Fig. 1.

[0013] Fig. 4A is an enlarged view of a portion of the bearing cage as shown in Fig. 4.

[0014] Fig. 5 is a side view of the bearing cage of Fig. 4.

[0015] Fig. 6 is a cross-sectional view, taken along line 6-6 of the bearing cage of Fig. 5.

DETAILED DESCRIPTION

[0016] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the

following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

[0017] A bearing assembly 20 includes an inner ring 24, and outer ring 28, and a plurality of circumferentially-distributed rolling elements 32 positioned between the inner and outer rings 24, 28. The inner and outer rings 24, 28 share a common bearing axis A. Although a variety of applications are possible, the bearing assembly 20 provides low friction (i.e., rolling) support of a first component (e.g., a rotating shaft) within a second component (e.g., a stationary housing). The inner ring 24 includes a radially inner surface 26 secured with the first component, and the outer ring 28 includes a radially outer surface 30 secured with the second component. Each of the rolling elements 32 defines a rolling surface in contact with raceway surfaces of both the inner and outer rings 24, 28. In the illustrated construction, the rolling elements 32 have cylindrical rolling surfaces, but other constructions (i.e., tapered, spherical) are optional. A cage 36 extends circumferentially around the bearing axis A at a radial position that is between the inner ring 24 and the outer ring 28. The cage 36 includes a pair of opposed axial end flanges 38 and a plurality of bridges 40 extending generally axially between the two end flanges 38 (Fig. 2). A roller pocket is defined between each adjacent pair of bridges 40, and thus, the cage 36 maintains a predetermined spacing between all of the rolling elements 32. As illustrated, the bearing assembly 20 can be configured to accommodate a 60mm diameter shaft, to be accommodated in a 110mm housing aperture, and to have an axial depth of about 22mm, but alternate configurations are optional.

[0018] One or both of the inner and outer rings 24, 28 can include one or two ribs to retain the rolling elements 32 therein. For example, in the illustrated construction, the inner ring 24 includes a single rib 42 that extends radially outward to overlap with the axial end faces of the plurality of rolling elements 32 on a first axial end of the bearing assembly 20. Also, the outer ring 28 includes a pair of ribs 46 that extend radially inward to overlap with the axial end faces of the plurality of rolling elements 32 on both axial ends of the bearing assembly 20. One of skill in the art will recognize that a variety of different rib configurations are optional. Wherever a rib-roller interface exists, a potential for wear (e.g., metal-on-metal) exists as the bearing assembly 20 is in operation and the rolling elements 32 travel circumferentially with respect to the inner and outer rings 24, 28. These interfaces can be a difficult location to ensure adequate lubrication during use. However, the cage 36 is provided with a lubrication distribution structure as described in further detail below.

[0019] The cage 36 of the illustrated bearing assembly 20 includes a structure for distributing lubricant to enhance wetting of the entire bearing chamber. The structure includes an array of projections or fingers 56 extending axially outwardly from at least one of the axial end flanges 38. In other words, each of the flanges 38 defines an axially-facing base surface, and the fingers 56 extend outwardly from this surface 60, with at least a component in the axial direction. In the illustrated construction, each of the fingers 56 extends parallel to the axis A. Furthermore, the fingers 56 are provided in substantially equivalent number and substantially equivalent arrangement on both axial end flanges 38 of the cage 36. The fingers 56 can be solid or hollow.

