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(71) Applicant (for all designated States except US): **AK-TIEBOLAGET SKF** [SE/SE]; Hornsgatan 1, S-415 50 Göteborg (SE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **ZIEGLER, Sebastian** [DE/NL]; Weerdestede 39, NL-3431 LS Nieuwegein (NL). **CHRISTIANSSON, Goran** [SE/NL]; Gerrit van der Veenstraat 67, NL-3762 XJ Soest (NL).

(74) Agent: **GOSDIN, Michael**; Adam-Stegerwald-Strasse 6, 97422 Schweinfurt (DE).

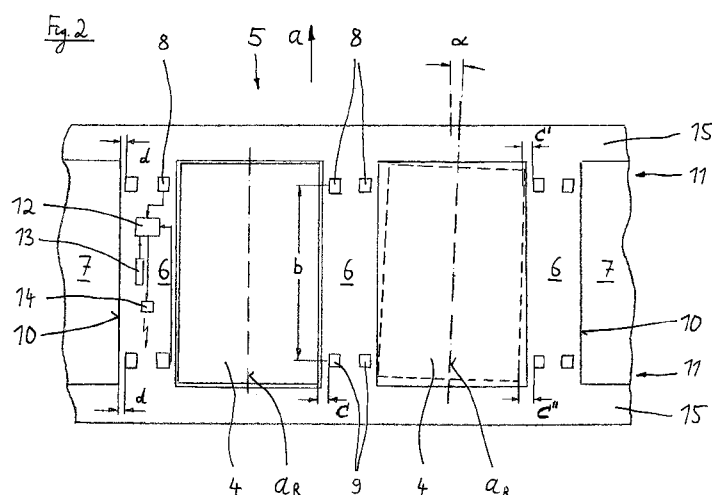
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(54) Title: ROLLER BEARING WITH CAGE-MOUNTED SENSORS



(57) Abstract: The invention relates to a roller bearing (1), comprising at least one inner ring (2) and at least one outer ring (3), wherein the inner ring (2) and the outer ring (3) are coaxially arranged around an axis (a), wherein rollers (4) having an elongated shape are arranged between the inner ring (2) and outer ring (3), wherein the rollers (4) are guided by a cage (5), wherein the cage (5) has a plurality of bars (6), wherein a pocket (7) for receiving a roller (4) is formed between two adjacent bars (6), and wherein the roller bearing (1) comprises at least one sensor element (8, 9) for detecting an operation condition of the roller bearing (1). To determine skew of the rollers in an easy and precise way the invention is characterized in that at least two sensor elements (8, 9) are arranged at at least one bar (6) of the cage (5) or are arranged at two adjacent bars (6) of the cage (5), wherein the two sensor elements (8, 9) are arranged with distance (b) in axial direction (a).

ROLLER BEARING WITH CAGE-MOUNTED SENSORS

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Technical Field

10 The invention relates to a roller bearing, comprising at least one inner ring and at least one outer ring, wherein the inner ring and the outer ring are coaxially arranged around an axis, wherein rollers having an elongated shape are arranged between the inner ring and outer ring, wherein the rollers are guided by a cage, wherein the cage has a plurality of bars, wherein a pocket
15 for receiving a roller is formed between two adjacent bars, and wherein the roller bearing comprises at least one sensor element for detecting an operation condition of the roller bearing.

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Background

Roller bearings of this kind are well known in the art. They are equipped with a sensor element to measure different operation condition.

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For example, **GB 2001 27 580 A** discloses a bearing assembly for a vehicle wheel arrangement. The bearing has a sensor for sensing the speed and the position of the bearing. A similar bearing is disclosed in **US 5 026 178 A**; also

here a sensor is employed by which the rotational speed and the angle of torsion of a shaft can be measured.

Sensors are also used for detecting and monitoring damages to races or adjacent regions of the bearing rings. Such a solution is shown in US 2010/058868 A.

WO 2009/052799 A employs a sensor in a bearing for setting the bearing play or the preload in a bearing arrangement.

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Other bearing arrangements which use a sensor to determine an operation condition are known for example from JP 2002 155933 A, from US 5 226 736 A, from US 6 161 962 A, from US 6 490 935 B, from US 2008/0159674 A1, from US 6 535 135 B and from WO 2008/098594 A.

