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(54) **Title**: CRANKSET ASSEMBLY FOR A BICYCLE AND BICYCLE EQUIPPED WITH SUCH A CRANKSET ASSEMBLY

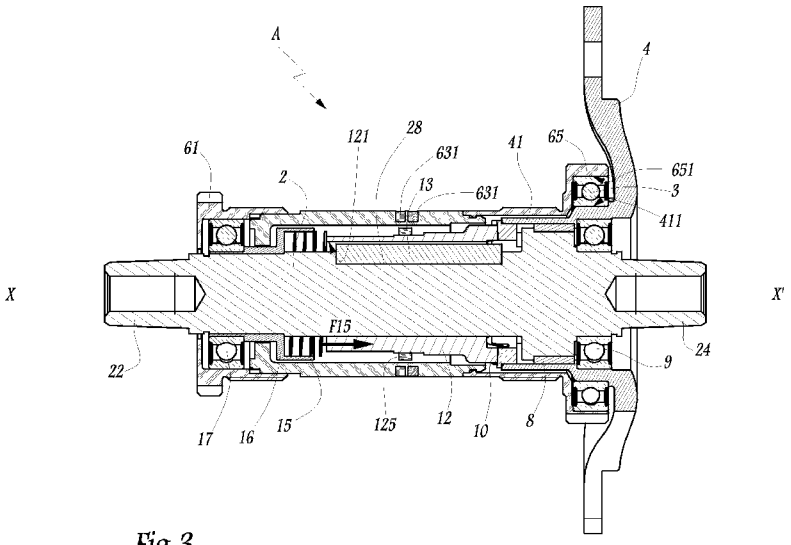

Fig.3

(57) **Abstract**: This crankset assembly (A) for a bicycle comprises a bracket shaft (2) connected by a first end (22) to a left pedal and by a second end (24) to a right pedal, and a coupling device (8) to transmit, from the bracket shaft (2) to a chain ring (4) of the assembly (A), a torque delivered by a user on each pedal. The coupling device (8) is adapted to generate an angular offset between the bracket shaft (2) and the chain ring (4). The crankset assembly comprises means (12, 125, 631) to determine the torque delivered by the user on one of the pedals on the basis of this angular offset.

WO 2013/041900 A1

CRANKSET ASSEMBLY FOR A BICYCLE AND BICYCLE EQUIPPED WITH SUCH A CRANKSET ASSEMBLY

TECHNICAL FIELD OF THE INVENTION

The invention concerns a crankset assembly for a bicycle. The invention also concerns a bicycle equipped with such a crankset assembly.

BACKGROUND OF THE INVENTION

Some bicycles are equipped with a torque sensor adapted to determine the torque delivered by the user of the bicycle on the bracket. This torque sensing feature can be used to provide torque assistance, for example in an ascending slope. This torque sensing feature can be realized either in a static or in a moving mode.

Some prior art techniques use a torsion bar which creates an angular offset between the chain ring and the pedals, in order to determine the torque delivered by the user on the basis of this angular offset. This technique allows only determining the torque delivered on the left pedal, or more generally on the pedal which is not fast in rotation with the chain ring. As the right pedal is generally fast in rotation with the chain ring, the torque sensing in static mode is not possible.

It is also known from US-A-2011/006760 to determine torque by sensing the rotation of the bracket shaft. As this technique uses a shaft which is fast in rotation with both pedals and with the chain ring, torque sensing in static mode is not possible. Actually, rotation of the bracket shaft can only be sensed when the bicycle starts moving, so that a torque delivered in static mode cannot be sensed. When torque assistance is required as the bicycle is not moving, in particular when starting on an ascending slope, the torque delivered by the user cannot be sensed and torque assistance cannot be delivered at the right time.

SUMMARY OF THE INVENTION

The aim of the invention is to provide a new crankset assembly for a bicycle allowing performing torque sensing with both left and right pedals in static and moving periods.