[0020] As shown in Fig. 1, the bearing assembly 20 can be provided in an area or environment having a supply or quantity of lubricant (e.g., either standing or moving through a sump incident on at least a lower portion of the bearing assembly 20). As the bearing assembly 20 facilitates rotational operation of the supported component(s) about the axis A and the rolling elements 32 roll on the surfaces of the inner and outer rings 24, 28, the cage 36 also rotates about the axis A. As the cage 36 rotates, the fingers 56 breach, penetrate through, and erupt back out from the surface of the lubricant, which can generate two-phase flow patterns that can more readily travel through the air and reach remote portions of the bearing assembly 20. The action of the fingers 56 may aerate the near bearing surface lubricant to generate mist, disrupting an otherwise natural flow, and tending to convert the liquid-only lubricant (e.g., oil) to approximate a two-phase flow pattern, including liquid and vapor. Alternately, the two-phase flow pattern may include stream lines and/or droplets. The action of the fingers 56 on the lubricant promotes more even distribution of the lubricant throughout the bearing chamber. Depending on various factors such as rotational speed and lubricant viscosity, the fingers 56 may distribute lubricant throughout the bearing assembly 20 without relying on generating a two-phase flow pattern. For example, each finger 56 entrains or pulls a quantity of lubricant from the sump as it passes through the lubricant and out the upper surface of the lubricant, and the fingers 56 carry or push the lubricant to various portions of the bearing assembly 20. The fingers 56 can entrain lubricant from the sump by surface tension of the lubricant, and optionally can wick the lubricant by capillary action. Distribution of the lubricant from the fingers 56 can be effected by one or more of centrifugal force or gravity.

[0021] Although illustrated as simple tubular or cylindrical projections, the fingers 56 may have other geometries, including one or more bends, non-round cross-section, etc. The fingers 56 can be integrally formed as part of the cage 36, which can be manufactured using additive manufacturing techniques, in which the cage 36 is built by sequential layering of material. The layering material can include one or more polymers. Alternately, the cage can be manufactured using known molding processes to mold the cage 36 from one or more polymers.

[0022] Various features and advantages of the invention are set forth in the following claims.

CLAIMS

What is claimed is:

1. A bearing assembly comprising:

an inner ring;

an outer ring;

a plurality of rolling elements situated between the inner and outer rings, the plurality of rolling elements facilitating relative rotation between the inner and outer rings about an axis; and

a cage situated between the inner and outer rings, the cage including a pair of axial end flanges and a plurality of bridges extending between the axial end flanges,

wherein at least one of the pair of axial end flanges of the cage includes an array of axially outwardly extending fingers configured to distribute lubricant from a quantity of lubricant during operation.
2. The bearing assembly of claim 1, wherein each of the pair of axial end flanges of the cage includes an array of axially outwardly extending fingers configured to distribute lubricant from the quantity of lubricant during operation.
3. The bearing assembly of claim 1, wherein the axially outwardly extending fingers of the array extend parallel to the axis.
4. The bearing assembly of claim 1, wherein the axially outwardly extending fingers of the array extend parallel to the axis are solid.
5. The bearing assembly of claim 1, wherein the axially outwardly extending fingers of the array extend parallel to the axis are hollow.
6. The bearing assembly of claim 1, wherein the cage is constructed of a polymer material by one of additive manufacturing and molding.

7. The bearing assembly of claim 1, wherein the axially outwardly extending fingers of the array do not extend past an axial periphery defined by the inner and outer rings.

8. A cage for use in a rolling element bearing assembly, the cage comprising:
- a pair of ring-shaped axial end flanges; and
- a plurality of bridges extending between the pair of axial end flanges, rolling element pockets being defined between each adjacent pair of bridges,
- wherein at least one of the pair of axial end flanges includes an array of axially outwardly extending fingers configured to distribute lubricant from a quantity of lubricant during operation.
8. The cage of claim 8, wherein each of the pair of axial end flanges of the cage includes an array of axially outwardly extending fingers configured to distribute lubricant from the quantity of lubricant during operation.
9. The cage of claim 8, wherein the axially outwardly extending fingers of the array extend parallel to the axis.
10. The cage of claim 8, wherein the axially outwardly extending fingers of the array extend parallel to the axis are solid.
11. The cage of claim 8, wherein the axially outwardly extending fingers of the array extend parallel to the axis are hollow.
12. The cage of claim 8, wherein the cage is constructed of a polymer material by one of additive manufacturing and molding

13. A method of lubricating a rolling element bearing assembly during use, the bearing assembly including a cage positioned between inner and outer rings and having a plurality of rolling element pockets, the method comprising:

during rotation of the cage about an axis, distributing lubricant with an array of fingers extending axially outwardly from the cage by passing the array of fingers through a quantity of lubricant to improve wetting of remote portions of the bearing assembly.

14. The method of claim 13, wherein distributing lubricant includes inducing a two-phase flow pattern by passing the array of fingers through the quantity of lubricant.

