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

(72) Inventor; and
(71) Applicant *(for SC only)*: **GUAN, Ran** [CN/CN]; Room 401, Building 143, Lane 568, Luoyang Road, Minhang District, Shanghai 201104 (CN).

(72) Inventor: **JIA, Xianlin**; 405, Building 5, No 199, Lvdi Road, Huaqiao Town, Kunshan, Jiangsu 215001 (CN).

(74) Agent: **LINDA LIU & PARTNERS**; F16 Tower C, Beijing Global Trade Center, 36 North Third Ring East Road, Dongcheng District, Beijing 100013 (CN).

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(54) Title: BEARING ASSEMBLY

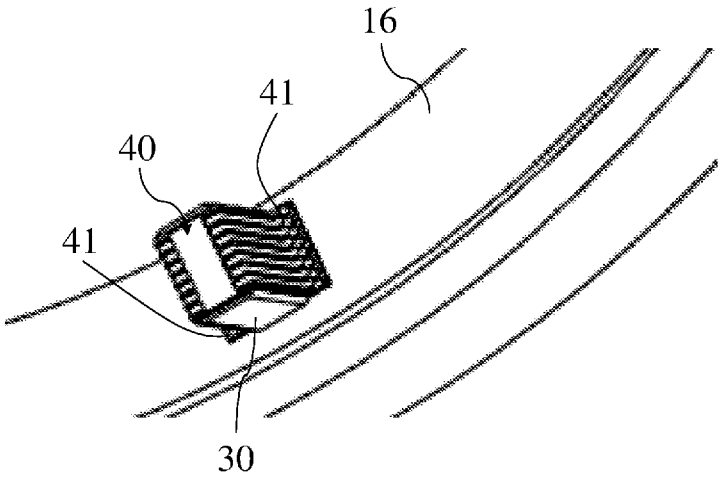


FIG. 3

(57) Abstract: A bearing assembly comprising: an outer ring arrangement (11) configured for connecting with the first partner in a rotationally fixed manner; an inner ring arrangement (12) configured for connecting with the second partner in a rotationally fixed manner; a first following component and a second following component both fixed on the outer ring arrangement (11); a pin (30) welded on the first following component and matched with a position-limiting portion on the second following component; and a crack sensor (40) of which a base part connects to the pin (30) and a remote part connects to the first following component. Electric current can flow between the base part and the remote part to generate a signal for detecting if the pin (30) is fixed safely with the first following component.

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SPECIFICATION

BEARING ASSEMBLY

TECHNICAL FIELD

This disclosure relates to a bearing, more specifically to a wheelset bearing device for vehicles.

BACKGROUND

Figure 1 shows a cross sectional view of a known wheelset bearing device (also being referred to below as "bearing") for railway vehicles. The bearing comprises an outer ring arrangement 11, an inner ring arrangement 12, a multitude of rollers 13, a cage 14, a housing 15 and a seal cap 16. Similar bearings are disclosed such as in WO2007/065413.

To monitor the working condition of the bearing, it further comprises a temperature sensor 20. The temperature sensor 20 is used to monitor temperature continuously to find potential problems while the bearing is in operation, so that there can be enough time to take remedial actions to avoid vehicle accidents.

The main body of the temperature sensor 20 is fixed on the housing 15 while the strain gauge of the temperature sensor 20 is attached on the seal cap 16. Normally, the housing 15, the outer ring arrangement 11, the seal cap 16 and the temperature sensor 20 remain stationary relative to each other.

However, the load on the axle housing will unexpectedly cause the outer ring arrangement 11 to rotate relative to the housing 15. The rotation of the outer ring arrangement 11 may further causes the seal cap 16 to rotate relative to the housing 15, which could make the connecting line between the strain gauge and the main body of the temperature sensor 20 break, causing a failure of the temperature sensor 20.

As shown in Figure 2, one possible way to solve the above problem is to fix a welding pin 30 on a face of the seal cap 16 facing the housing 15, while there are two blocks 151 acting as a position-limiting portion formed on the housing 15. The two blocks 151 locates at two circumferential sides of the pin 30 to sandwich the pin 30, so that the rotation of the seal cap 16 together with the pin 30 relative to the housing 15 can be prohibited.