To this end, the invention concerns a crankset assembly for a bicycle comprising a bracket shaft connected by a first end to a left pedal and by a second end to a right pedal, and a coupling device to transmit, from the bracket shaft to a chain ring of the assembly, the torque delivered by a user on each pedal. This crankset assembly is characterized in that the means to transmit the torque delivered by the user are adapted to generate an angular offset between the bracket shaft and the chain ring, and in that the crankset

assembly further comprises means to determine the torque delivered by the user on the basis of the angular offset.

Thanks to the invention, the possibility to create an angular offset between the bracket shaft and the chain ring allows to sense the torque delivered on one of the pedals when the bicycle is stopped. Moreover, the torque sensing is efficient on either of the pedals of the bicycle.

According to further aspects of the invention which are advantageous but not compulsory, such a crankset assembly may incorporate one or several of the following features:

- The coupling device comprises at least one elastically deformable element.

- A first portion of the elastically deformable element is fast in rotation with the bracket shaft, while a second portion of the elastically deformable element is fast in rotation with the chain ring.

- The bracket shaft is inserted in the elastically deformable element, and whereas said elastically deformable element is inserted in the chain ring.

- The elastically deformable element is made of a polymeric, an elastomeric or a metallic material.

- The elastically deformable element comprises cavities respectively adapted to cooperate, on an inner side, with protruding ribs of the bracket shaft, and on the outer side, with protruding ribs of the chain ring.

- The elastically deformable element is annular, whereas a first annular surface of the elastically deformable element is fixed to the bracket shaft by a first set of bolts, and whereas a second annular surface of the elastically deformable element is fixed to the chain ring holder by a second set of bolts.

- The coupling device comprises at least one spring.

- The spring is a leaf springs or a leaf springs set.

- The means for determining the torque delivered by the user on one of the pedals comprise means to generate, from the angular offset, a translational motion of a movable part of the assembly.

- The movable part is a sleeve movable along the longitudinal axis of the bracket shaft.

- The means to generate a translational motion comprise, on an axially-oriented peripheral circular edge of an element fast in rotation with the chain ring, sloped surfaces adapted to make a sliding contact with corresponding sloped surfaces of the movable sleeve.

- The movable sleeve is guided in translation and fast in rotation with the bracket shaft by at least one key.

- The means for determining the torque delivered by the user comprise a target ring fast in translation with the movable sleeve, and two electrically fed coils carried by a fixed part of the assembly.

- The means for determining the torque delivered by the user on one of the pedals comprise means to sense the angular offset.

- The means to sense the angular offset comprise a Hall effect sensor adapted to sense magnetic field variations generated by a relative rotation of a magnetized ring fast in rotation with the bracket shaft with respect to a magnetized ring fast in rotation with the chain ring.

- The means to sense the angular offset comprise a Hall effect sensor adapted to sense magnetic field variations generated, on a magnetic field emitted by a magnetized ring, by a relative rotation of a slotted disk fast in rotation with the bracket shaft with respect to a slotted disk fast in rotation with the chain ring.

- The crankset assembly comprises means to limit the rotation of the chain ring with respect to the bracket shaft.

The invention also concerns a bicycle equipped with a crankset assembly as mentioned here-above.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be explained in correspondence with the annexed figures, and as an illustrative example, without restricting the object of the invention. In the annexed figures:

- figure 1 is a perspective view of a crankset assembly according to the invention;
- figure 2 is an exploded perspective view of the crankset assembly of figure 1;
- figure 3 is a longitudinal sectional view of the crankset assembly of figures 1 and 2;
- figure 4 is a view similar to figure 1, on which external parts and a movable sleeve are partly hidden;
- figure 5 is a perspective view of a bracket shaft of the crankset assembly of figures 1 to 4;
- figure 6 is a side view, at a larger scale and from a different angle, of the bracket shaft of figure 5;
- figure 7 is a partially exploded perspective view of a bracket shaft, an elastic element and a chain ring holder belonging to the crankset assembly according to the invention;