15. The method of claim 14, wherein inducing the two-phase flow pattern includes aerating lubricant from the quantity of lubricant into a mist.

16. The method of claim 13, wherein distributing lubricant includes wicking lubricant from the quantity of lubricant.

17. The method of claim 16, wherein distributing lubricant further includes delivering the lubricant to the remote portions of the bearing assembly by at least one of centrifugal force and gravity.

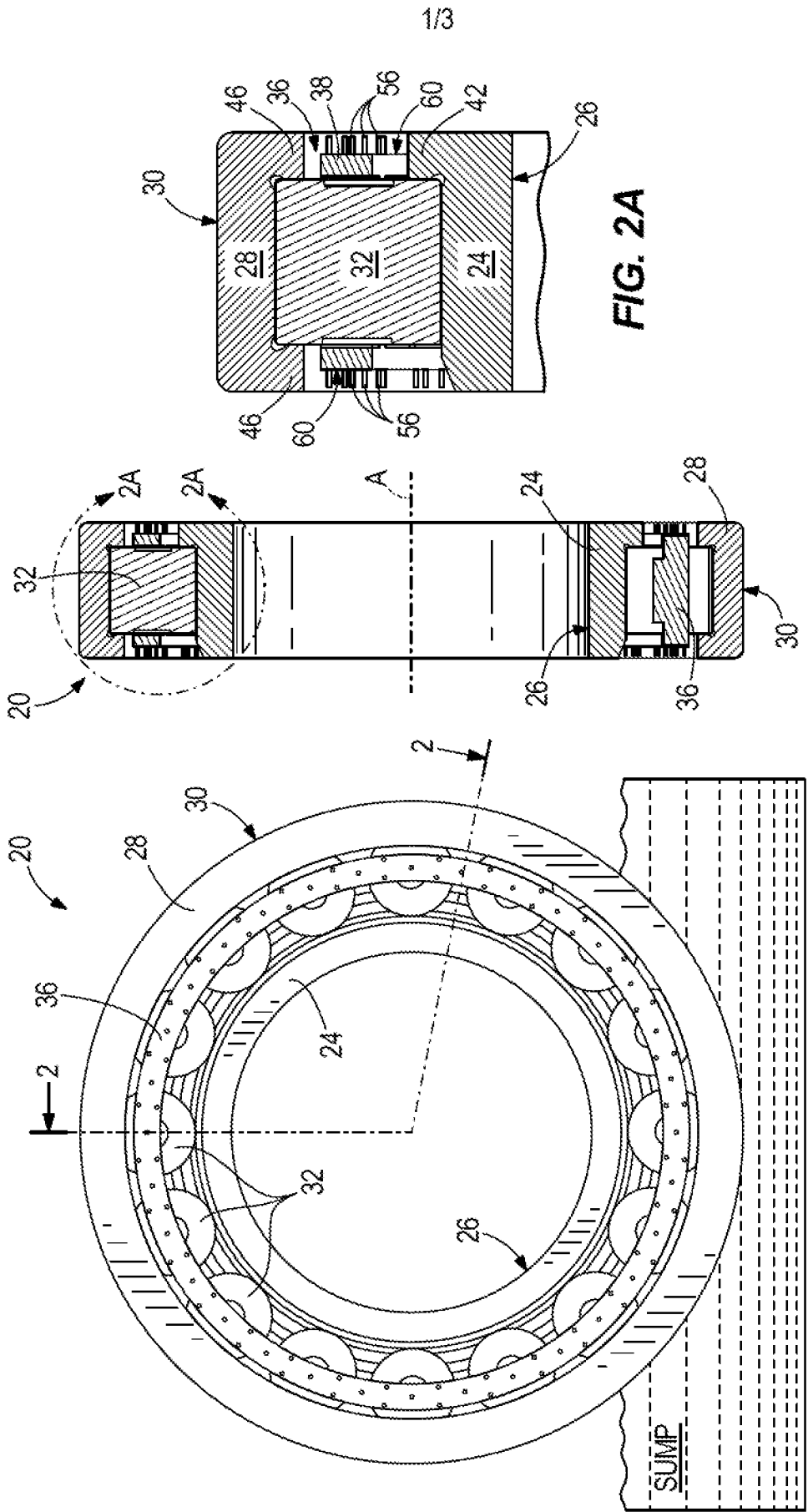


FIG. 2

FIG. 1

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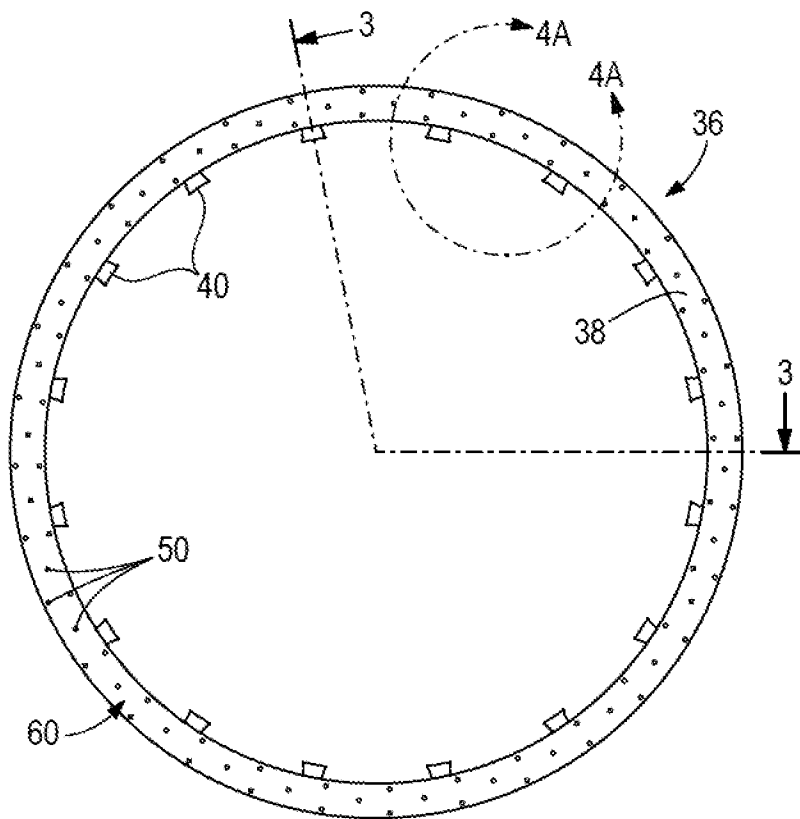