Unfortunately, there is still a risk that the welded joint or the weld seam may break when the bearing endures high impact load. Then the temperature sensor 20 may break due to the relative rotation between the seal cap 16 and the housing 15.

SUMMARY

An object of this disclosure is to overcome or at least alleviate at least one of the above-mentioned shortcomings in the prior art, and to provide a bearing assembly whose working condition can be monitored effectively.

According to this disclosure, there is provided a bearing assembly used to connect a first partner and a second partner designed to rotate relative to each other, comprising:

an outer ring arrangement configured for connecting with the first partner in a rotationally fixed manner;

an inner ring arrangement configured for connecting with the second partner in a rotationally fixed manner;

a multitude of rollers located between the outer ring arrangement and the inner ring arrangement;

a first following component and a second following component both fixed on the outer ring arrangement;

a pin welded on the first following component and matched with a position-limiting portion on the second following component, so as to ensure the first following component and the second following component keep stationary relative to each other; and

a crack sensor of which a base part connects to the pin and a remote part connects to the first following component, wherein electric current can flow between the base part and the remote part to generate a signal for detecting if the pin is fixed safely with the first following component.

In at least one embodiment, the crack sensor comprises a middle electrode as a part of the base part and one or more branch electrodes forming at least a part of the remote part and connecting with the middle electrode, while the middle electrode is configured for connecting to a voltage source, and the branch electrode is configured for connecting to a detect unit for detecting if the branch electrode is break.

In at least one embodiment, each of the branch electrodes is connected to an AD converter for converting the voltage outputting from the branch electrode as one or zero.

In at least one embodiment, the quantity of the branch electrodes is more than two, and the branch electrodes are set in two lines and array at two circumferential sides of the middle electrode, wherein the circumferential direction is the direction along which the inner ring arrangement rotating relative to the pin.

In at least one embodiment, the branch electrode has an elongate shape.

In at least one embodiment, the crack sensor further comprises a flexible base sheet, and the middle electrode and the branch electrodes are fixed on one face of the base sheet.

In at least one embodiment, the crack sensor extends through a weld seam between the pin and the first following component.

In at least one embodiment, the bearing assembly further comprising a condition sensor penetrating into the second following component and touching the first following component.

In at least one embodiment, the condition sensor is a temperature sensor, and the body of the temperature sensor is fixed on the second following component while a strain gauge of the temperature sensor is attached on the first following component.

In at least one embodiment, the bearing assembly is used for a wheelset of a railway vehicle, and the first partner is an axle housing while the second partner is an axle,

the first following component is a seal cap arranged at one axial end of the outer ring arrangement and covering a radical gap between the outer ring arrangement and the inner ring arrangement,

the second following component is a housing covering the seal cap and the outer ring arrangement at an axial end, and

the pin locates between the housing and the seal cap in an axial direction.

In this disclosure, the first following component of the bearing and the second following component of the bearing are prevented to rotate relatively to each other by the pin, and also the working condition of the pin can be monitored effectively.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view of a known wheelset bearing.

FIG. 2 is a schematic three-dimensional view of the bearing in FIG. 1.

FIG. 3 is a partial schematic three-dimensional view of one embodiment of the bearing of this disclosure.

FIG. 4 is a magnifying view of one embodiment of the crack sensor covering the pin of this disclosure.

DESCRIPTION OF REFERENCE SIGNS

11 outer ring arrangement, 12 inner ring arrangement, 13 roller, 14 cage,

15 housing, 16 seal cap,

20 temperature sensor,

30 pin,

40 crack sensor, 41 connecting area,

401 base sheet, 402 middle electrode, 403 branch electrode.

DETAILED DESCRIPTION

Exemplary embodiments of this disclosure will be described below with reference to the drawings. It should be understood that these specific descriptions are only intended to teach those skilled in the art how to practice this disclosure, and are not intended to be exhaustive of all possible ways of carrying out this disclosure or to limit the scope of this disclosure.

