

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
16 March 2006 (16.03.2006)

PCT

(10) International Publication Number
WO 2006/027342 A1

(51) International Patent Classification:
F16C 33/41 (2006.01)

(21) International Application Number:
PCT/EP2005/054348

(22) International Filing Date:
5 September 2005 (05.09.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
TO2004A000594 9 September 2004 (09.09.2004) IT

(71) Applicant (for all designated States except US): **AK-TIEBOLAGET SKF** [SE/SE]; S-415 50 Göteborg (SE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **VIGNOTTO, Angelo** [IT/IT]; Via Montevideo 48, I-10134 Torino (IT). **NICASTRI, Fulvio** [IT/IT]; Reg. Case Nuove 7/B, I-10060 Garzigliana (IT).

(74) Agents: **FIORAVANTI, Corrado** et al.; Corso Emilia 8, I-10152 Torino (IT).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

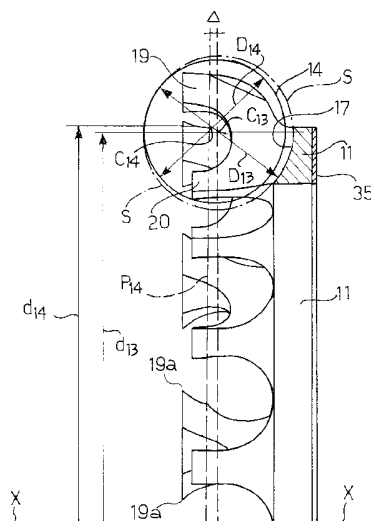
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG,

[Continued on next page]

(54) Title: BALL BEARING UNIT WITH AN IMPROVED BALL RETAINING CAGE



(57) Abstract: A ball bearing unit comprises an outer race (30), one or two inner races (31, 32), one or two series of balls (14) arranged between the inner race and the outer race. The balls have a diameter (D14) and centres (C14) arranged along a pitch line (P14) having a diameter (d14). The bearing unit comprises at least one cage (10) for keeping the balls (14) equally spaced along said pitch line. The cage forms a plurality of sockets (13) for receiving the balls (14). Each socket (13) forms a part of a hollow spherical surface (S) having a centre (C13) and a diameter (D13) slightly greater than the diameter (D14) of the balls (14). The centres (C13) of the spherical surfaces (S) are arranged along a circumference (P13) having a diameter (d13). The diameter (d13) of the circumference (P13) passing through the centres of the spherical surfaces (S) is smaller than the diameter (d14) of the pitch line (P14) passing through the centres (C14) of the balls (14).

WO 2006/027342 A1



SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

— of inventorship (Rule 4.17(iv)) for US only

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Ball bearing unit with an improved ball retaining cage

The present invention relates to a ball bearing unit with an improved ball retaining cage.

For a better understanding of the state of the art and the problems relating thereto, a retaining cage of the type known from EP-A 0,592,839 will first be described. With reference to Figures 5 to 8, a cage 10 comprises a circular base ring 11 from one side of which a plurality of circumferentially equally spaced C-shaped hooks 12 extend. The base ring 11 and the hooks 12 have partially spherical concave surfaces 15, 16, 17 which together define a plurality of partially spherical sockets or recesses 13 for retaining balls 14 circumferentially equally spaced between the rolling tracks of a bearing.

Hitherto, cages of this type have been designed with dimensions such that the balls are seated concentrically inside the sockets, as schematically shown in Figures 6-8. These two geometric conditions are satisfied:

- a) the centres C13 of the sockets lie on a circumference P13 which coincides with the circumference P14 (known as "pitch line") which passes through the centres of the balls and which is defined by the bearing raceways;

- b) the spherical surfaces defined by the sockets have a diameter slightly greater than the diameter of the balls.

Consequently, between each ball and the respective socket there exists a slight play both in the circumferential direction and in the axial direction. Owing to the play in the circumferential direction, during operation the cage is continually struck by the balls so that the cage does not rotate at a constant instantaneous speed about the axis of

rotation of the bearing, but is jolted about this axis.

The present invention is intended to be used, in particular but not exclusively, for bearing assemblies comprising sensor devices for detecting the rotation of the bearing, as for example described in GB-A-2,382,142. In these applications, an encoder is mounted on the cage and associated operationally with a sensor arranged on the stationary ring of the bearing.