FIG. 4

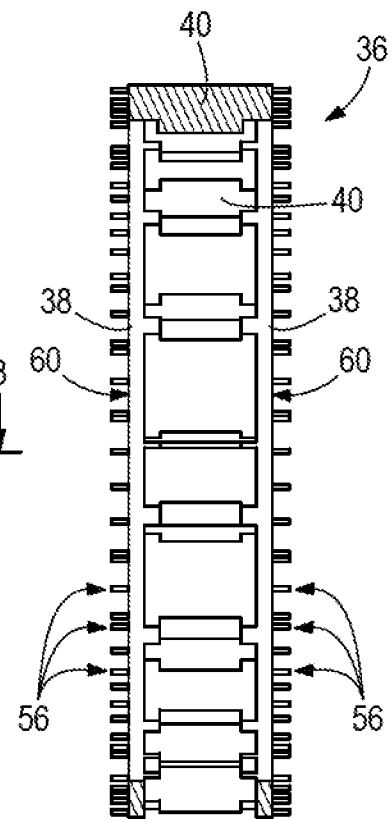


FIG. 3

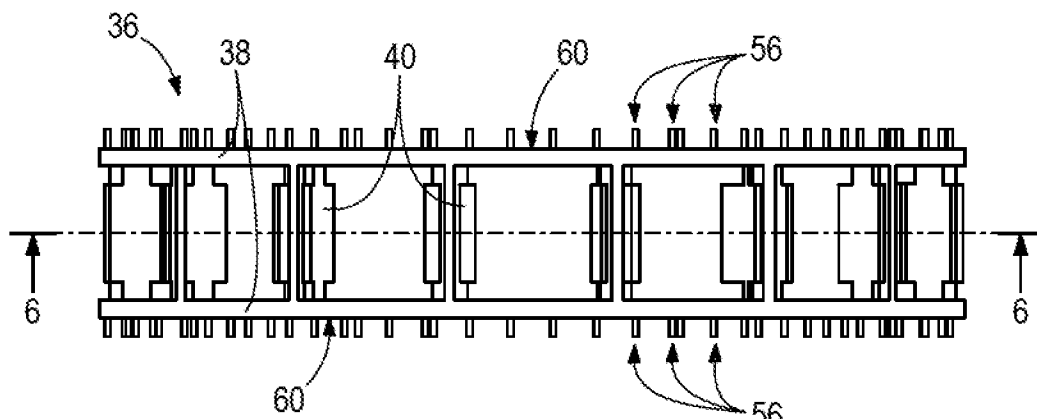