- figure 8 is a side view of the bracket shaft, the elastic element and the chain ring holder of figure 7;

- figure 9 is a sectional view of the bracket shaft, the elastic element and the chain ring holder of figures 7 and 8, along plane IX on figure 8;

- figure 10 is a partially exploded perspective view of a bracket shaft, an elastic element and a chain ring holder belonging to a crankset assembly according to a second embodiment of the invention;

- figure 11 is a side view along arrow XI of the bracket shaft, the elastic element and the chain ring holder of figure 10;

- Figure 12 is a sectional view along line XII of the bracket shaft, the elastic element and the chain ring holder of figures 10 and 11.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

The crankset assembly A represented on the figures is adapted to be mounted in the frame of a non-shown bicycle. Crankset assembly A comprises a bracket shaft 2, equipped at a first left end 22 with means for fastening a non-shown left pedal, and on a second right end 24 with means for fastening a non-shown right pedal.

In the vicinity of right end 24, assembly A comprises a chain ring 4 represented by a chain ring holder having a five-star shape in which a non-shown toothed ring is adapted to receive the chain of the bicycle.

Crankset assembly A comprises a left cover 61, a central cylindrical cover 63 and a right cover 65. Left and right covers are adapted to be fast with central cover 63 in a non-shown bore of the frame of the bicycle in which crankset assembly A is mounted.

Axis X-X' denotes that longitudinal axis of bracket shaft 2 and also the rotation axis of assembly A.

Chain ring holder 4 comprises an axial cylindrical portion extending along axis X-X' opposite from right end 24. Chain ring holder 4 is rotatable with respect to right cover 65 thanks to a rolling bearing 3, which is mounted between an inner cylindrical surface 651 of cover 65 and an outer cylindrical surface 411 of axial portion 41.

Bracket shaft 2 comprises protruding ribs 26 which extend radially from an outer peripheral surface 25 in the vicinity of right end 24. Bracket shaft 2 comprises preferably four protruding ribs 26 opposed by pairs with respect to axis X-X'. Protruding ribs 26 are approximately parallepiped-shaped.

On an inner cylindrical surface 413 of axial portion 41, chain ring holder 4 comprises protruding ribs 415 which have substantially the same shape as protruding ribs 26.

Chain ring holder 4 comprises preferably four ribs 415 opposed by pairs with respect to axis X-X'.

Protruding ribs 415 and protruding ribs 26 face each other radially with respect to axis X-X' and are preferably angularly offset by 45° so that, for example, one rib 415 is located between two ribs 26.

Crankset assembly A comprises a coupling device between bracket shaft 2 and chain ring holder 4. This coupling device is an elastically deformable element 8 which is inserted between protruding ribs 26 and protruding ribs 415. Deformable element 8 therefore comprises, on an inner side, cavities 81 corresponding to protruding ribs 26, and on an outer side, cavities 83 corresponding to protruding ribs 415. Inner cavities 81 are angularly offset with respect to outer cavities 83. An outer surface of deformable element 8 is fast in rotation with chain ring holder 4, while an inner surface of deformable element 8 is fast in rotation with bracket shaft 2.

Between inner cavities 81 and outer cavities 83, deformable element 8 comprises intermediate portions 811 on the left of inner cavities 81, and 813 on the right of inner cavities 81. The terms "left" and "right" are used with reference to the orientation of figure 7. A left intermediate portion 811 is larger than a right intermediate portion 813 in the circumferential direction. This allows, when bracket shaft 2 is rotated along arrow A1, to create an angular offset between the rotation of bracket shaft 2 and the rotation of chain ring holder 4. The elastic properties of elastic element 8 allow de-correlating the rotation of bracket shaft 2 with respect to the rotation of chain ring holder 4. This permits to detect the torque delivered by the user on one of the pedals, even if the bicycle is stopped. The sensing of the angular offset between bracket shaft 2 and chain ring holder 4 permits to determine the torque delivered by the user.