Unless defined otherwise, the adjective "axial" is used with reference to the direction of the axis of the bearing, the adjective "radial" is used with reference to the radial direction of the bearing, and the adjective "circumferential" is used with reference to the circumferential direction of the bearing.

An improvement of this disclosure lies in an additional part, which is the crack sensor 40, using to monitor the condition of the pin 30.

According to this disclosure, other parts of the bearing except for the crack sensor 40 could remain as before. So in order to make an easy description, figure 1 and figure 2 will be introduced again to show the main structure of the bearing assembly of this disclosure.

The wheelset bearing assembly comprises an outer ring arrangement 11, an inner ring arrangement 12 and a plurality of rollers 13 between the inner ring arrangement 12 and the outer ring arrangement 11.

The inner ring arrangement 12 comprises two inner rings adjacent to each other in the axial direction. The inner ring arrangement 12 is designed for supporting an axle in a rotationally fixed manner (which means the two parts will not rotate relative to each other). In operation, the inner ring arrangement 12 rotates together with the axle.

The outer ring arrangement 11 is designed to connect to an axle housing in a rotationally fixed manner.

The wheelset bearing assembly further comprises a seal cap 16 as a first following component which is arranged at one axial end of the outer ring arrangement 11, and fixed on the outer ring arrangement 11. The seal cap 16 covers the radical gap between the outer ring arrangement 11 and the inner ring arrangement 12 for sealing against dirt.

The wheelset bearing assembly further comprises a housing 15 as a second following component. The housing 15 is located at one axial end of the outer ring arrangement 11 to cover the outer ring arrangement 11. The outer ring arrangement 11 and the housing 15 are fixed on each other.

To monitor the operation condition, the wheelset bearing assembly further comprises a temperature sensor 20 as a condition sensor. The main body of the temperature sensor 20 is fixed on the housing 15, and penetrates into the housing 15 so that the strain gauge (not depicted in the figures) of the temperature sensor 20 is attached on the surface of the seal cap 16.

To prevent movement between the seal cap 16 and the housing 15, there are two blocks 151 formed on the housing 15. The two blocks 151 are formed on the inner wall of the housing 15 facing the seal cap 16, and protrude toward the seal cap 16. The two blocks 151 are circumferentially aligned with a notch between them. The notch provides a room to accommodate the pin 30. Once the seal cap 16 rotates relative to the housing 15, the pin 30 will be blocked by either block 151, so that the rotation of the seal cap 16 is stopped.

Figure 3 and figure 4 show the structure of the crack sensor 40 and its connecting way with other parts of the bearing assembly.

The pin 30 is covered by the crack sensor 40. The crack sensor 40 is in a form of sheet, and can be shaped according to the profile of the pin 30 as it covers the pin 30.Two end parts of the crack sensor 40 stretch from the surface of the pin 30 to the surface of the seal cap 16, and the two end parts are finally fixed on the seal cap 16 at two circumferential sides of the seal cap 16, constituting two connecting areas 41. And the middle part of the crack sensor 40 is preferably fixed on the pin 30.

The crack sensor 40 comprises a base sheet 401 and an electrode part.

The electrode part is attached to the base sheet 401. The base sheet 401 is a flexible substrate coating with high resistivity layer, so that it can give the electrode part a safe and stable base. With the base sheet 401, the electrode part is easy to form and keeps its designed pattern, and the electrode part can be insulated from the outer environment. The base sheet 401 being flexible means that, the shape of the base sheet 401 is easy to be changed so it can be smoothly pressed on the pin 30 and the seal cap 16. Moreover, the malleability of the base sheet 401 may be higher than that of the electrode part, so that when a tiny crack occurs on the weld seam, the electrode part (one or more branch electrodes 403 mentioned below) will break to give a signal while the base sheet 401 can still keep unbroken to provide a safe base.