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A special problem of a bearing arrangement of the kind mentioned above, i. e. of a bearing having elongated rollers which are arranged in receiving pockets of a cage, is that the rollers can skew within their pockets during operation. That means that the axis of the roller of a cylindrical roller bearing which should be parallel to the axis of the bearing includes a small angle to the axis of the bearing. Skewing of the rollers in the cage pockets has been found to be a major source of bearing failure especially in the case of cylindrical roller bearings and taper roller bearing. Skewing is a symptom of uncontrolled bearing conditions.

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Thus, it is an object of the invention to propose a design for a roller bearing as defined above which allows to survey skewing of the rollers in their receiving pockets of the cage in an easy and efficient way. So, it should

25

become possible to be aware that skewing of the rollers takes place in an early stage before a failure of the bearing happens.

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Summary of the invention

A solution according to the invention is characterized in that at least two sensor elements are arranged at at least one bar of the cage or are
10 arranged at two adjacent bars of the cage, wherein the two sensor elements are arranged with distance in axial direction.

According to one possible embodiment, the at least two sensor elements are arranged with equal distance from an edge of the pocket. The at least two
15 sensor elements are preferably arranged in opposite axial end regions of the pocket.

The sensor elements are preferably eddy current sensors. Eddy current sensors detect eddy currents (also called Foucault currents) which are currents
20 induced in conductors, opposing the change in flux that generated them. The current is caused when a conductor is exposed to a changing magnetic field due to relative motion of the field source and the conductor and also as a result of a variation of the field over time. This can cause a circulating flow of electrons, or a current, within the body of the conductor. These circulating
25 eddies of current create induced magnetic fields that oppose the change of the original magnetic field due to Lenz's law, causing repulsive or drag forces between the conductor and the magnet.

Alternatively, the sensor elements can be capacitive sensors, inductive sensors or optical sensors; also other types of sensors are suitable.

5 The roller bearing is preferably a cylindrical roller bearing, a taper roller bearing, a spherical roller bearing or a toroidal roller bearing.

The sensor elements can be electrically connected with a control unit (microcontroller), which is located on or in the cage. The control unit can be electrically connected with or comprises a power supply; the power supply
10 can be a battery or a receiving element for receiving energy wireless from an external source. The control unit can further be electrically connected with a data interface; the data interface can be designed for a wireless data transfer (e. g. via RFID).

15 Thus, two or more sensors, preferably being eddy current sensors, are attached to the bearing cage facing the contact surface of the roller, i. e. facing a roller along its length. The sensors measure the distance between the cage and the roller at two positions which are spaced in axial direction and therefore it becomes possible to detect skewing of the rollers in an easy and
20 precise way.

In this connection a preferred embodiment proposes the arrangement of the (at least) two sensors – being spaced in axial direction – at at least one bar of the cage. But it is e. g. also possible to arrange the two sensors – again being
25 spaced in axial direction – at two adjacent bars which form the receiving pocket for a roller. So, a possible arrangement of the sensors is diagonally with respect to the pocket. Thus, the sensors do not have to be on the same bar, but they have to look at the same roller.

Brief description of the drawings

5 The drawings show an embodiment of a roller bearing according to the invention.

Fig. 1 shows a radial cross section of a cylindrical roller bearing and

10 Fig. 2 shows a view of a part of a cage of the bearing according to Fig. 1 seen from a radial direction.

15 Detailed description of the invention

In Fig. 1 a cylindrical roller bearing 1 is shown in radial cross section which has an inner ring 2 and an outer ring 3. The two rings 2, 3 are arranged concentrically around an axis a. Cylindrical rollers 4 are arranged between the
20 rings 2, 3. The rollers 4 are guided by a cage 5.

Turning now to Fig. 2 a part of the cage 5 is shown, seen from a radial direction and from the radial outer side of the cage 5. The cage has side rings 15 which are connected by a plurality of bars 6; the number of bars 6
25 corresponds to the number of rollers 4 which are to be guided by the cage 5. Two adjacent bars 6 define – together with the side rings 15 – a pocket 7 which is designed to receive and to guide a roller 4.