Elastically deformable element 8 is preferably in a plastic material, and more preferably in a polymeric or elastomeric material. Alternatively, elastically deformable element 8 can be in a metallic material.

Relative rotation of bracket shaft 2 with respect to chain ring holder 4 is permitted by a bearing 9 mounted along axis X-X' on an outer surface of bracket shaft 2 and on an inner surface of chain ring holder 4.

In order to determine the torque, crankset assembly A comprises means to transform the angular offset into a translational motion. To this end, assembly A comprises an element fast in rotation with chain ring 4, which can be defined as a motion transformation ring 10. Motion transformation ring 10 is centered around axis X-X' and fast in rotation with chain ring holder 4 thanks to striker pins 101 protruding from an external surface of ring 10 and adapted to be received in corresponding slots 417 which open in

the axial edge 419 of axial portion 41 oriented towards left end 22. On an axially-oriented peripheral circular edge of ring 10, ring 10 comprises sloped surfaces 103. Sloped surfaces 103 are oriented along planes which make an angle with respect to a plane perpendicular to axis X-X'. Motion transformation ring 10 preferably comprises several sloped surfaces 103 regularly distributed around the circumference of ring 10.

Crankset assembly A further includes a part adapted to move in a translational motion along axis X-X' with respect to shaft 2. This movable part is a sleeve 12 which is fast in rotation with bracket shaft 2 thanks to keys 13, which extends parallely to axis X-X' and are housed in corresponding slots 28 of bracket shaft 2. Sleeve 12 is mounted on keys 13 and on bracket shaft 2 so as to translate along axis X-X'. The translation of sleeve 12 along axis X-X' is guided by keys 13, which slide in corresponding slots 121 of sleeve 12. Assembly A preferably comprises three keys 13.

On an axially oriented edge, sleeve 12 comprises sloped surfaces 123 having a shape corresponding to sloped surfaces 103 and adapted to make a sliding contact with sloped surfaces 103.

Sloped surfaces 123 are kept in contact against sloped surfaces 103 thanks to a spring 15 which exerts a compression force F15 on sleeve 12. Spring 15 is mounted between sleeve 12 and a part 16 which is fast in rotation with shaft 2.

Assembly A further comprises a bearing 17 mounted between an inner surface of left cover 61 and an outer surface of part 16, which allows rotation of bracket shaft 2 with respect to left cover 61. As an alternative embodiment, bearing 17 may be mounted directly on an outer surface of bracket shaft 2.

The crankset assembly works in the following way: when the user pushes on one of the pedals of the bicycle, a rotation around axis X-X' is transmitted to bracket shaft 2, as shown by arrow A1. This rotation, which is de-correlated from the rotation of chain ring holder 4, creates an angular offset thanks to elastic element 8. The left portions 811 of deformable element 8 are compressed during this period, allowing an angular offset of a few degrees.

The rotation of bracket shaft 2 is transmitted to sleeve 12 thanks to keys 13, as shown by arrows A2. Sloped surfaces 123 of sleeve 12 are kept in contact against sloped surfaces 103 of ring 10 by spring 15, and ring 10 is fixed in translation with respect to the whole assembly A. As a result, the sliding cooperation between sloped surfaces 123 and sloped surfaces 103 induces a translation motion of sleeve 12 along axis X-X', as shown by arrow A3. This means the angular offset obtained thanks to deformable element 8 is transformed into a proportional translational motion which can be sensed in order to determine the torque delivered by the user to the pedals.

The relative rotation of bracket shaft 2 with respect to chain ring holder 4 is limited by axial fingers 105 of ring 10 which are axially inserted into holes 30 distributed in a radially extending annular wall 31 of bracket shaft 2. This permits to deliver the torque created by the user to the chain ring holder 4 once the torque determination has been made.