The object of the invention is to provide a bearing unit in which the circumferential play between the balls and the cage is eliminated or at least reduced so that the cage is able to rotate in a more uniform manner about the axis of the bearing and therefore allow more precise and simplified reading of the speed of rotation of the cage.

This object is achieved, according to a first aspect of the invention, by a bearing unit having the characteristic features defined in Claim 1. According to another aspect of the invention, this object is achieved by a bearing assembly according to Claim 2.

A preferred, but non-limiting embodiment of the invention will now be described, with reference to the accompanying drawings, in which:

- Figure 1 is an axially sectioned view of a ball bearing provided with two ball retaining cages according to the invention;
- Figure 2 is a perspective view of the cages according to Figure 1;
- Figure 3 is a partial view, sectioned and on a larger scale, of the cage according to Figure 2;
- Figure 4 is a schematic perspective view on a larger

scale showing the arrangement of a ball inside a socket of the cage according to Figures 2 and 3;

- Figure 5 is a perspective view of a cage of the known type;

- Figure 6 is a partial sectioned view of the cage of Figure 5;

- Figure 7 is a view in the direction of the arrow A of Figure 6; and

- Figure 8 is a schematic perspective view on a larger scale showing the concentric arrangement of a ball inside a socket of a conventional cage of the type shown in Figures 5-7.

With reference initially to Figure 1, a ball bearing unit comprises a stationary outer race 30, two rotatable inner races 31, 32, two series of balls 14 and two respective ball retaining cages 10. The characteristics of the bearing races are not per se important for the purposes of understanding the invention and will therefore not be described in detail. 33 denotes a sensor carrier body having sensors 34 axially facing two annular encoders or phonic wheels 35 (one of which is shown in Figure 3) each mounted on one of the two cages 10 for detecting the rotation of the cages about the axis of rotation x of the bearing, generating electric signals indicating rotation of the cages.

As shown in Figure 2, the cage 10 forms a circular base ring 11 from one side of which a plurality of circumferentially equidistant C-shaped hooks 12 extend. The base ring 11 and the hooks 12 have partially spherical concave surfaces 15, 16, 17 which together define a plurality of partially spherical sockets or recesses 13 for keeping the balls 14 equally spaced along a pitch line P14 passing through the centres of the balls. The hooks 12 are each formed by two

curved arms projecting from the ring 11: a longer arm 19 and a shorter arm 20, both having opposite ends 19a, 20a diverging in a substantially tangential direction. The concave surfaces 15, 16, 17 of each socket together cover an arc which extends over more than 180 degrees around each ball.

As shown in Figure 3, each socket 13 forms a part of a spherical surface S having a centre C13 and a diameter D13 slightly greater than the diameter D14 of the balls 14.

According to the invention, the circumference P13 passing through the centre of the sockets has a diameter d13 slightly smaller than the diameter d14 of the pitch line P14 passing through the centres of the balls 14. Preferably the difference between the diameters d14 and d13 is smaller than 0.4 mm. Owing to this arrangement, during operation the cage 10 is arranged in a position where the circumference P13 is axially displaced by a distance Δ from the pitch line P14 towards the opposite side of the base ring 11 of the cage.

When the bearing rotates, the cage assumes a floating equilibrium position where there is a certain axial play Δ between the balls and the sockets (as indicated schematically also in Figure 4), but there is no circumferential play between the cage and the balls. The distance between the centres of two consecutive sockets 13 is slightly smaller than the distance between the centres of two consecutive balls 14.

Those skilled in the art will recognise that this absence of circumferential play is accompanied, as mentioned, by an axially floating (and therefore free) condition of the cage where the balls lightly touch the free end zones 19a of the

projecting hooks. There is no contact, however, between the balls 14 and the base ring 11 (Figure 4).

Owing to the absence of an appreciable amount of circumferential play, the cage rotates in a uniform manner about the axis of rotation of the bearing. As a result, the speed signals detected by a sensor facing the cage are also more uniform and therefore are able to give precise indications as to the instantaneous speed of rotation of the bearing without requiring special modifications for eliminating the effects of the variations due to the impacts in the circumferential direction, as discussed in the introductory part of the description with reference to the known art.