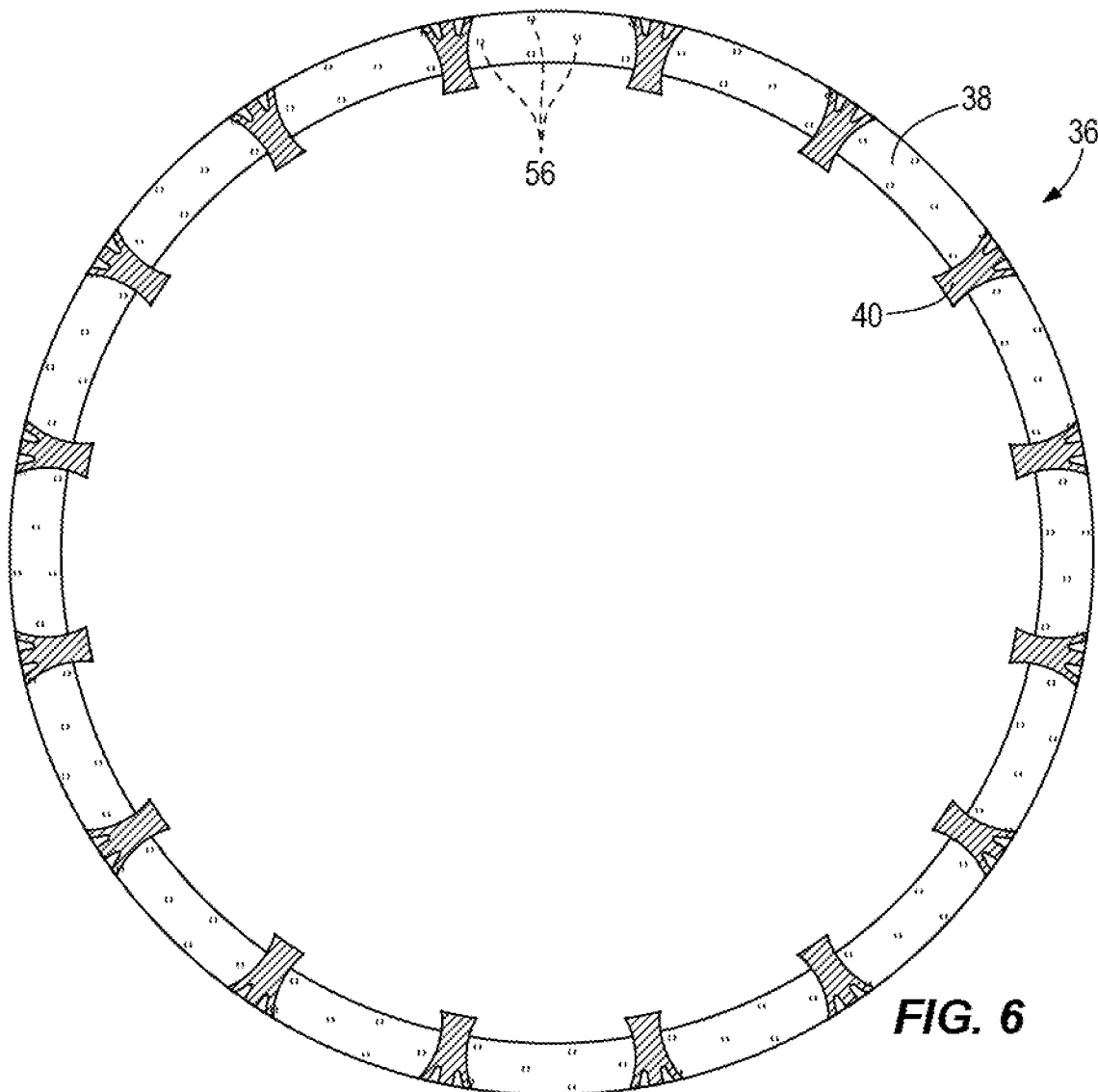
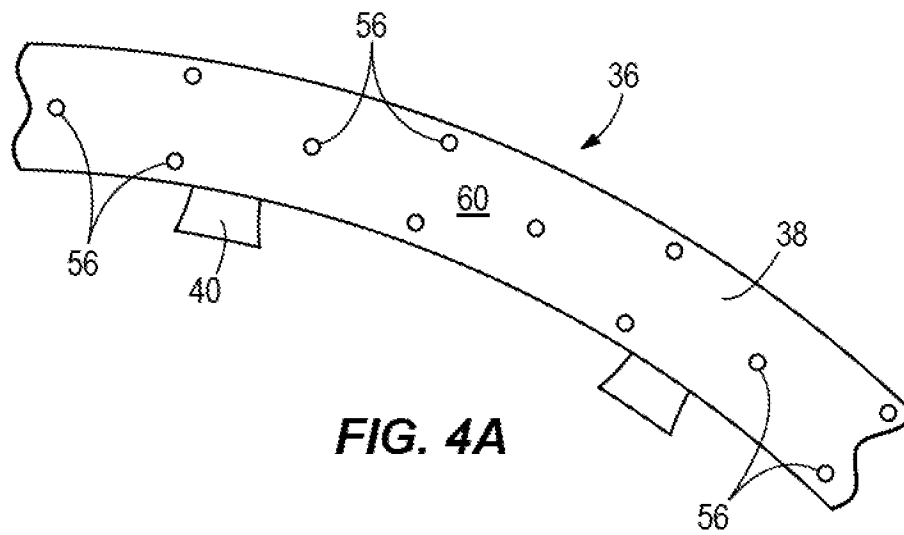