Preferably, the base sheet 401 is attached to the pin 30 and the seal cap 16 through hot melting process. In other embodiments, the base sheet 401 can also be attached to the pin 30 and the seal cap 16 by glue or other sticky materials. Preferably, the base sheet 401 is attached to the weld seam which is formed between the pin 30 and the seal cap 16, while the weld seam normally forms a ring around the pin 30 welded on the seal cap 16.

The electrode part is attached on one face of the base sheet 401 and coated with high resistivity material on its outer surface. The electrode part comprises a middle electrode 402 (also named as a base part) and a plurality of branch electrodes 403 (also named as a remote part). The branch electrodes 403 are set in two lines and array at both circumferential sides of the middle electrode 402, while in this embodiment, each line includes eight branch electrodes 403. Each branch electrode 403 has an elongate shape with one end connecting to the middle

electrode 402 and the other end (also named as remote end) stretches to the same-side connecting area 41. The two lines of branch electrodes 403 are axial symmetry.

In the example shown in figure 4, the middle electrode 402 is located at the middle portion of the inner surface of the pin 30, and the branch electrodes 403 stretch to two sides in the circumferential direction of the pin 30 from the middle electrode 402. To be specific, the one end of the electrode 402 connects to the middle electrode 402 on the inner surface side of the pin 30, and the other end of the branch electrode 402 is located on the inner surface side of the seal cap 16 after extending across the weld seam between the pin 30 and the seal cap 16. The middle portion of the branch electrode 402 is located at a side surface of the pin 30 in the circumferential direction.

The middle electrode 402 is connected to a stable voltage source, and each branch electrode 403 is connected to an AD converter (Analog to Digital converter) at its remote end and then to a detect unit. When the whole branch electrode 403 is connected well with the middle electrode 402, the AD converter will receive a high level signal and output a digital signal of one, otherwise the AD converter will receive a low level signal and output a digital signal of zero.

Since each branch electrode 403 has a thin and elongate shape, when the weld seam between the pin 30 and the seal cap 16 cracks, or even worse when the pin 30 moves relatively to the seal cap 16, the branch electrode 403 will break, so that the AD converter will output a digital signal of zero as a detecting signal.

It is easy to understand that the weld seam at the two circumferential sides of the pin 30 have a higher possibility to break than at other areas, so the crack sensor 40 is preferably designed to cover these two areas, and also the branch electrodes 403 are preferably designed to stretch through these areas. However, in other embodiments, the crack sensor 40 can also be positioned at other areas of and near the pin 30; or there may be more than one crack sensor 40 covering other areas of and near the pin 30; or the branch electrodes 403 of one crack sensor 40 may together form other patterns.

Since there are multiple branch electrodes 403, the crack area being detected is divided into several tiny areas, while each branch electrode 403 detects one area. With a large number of the branch electrodes 403, not only the detecting precision is raised, but also the proximate length or the relative length of the crack can be found. For example, two signals of zero out of all sixteen signals represent a smaller crack than 5 signals of zero out of all sixteen signals.

With the crack sensor 40, an early damage of the pin 30 can be detected. While the early damage means there is only a small crack between the pin 30 and the seal cap 16, and the pin 30 still has a certain connection with the seal cap 16. From an early damage to the wholly

damage when the pin 30 is separated from the seal cap 16, there is enough time for the operator to take action before the seal cap 16 rotates and the temperature sensor 20 breaks.

A maintenance method can be as following. Once one of the AD converters outputs a signal of zero, the maintenance operation is being started, such as to stop the vehicle at the earliest proper time and to check the condition of the pin 30.

Another alternative maintenance method relates to considering the risk grade. Different numbers of signals of zero represent different risk grades. For example one to two signals of zero out of all sixteen signals represent a level I risk grade, while three to four signals of zero out of all sixteen signals represent a level II risk grade. Once a typical risk grade is reached, an immediate maintenance operation should be started.

This disclosure has at least one of the following advantages:

(i) A pin 30 is used to ensure that the seal cap 16 and the housing 15 will not rotate relative to each other, and the crack sensor 40 can monitor if the pin 30 is well fixed.