Obviously, without modifying the principle of the invention, the constructional details and the embodiments may be widely varied with respect to that described and illustrated, without thereby departing from the scope of the present invention.

CLAIMS

1. A ball bearing unit of the type comprising:

- an outer race (30),
- at least one inner race (31, 32),
- at least one series of balls (14) arranged between the inner race and the outer race, the balls having a diameter (D14) and centres (C14) arranged along a pitch line (P14) having a diameter (d14),
- at least one cage (10) for keeping the balls (14) equally spaced along said pitch line, wherein the cage forms a plurality of sockets (13) for receiving said balls (14), each socket (13) forming a part of a hollow spherical surface (S) having a centre (C13) and a diameter (D13) slightly greater than the diameter (D14) of the balls (14), the centres (C13) of the spherical surfaces (S) being arranged along a circumference (P13) having a diameter (d13);

characterized in that the diameter (d13) of the circumference (P13) passing through the centres of the spherical surfaces (S) is smaller than the diameter (d14) of the pitch line (P14) passing through the centres (C14) of the balls (14).

2. A bearing assembly comprising:

- at least one outer race (30) and at least one inner race (31, 32), where at least one (30) of said races is stationary and at least another one of said races is rotatable (31, 32);
- at least one series of balls (14) arranged between said races (30, 31, 32), the balls having a diameter (D14) and centres (C14) arranged along a pitch line (P14) having a diameter (d14),
- at least one cage (10) for keeping the balls (14) equally spaced along said pitch line, where the cage forms a

plurality of sockets (13) for receiving said balls (14), where each socket (13) forms a part of a hollow spherical surface (S) having a centre (C13) and a diameter (D13) slightly greater than the diameter (D14) of the balls (14), the centres (C13) of the spherical surfaces (S) being arranged along a circumference (P13) having a diameter (d13);

- at least one annular encoder (35) fixed onto the cage (10);

characterized in that the diameter (d13) of the circumference (P13) passing through the centres of the spherical surfaces (S) is smaller than the diameter (d14) of the pitch line (P14) passing through the centres (C14) of the balls (14).