FIG. 5

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/064812

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16C19/26 F16C33/66 F16C33/46
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 practicable, 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	US 7 380 990 B2 (SUZUKI MASAKUNI [JP]) 3 June 2008 (2008-06-03) column 2, lines 23-40 column 4, line 54 - column 6, line 25; figures	1-18
A	DE 21 19 917 A1 (DEUTSCHE STAR KUGELHALTER GMBH) 9 November 1972 (1972-11-09) page 5; figure 5	1,4,6-8, 11, 13-15,18
A	EP 1 741 944 A1 (NSK STEERING SYS CO LTD [JP]) 10 January 2007 (2007-01-10) paragraphs [0020], [0021], [0032] - [0035], [0070] - [0074]; figures 2a,5 -/-	1,5,7,8, 12,14,15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

21 January 2015

Date of mailing of the international search report

30/01/2015

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

International application No

PCT/US2014/064812

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010/035753 A1 (JTEKT CORP [JP]; YAMAMOTO TAKESHI [JP]; HAYASHI YUICHIRO [JP]) 1 April 2010 (2010-04-01) the whole document -----	1,2,8,9, 14-16
A	US 4 509 869 A (JOHNSTON KENNETH R [US]) 9 April 1985 (1985-04-09) column 2, line 60 - column 3, line 25; figures -----	1,8,14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/064812

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7380990	B2	03-06-2008	CN 1782392 A 07-06-2006
			DE 102005057751 A1 14-06-2006
			JP 4254702 B2 15-04-2009
			JP 2006161598 A 22-06-2006
			US 2006120646 A1 08-06-2006
DE 2119917	A1	09-11-1972	AT 309918 B 10-09-1973
			DE 2119917 A1 09-11-1972
EP 1741944	A1	10-01-2007	CN 1938525 A 28-03-2007
			EP 1741944 A1 10-01-2007
			WO 2005093273 A1 06-10-2005
WO 2010035753	A1	01-04-2010	NONE
US 4509869	A	09-04-1985	NONE