(ii) An early damage of the pin 30 can be alarmed before the pin 30 moves relative to the seal cap 16, and even the crack length can be known, which helps to prevent the performance failure of the temperature sensor 20 or even the vehicle.

(iii) The crack sensor 40 has a simple structure and a simple working process.

(iv) The crack sensor 40 is easy to be installed, and it will not occupy too much room inside the bearing.

Although the embodiments of this disclosure have been described above, it will be appreciated that the above descriptions are merely exemplary, but not exhaustive; and that the disclosed embodiments are not limiting. A number of variations and modifications may occur to one skilled in the art without departing from the scopes and spirits of the described embodiments. For example,

(i) Unlike that the electrode part is set on the outer face of the base sheet 401 shown in figure 4, the electrode part can be fixed on the other face of the base sheet 401, which means that the electrode part may locate between the base sheet 401 and the pin 30. In other embodiments, the base sheet 401 can even be omitted by coating all over the electrode part with high resistivity material.

(ii) The temperature sensor 20 can be changed to other sensors, as long as the sensor has two parts locating respectively on a first following component of the bearing (e.g. the seal cap 16 or the outer ring arrangement 11) and a second following component of the bearing (e.g. the housing 15), because the first following component and the second following component are designed to do not rotate but still has a risk to rotate relative to each other, so it is meaningful to detect if the rotation occurs.

(iii) Although a wheelset bearing used for railway vehicles is introduced as an embodiment, the bearing assembly of this disclosure can also be applied in other vehicles or machines.

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CLAIMS

1. A bearing assembly used to connect a first partner and a second partner designed to rotate relative to each other, comprising:

an outer ring arrangement (11) configured for connecting with the first partner in a rotationally fixed manner;

an inner ring arrangement (12) configured for connecting with the second partner in a rotationally fixed manner;

a multitude of rollers (13) located between the outer ring arrangement (11) and the inner ring arrangement (12);

a first following component and a second following component both fixed on the outer ring arrangement (11);

a pin (30) welded on the first following component and matched with a position-limiting portion on the second following component, so as to ensure the first following component and the second following component keep stationary relative to each other; and

a crack sensor (40) of which a base part connects to the pin (30) and a remote part connects to the first following component, wherein electric current can flow between the base part and the remote part to generate a signal for detecting if the pin (30) is fixed safely with the first following component.

2. The bearing assembly of claim 1, wherein the crack sensor (40) comprises a middle electrode (402) as a part of the base part and one or more branch electrodes (403) forming at least a part of the remote part and connecting with the middle electrode (402), while the middle electrode (402) is configured for connecting to a voltage source, and the branch electrode (403) is configured for connecting to a detect unit for detecting if the branch electrode (403) is break.

3. The bearing assembly of claim 2, wherein each of the branch electrodes (403) is connected to an AD converter for converting the voltage outputting from the branch electrode (403) as one or zero.

4. The bearing assembly of claim 2 or 3, wherein the quantity of the branch electrodes (403) is more than two, and the branch electrodes (403) are set in two lines and array at two circumferential sides of the middle electrode (402), wherein the circumferential direction is the direction along which the inner ring arrangement (12) rotating relative to the pin (30).

5. The bearing assembly of any one of claims 2 to 4, wherein the branch electrode (403) has an elongate shape.

6. The bearing assembly of any one of claims 2 to 5, wherein the crack sensor (40) further comprises a flexible base sheet (401), and the middle electrode (402) and the branch electrodes

(403) are fixed on one face of the base sheet (401).

7. The bearing assembly of any one of claims 1 to 6, wherein the crack sensor (40) extends through a weld seam between the pin (30) and the first following component.

8. The bearing assembly of any one of claims 1 to 7 further comprising a condition sensor penetrating into the second following component and touching the first following component.

9. The bearing assembly of claim 8, wherein the condition sensor is a temperature sensor (20), and the body of the temperature sensor is fixed on the second following component while a strain gauge of the temperature sensor is attached on the first following component.