The translation along axis X-X' of sleeve 12 is limited by the limitation of the relative rotation of bracket shaft 2 with respect to chain ring holder 4.

In order to determine the torque, the translation of sleeve 12 is measured thanks to a target ring 125 which is fast to sleeve 12. Assembly A further comprises two coils 631 which are mounted on central cover 63 and around axis X-X'. As central cover 63 is fixed in translation with respect to sleeve 12, the translation of target ring 125, which is made in an electrically conductive material, with respect to coils 631, which are fed with electrical current, induces impedance variations and generates a sinusoidal signal which can be processed to determine the torque delivered by the user on the pedals. Crankset assembly A can to this end include processing means, such as a microprocessor.

This torque determination can be used, for example, to calculate and provide a torque assistance when the bicycle must be started in an ascending slope.

A second embodiment of the invention is represented on figures 10 to 12. In this embodiment, elements similar to the first embodiment have the same references and work in the same way. Only the differences with respect to the first embodiment are described hereafter.

In this embodiment, the coupling device is an elastically deformable element 800, which has an annular shape centered on axis X-X'.

Element 800 comprises a first annular and planar surface 801 adapted to be fast in rotation with bracket shaft 2 and a second annular and planar surface 802 adapted to be fast in rotation with chain ring holder 4. More precisely, surface 801 is fixed to walls 31, which comprise holes 311 for passing a first set of bolts 51, inserted in corresponding holes 803 of deformable element 800. In the same way, surface 802 is fixed to ribs 43 of chain ring holder 4 thanks to a set of bolts 52 inserted into holes 431 of ribs 43 and into holes 803 of elastic element 800.

Element 800 preferably comprises eight substantially similar holes 803, preferably distributed along the circumference of element 800. Assembly A comprises four bolts 51 and four bolts 52 adapted to be inserted in four holes 311 of wall 31 and in one hole 431 of each of four ribs 43.

In a normal configuration of assembly A, in other words, when the rotation of bracket shaft 2 and chain ring holder 4 are synchronized, bolts 51 and bolts 52 are angularly offset

by an angle of 45°. Bolts 51 and 52 are alternatively inserted in element 800 and screwed into nuts 804 mounted into holes 803. In other words, a bolt 51 is inserted in a hole 803 between two adjacent bolts 52 inserted into holes 803, in the opposite direction parallel to axis X-X'.

When the user exerts a force on one pedal, elastically deformable element 800 undergoes a shear deformation. In other words, surface 801 rotates with respect to surface 802 around axis X-X'. This allows to detect the angular offset between bracket shaft 2 and chain ring holder 4 and, therefore, to determine the torque delivered by the user on one of the pedals.

According to a non-shown embodiment, surfaces 801 and 802 may have different geometry and shapes, for example a tronconical shape.

According to another non-shown embodiment, the fastening of surfaces 801 and 802 with respectively bracket shaft 2 or chain ring holder 4 can be realized in a different way, e.g. by cooperation of shape.

According to a non-shown embodiment of the invention, the angular offset of shaft 2 with respect to chain ring holder 4 can be obtained, thanks to leaf springs mounted between shaft 2 and chain ring holder 4.

According to a non-shown embodiment, crankset assembly A may not comprise any means for transforming the angular offset into a translational motion of a movable part. In this case, assembly A does may comprise any sleeve 12, and the angular offset may be directly sensed thanks to detection means such as a Hall effect sensor fixed on central cover 63. A first magnetic multipole ring may be fast in rotation with bracket shaft 2, while a second magnetic multipole ring may be fast in rotation with chain ring holder 4. By sensing the relative rotation between the two magnetized rings thanks to the Hall Effect sensor, the torque delivered by the user can be determined.