1/3

FIG. 1

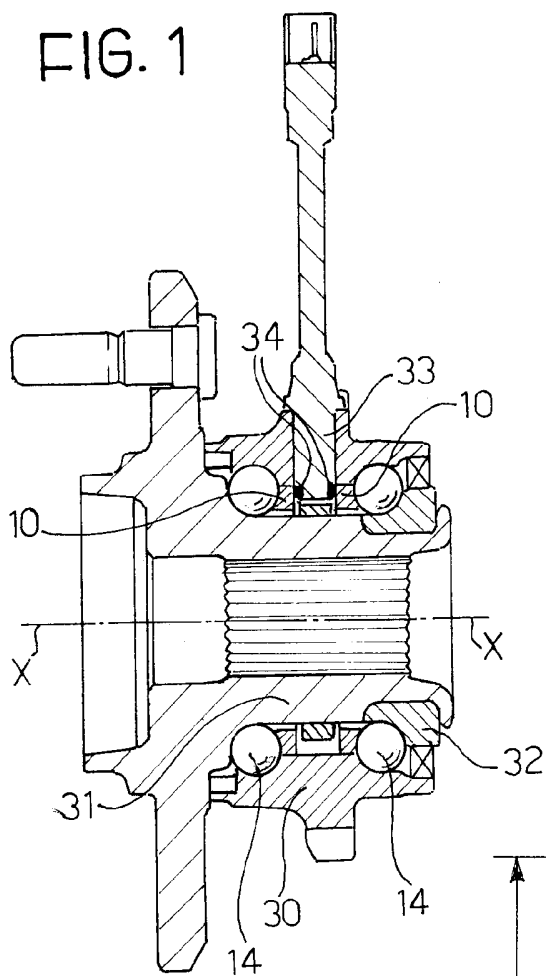


FIG. 2

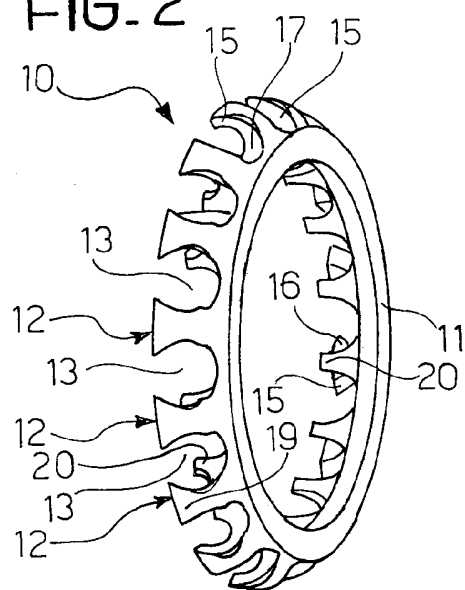
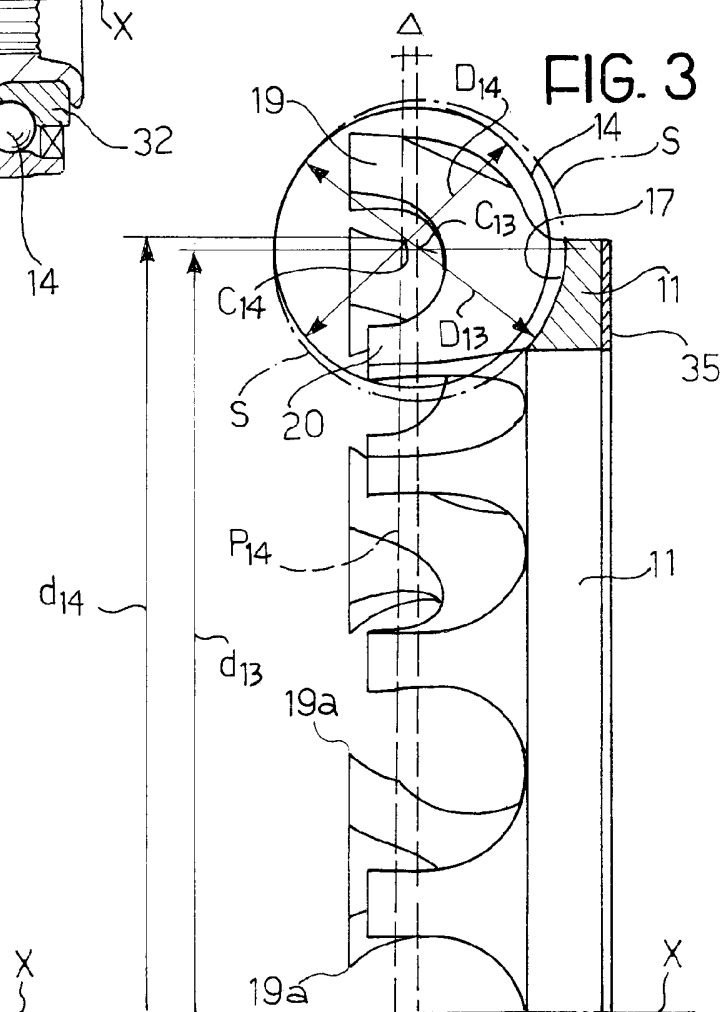