Ideally, the roller 4 is arranged in its pocket 7 during operation in such a way that its longitudinal axis a_R is parallel to the axis a of the roller bearing 1. This situation is depicted in the left half in Fig. 2 (see roller 4 with dashed lines).

5 During realistic operation conditions it can happen that the roller 4 skews. This means that its axis a_R is not parallel to the axis a of the roller bearing but includes a small angle α with the axis a of the roller bearing. This is depicted in the right half in Fig. 2.

10 To allow the detection of skew the cage 5 is equipped with sensors 8, 9 as follows:

Each bar 6 has at least two sensors 8, 9 which are arranged in a distance d from the edge 10 of the pocket 7. The two sensors 8, 9 are arranged in the
15 axial end regions 11 of the pocket 7. The sensors 8, 9 are arranged in an axial distance b .

If no skewing takes place both sensors 8, 9 detect a distance c as shown in the left half of Fig. 2. Thus the difference of the measured values of the two
20 sensors 8, 9 is zero which indicates that no skewing takes place.

If skewing happens the two sensors 8, 9 detect different distance c' and c'' as shown in the right half of Fig. 2. The skewing roller 4 is shown with dashed lines. Thus the difference of the measured values c' and c'' is not equal zero
25 which indicates that skewing takes place now.

To monitor this situation the cage 5 carries a control unit 12 which is electrically connected with both sensors 8, 9. The control unit 12 is supplied with energy from a power source 13 which can be a battery or an element

which receives energy from a remote source. Furthermore, the control unit 12 is electrically connected with a data interface 14 which transfers the measures data from the sensors 8, 9 wireless to a monitoring station remote from the cage.

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So, the monitoring of the skew and of its magnitude becomes possible in a precise way and with cheap means.

The mentioned electronic elements can also be arranged in a common housing, i. e. they can be designed as an integral unit.

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As can be seen from Fig. 2 a plurality of sensors 8, 9 can be arranged at the cage 5. In the depicted embodiment of a cylindrical roller bearing sensors 8, 9 are arranged at each side near the edge 10 of the pockets 7. So, a full detection of the skew of all rollers 4 becomes possible, even with a redundancy control as a pocket 4 is monitored from two sides.

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Of course it is not mandatory to equip the cage with such a plurality of sensors. It can be even enough to survey only one of a certain number of pockets with respect of skewing of the rollers 4 to get relevant information concerning the operation condition of the roller bearing 1.

20

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Reference Numerals:

	1	Roller bearing
5	2	Inner ring
	3	Outer ring
	4	Roller
	5	Cage
	6	Bar
10	7	Pocket
	8	Sensor element
	9	Sensor element
	10	Edge
	11	Axial end region
15	12	Control unit
	13	Power supply
	14	Data interface
	15	Side ring
	.	
20	a	Axis / axial direction
	a _R	Axis of the roller
	b	Distance
	c	Distance
	c'	Distance
25	c''	Distance
	d	Distance
	α	Angle

Patent Claims:

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1. Roller bearing (1), comprising at least one inner ring (2) and at least one outer ring (3), wherein the inner ring (2) and the outer ring (3) are coaxially arranged around an axis (a), wherein rollers (4) having an elongated shape are arranged between the inner ring (2) and outer ring (3), wherein the rollers (4) are guided by a cage (5), wherein the cage (5) has a plurality of bars (6), wherein a pocket (7) for receiving a roller (4) is formed between two adjacent bars (6), and wherein the roller bearing (1) comprises at least one sensor element (8, 9) for detecting an operation condition of the roller bearing (1),

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characterized in

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that at least two sensor elements (8, 9) are arranged at at least one bar (6) of the cage (5) or are arranged at two adjacent bars (6) of the cage (5), wherein the two sensor elements (8, 9) are arranged with distance (b) in axial direction (a).

25

2. Roller bearing according to claim 1, characterized in that the at least two sensor elements (8, 9) are arranged with equal distance (d) from an edge (10) of the pocket (7).

3. Roller bearing according to claim 1 or 2, characterized in that the at least two sensor elements (8, 9) are arranged in opposite axial end regions (11) of the pocket (7).