According to another non-shown embodiment, the sensing of the angular offset can be performed using two slotted disks rotating one with respect to the other in a similar way to the magnetized rings previously described. In this case, a Hall Effect sensor may be used to sense the magnetic field variations provoked by the relative rotations of the slotted disks on a magnetic field emitted by a magnetic ring.

CLAIMS

1.- Crankset assembly (A) for a bicycle, comprising a bracket shaft (2) connected by a first end (22) to a left pedal and by a second end (24) to a right pedal, and a coupling device (8, 800) to transmit, from the bracket shaft (2) to a chain ring (4) of the assembly (A), a torque delivered by a user on each pedal, wherein the coupling device (8, 800) is adapted to generate an angular offset between the bracket shaft (2) and the chain ring (4), and wherein the crankset assembly comprises means (12, 125, 631) to determine the torque delivered by the user on one of the pedals on the basis of this angular offset.

2.- Crankset assembly according to claim 1, wherein the coupling device comprises at least one elastically deformable element (8, 800).

3.- Crankset assembly according to claim 2, wherein a first portion (81, 801) of the elastically deformable element (8, 800) is fast in rotation with the bracket shaft (2), while a second portion (83, 802) of the elastically deformable element (8, 800) is fast in rotation with the chain ring (4).

4.- Crankset assembly according to claim 3, wherein the bracket shaft (2) is inserted in the elastically deformable element (8, 800), and wherein said elastically deformable element is inserted in the chain ring (4).

5.- Crankset assembly according to claim 4, wherein the elastically deformable element (8, 800) is made of a polymeric, an elastomeric or a metallic material.

6.- Crankset assembly according to one of claims 4 and 5, wherein the elastically deformable element (8) comprises cavities (81, 83) respectively adapted to cooperate, on an inner side, with protruding ribs (26) of the bracket shaft (2), and on the outer side, with protruding ribs (415) of the chain ring (4).

7.- Crankset assembly according to one of claims 2 to 5, wherein the elastically deformable element (800) is annular, wherein a first annular surface (801) of the elastically deformable element (800) is fixed to the bracket shaft (2) by a first set of bolts (51), and wherein a second annular surface (802) of the elastically deformable element (800) is fixed to the chain ring holder (4) by a second set of bolts (52).

8.- Crankset assembly according to claim 1, wherein the coupling device comprises at least one spring.

9.- Crankset assembly according to claim 8, wherein the spring is a leaf spring or a leaf springs set.

10.- Crankset assembly according to one of the previous claims, wherein the means for determining the torque delivered by the user on one of the pedals comprise means (103, 123, 15) to generate, from the angular offset, a translational motion (A3) of a movable part (12) of the assembly (A).

11.- Crankset assembly according to claim 10, wherein the movable part is a sleeve (12) movable along the longitudinal axis (X-X') of the bracket shaft (2).

12.- Crankset assembly according to claim 11, wherein the means to generate a translational motion comprise, on an axially-oriented peripheral circular edge of an element (10) fast in rotation with the chain ring (4), sloped surfaces (103) adapted to make a sliding contact with corresponding sloped surfaces (123) of the movable sleeve (12).

13.- Crankset assembly according to claim 12, wherein the movable sleeve (12) is guided in translation and fast in rotation with the bracket shaft (2) by at least one key (13).

14.- Crankset assembly according to claim 13, wherein the means for determining the torque delivered by the user comprise a target ring (125) fast in translation with the movable sleeve (12), and two electrically fed coils (631) carried by a fixed part (63) of the assembly (A).

15.- Crankset assembly according to one of claims 1 to 9, wherein the means for determining the torque delivered by the user on one of the pedals comprise means to sense the angular offset.

16.- Crankset assembly according to claim 15, wherein the means to sense the angular offset comprise a Hall effect sensor adapted to sense magnetic field variations generated by a relative rotation of a magnetized ring fast in rotation with the bracket shaft (2) with respect to a magnetized ring fast in rotation with the chain ring (4).