FIG. 3



2/3

FIG. 4

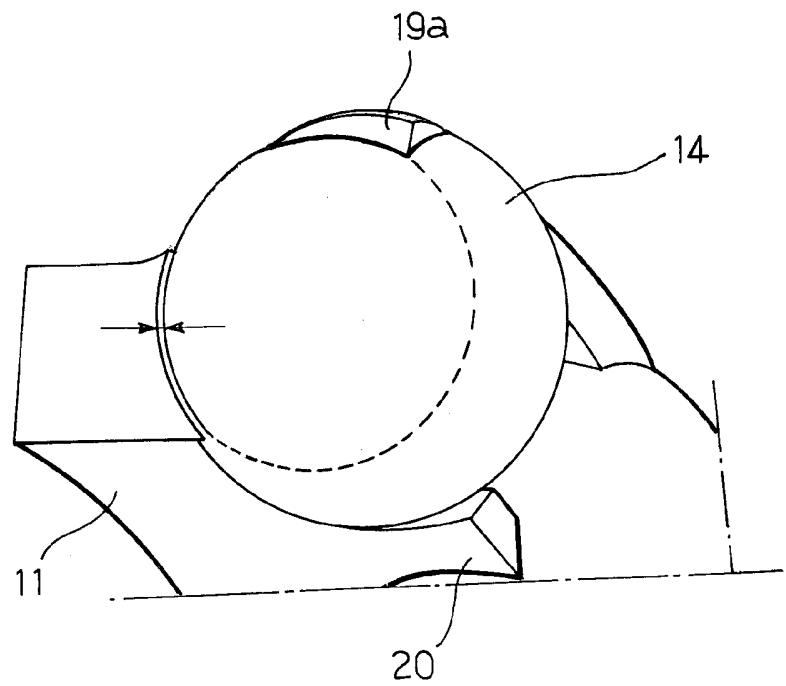
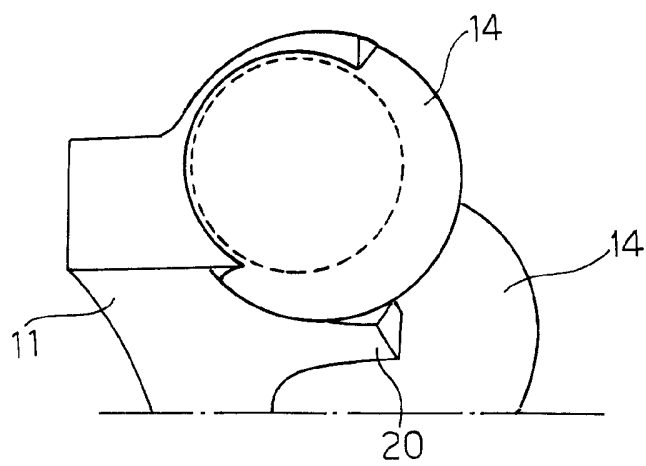


FIG. 8 (PRIOR ART)



3/3

FIG. 5 (PRIOR ART)

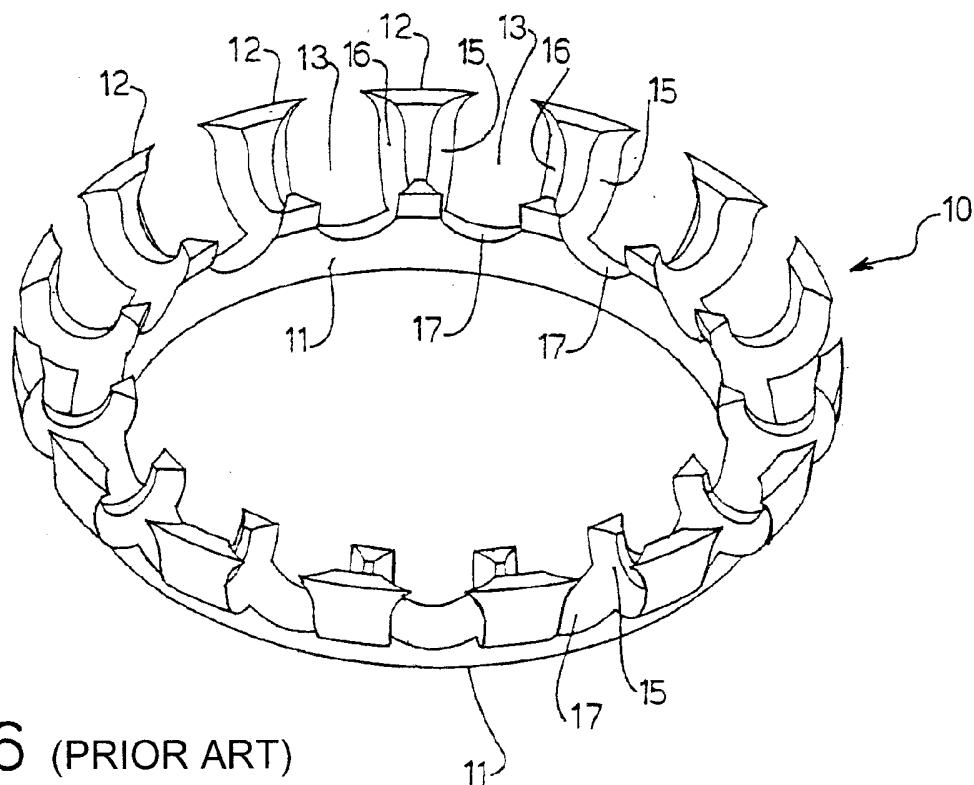


FIG. 6 (PRIOR ART)