5

4. Roller bearing according to one of claims 1 to 3, characterized in that the sensor elements (8, 9) are eddy current sensors.

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5. Roller bearing according to one of claims 1 to 3, characterized in that the sensor elements (8, 9) are capacitive sensors.

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6. Roller bearing according to one of claims 1 to 3, characterized in that the sensor elements (8, 9) are inductive sensors.

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7. Roller bearing according to one of claims 1 to 3, characterized in that the sensor elements (8, 9) are optical sensors.

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8. Roller bearing according to one of claims 1 to 7, characterized in that it is a cylindrical roller bearing.
9. Roller bearing according to one of claims 1 to 7, characterized in that it is a taper roller bearing.

10. Roller bearing according to one of claims 1 to 7, characterized in that it is a spherical roller bearing.

5 11. Roller bearing according to one of claims 1 to 7, characterized in that it is a toroidal roller bearing.

10 12. Roller bearing according to one of claims 1 to 11, characterized in that the sensor elements (8, 9) are electrically connected with a control unit (12), which is located on or in the cage (5).

15 13. Roller bearing according to claim 12, characterized in that the control unit (12) is electrically connected with or comprises a power supply (13).

20 14. Roller bearing according to claim 13, characterized in that the power supply (13) is a battery.

25 15. Roller bearing according to claim 13, characterized in that the power supply (13) is a receiving element for receiving energy wireless from an external source.

16. Roller bearing according to one of claims 12 to 15, characterized in that the control unit (12) is electrically connected with or comprises a data interface (14).

17. Roller bearing according to claim 16, characterized in that the data interface (14) is designed for a wireless data transfer.