10. The bearing assembly of any one of claims 1 to claim 9, wherein the bearing assembly is used for a wheelset of a railway vehicle, and the first partner is an axle housing while the second partner is an axle,

the first following component is a seal cap (16) arranged at one axial end of the outer ring arrangement (11) and covering a radical gap between the outer ring arrangement (11) and the inner ring arrangement (12),

the second following component is a housing (15) covering the seal cap (16) and the outer ring arrangement (11) at an axial end, and

the pin (30) locates between the housing (15) and the seal cap (16) in an axial direction.

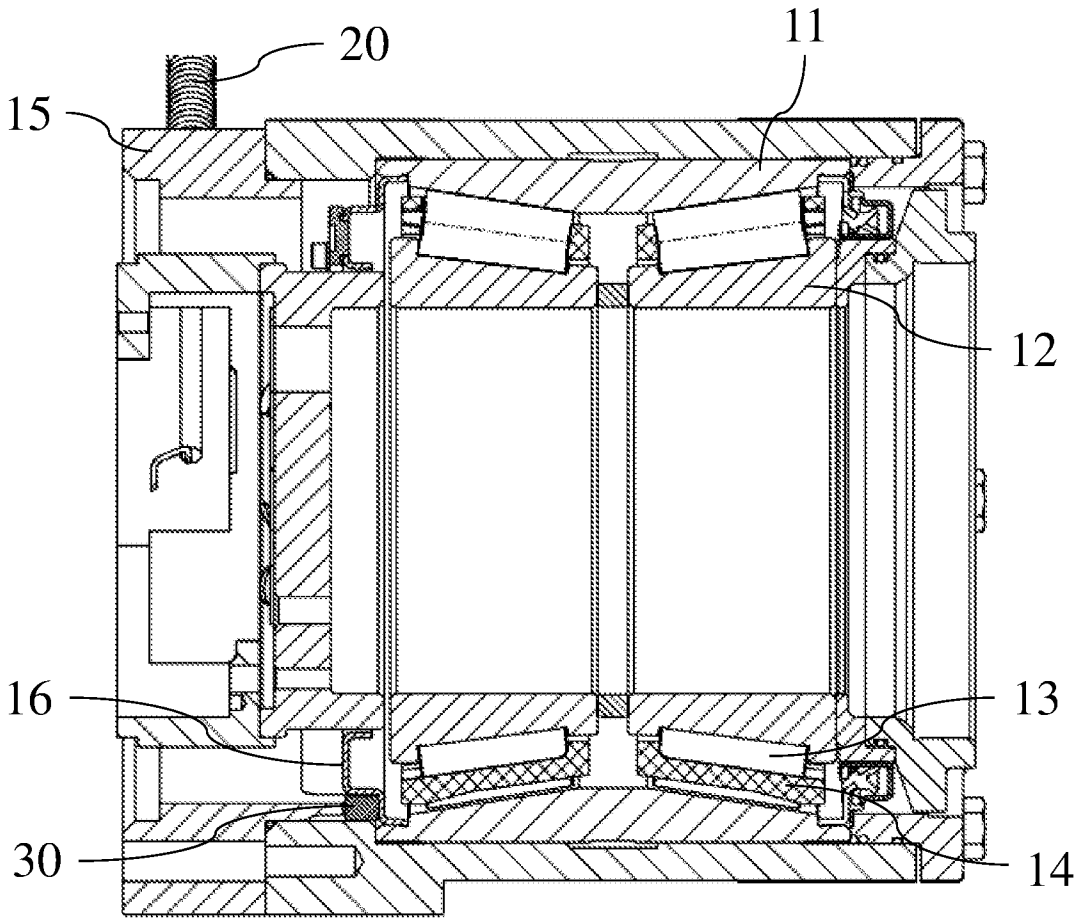


FIG. 1

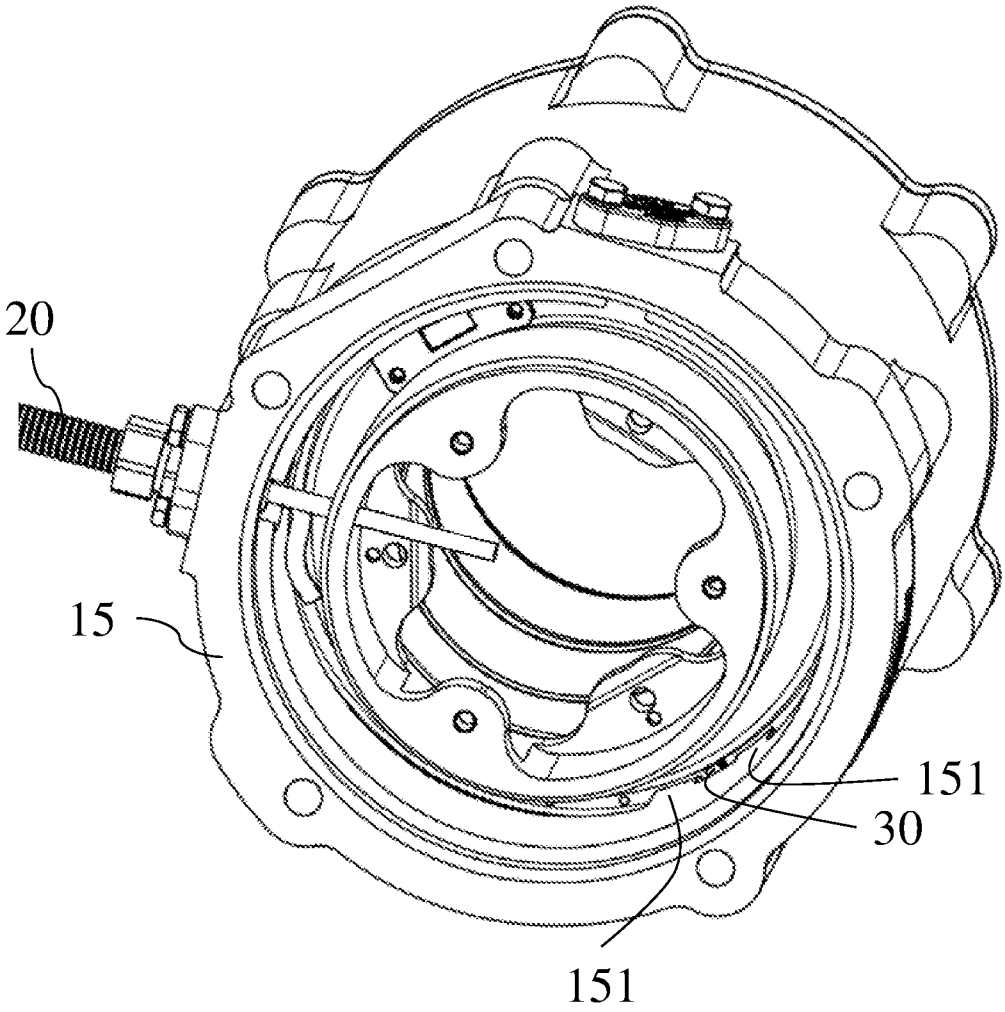


FIG. 2

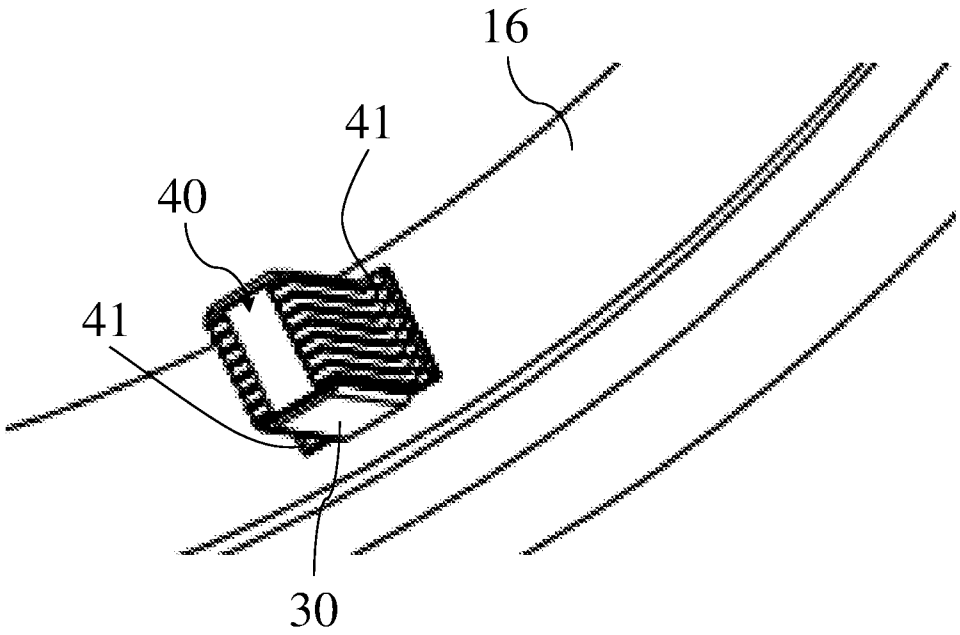


FIG. 3

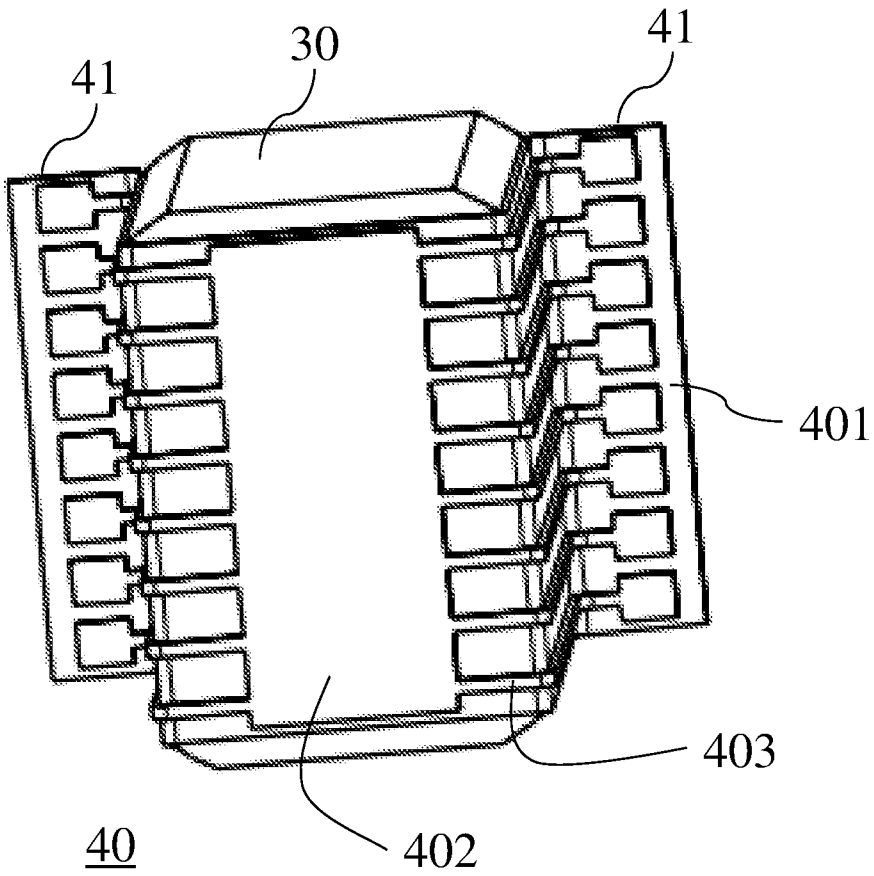


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

F16C 41/00(2006.01)i; B61F 15/20(2006.01)i; G01P 3/44(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; B61F; G01P

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)

VEN;CNABS;CNKI:wheel,cap,set,house,sensor,limit+,electric,crack,electrode,pin,bearing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
24 May 2019	**27 June 2019**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer **XU,Yuan** Telephone No. **86-10-62089943**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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