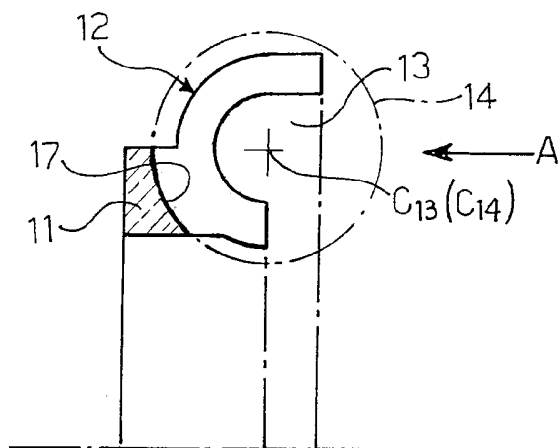
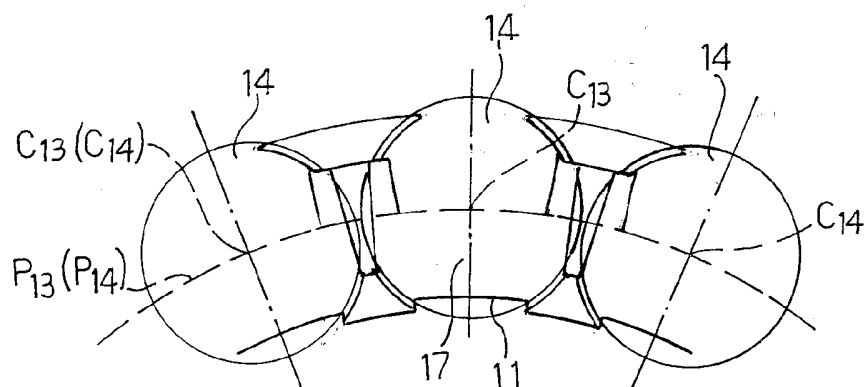


FIG. 7 (PRIOR ART)



INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/054348

A. CLASSIFICATION OF SUBJECT MATTER

F16C33/41

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)

EP0-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 4 493 513 A (OSAWA ET AL)	1
Y	15 January 1985 (1985-01-15) column 3, lines 1-21; figure 2	2
X	FR 2 538 474 A (SKF KUGELLAGERFABRIKEN GMBH) 29 June 1984 (1984-06-29)	1
Y	page 4, lines 3-14; figures 2,3	2
X	US 6 276 836 B1 (SUZUKI HIRONORI ET AL)	1
Y	21 August 2001 (2001-08-21) page 8, lines 12-32; figures 4a,b	2
Y	GB 2 382 142 A (* NSK EUROPEAN TECHNOLOGY CO LIMITED) 21 May 2003 (2003-05-21) cited in the application the whole document	2
	----- -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in 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 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
- "&" document member of the same patent family

Date of the actual completion of the international search

25 November 2005

Date of mailing of the international search report

05/12/2005

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

BEGUIN, C

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP2005/054348

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/103703 A1 (ISHIWADA HIROSHI ET AL) 5 June 2003 (2003-06-05) paragraphs '0030! - '0038!; figure 2 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP2005/054348

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 4493513	A	15-01-1985	JP	58195118 U	26-12-1983
FR 2538474	A	29-06-1984	DE	3247948 A1	05-07-1984
			GB	2132287 A	04-07-1984
			IT	1214394 B	18-01-1990
			JP	1055808 B	27-11-1989
			JP	1569570 C	10-07-1990
			JP	59197616 A	09-11-1984
			US	4560291 A	24-12-1985
US 6276836	B1	21-08-2001	GB	2320744 A	01-07-1998
			JP	10238543 A	08-09-1998
GB 2382142	A	21-05-2003	NONE		
US 2003103703	A1	05-06-2003	JP	2000337387 A	05-12-2000