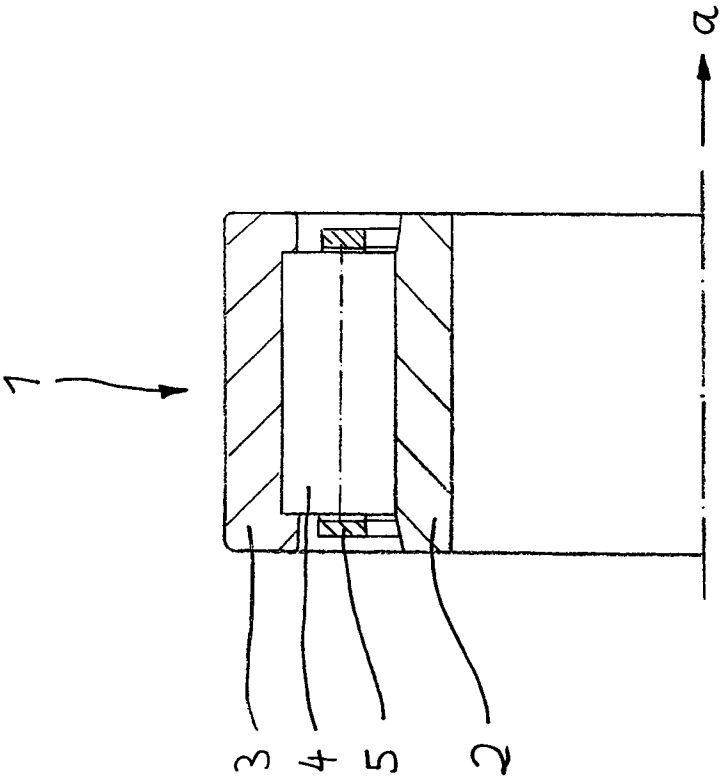


Fig. 1

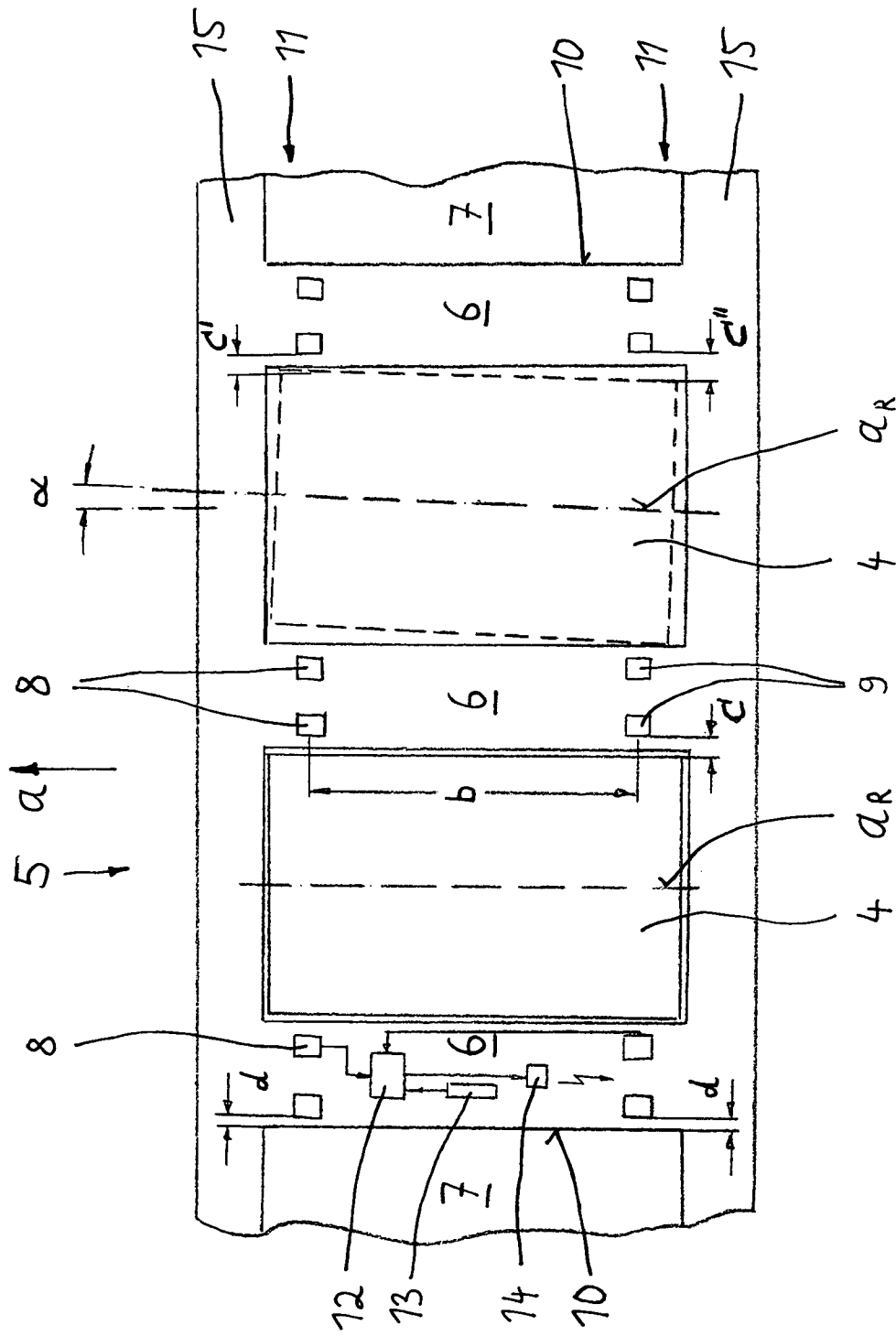


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/007867

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16C19/52 F16C33/46 F16C41/00
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 G01M G01D H02K

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	US 2008/159674 A1 (VARONIS ORESTES J [US]) 3 July 2008 (2008-07-03) cited in the application paragraphs [0002], [0007], [0008], [0030], [0031], [0032], [0043], [0044], [0060] sentences 1-3, 12-13, paragraph 40 sentences 7-12, paragraph 45 sentences 1-4,12-16,20-23, paragraph 61 figures 2, 7, 11	1-17
X	US 5 226 736 A (BECKER DIETER [DE] ET AL) 13 July 1993 (1993-07-13) cited in the application	1,4,6, 8-17
Y	column 1, lines 6-7, 50-53 column 2, lines 8-46 figures 1, 2	7
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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.

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Date of the actual completion of the international search

22 August 2011

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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

Dumont, Marie-Laure

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/007867

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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