17.- Crankset assembly according to claim 15, wherein the means to sense the angular offset comprise a Hall effect sensor adapted to sense magnetic field variations generated, on a magnetic field emitted by a magnetized ring, by a relative rotation of a slotted disk fast in rotation with the bracket shaft (2) with respect to a slotted disk fast in rotation with the chain ring (4).

18.- Crankset assembly according to one of the previous claims, wherein it comprises means (30, 31, 105) to limit the rotation of the chain ring (4) with respect to the bracket shaft (2).

19. Bicycle equipped with a crankset assembly (A) according to any of the previous claims.

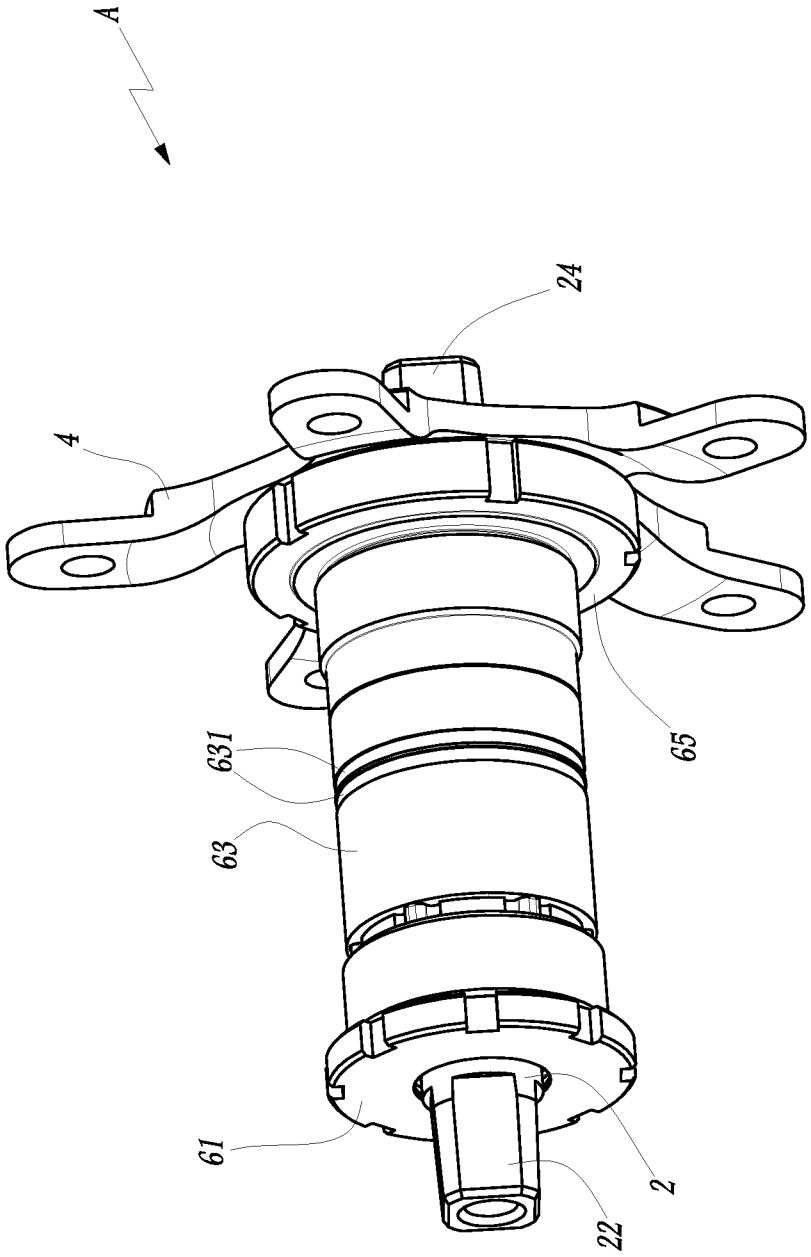

Fig. 1

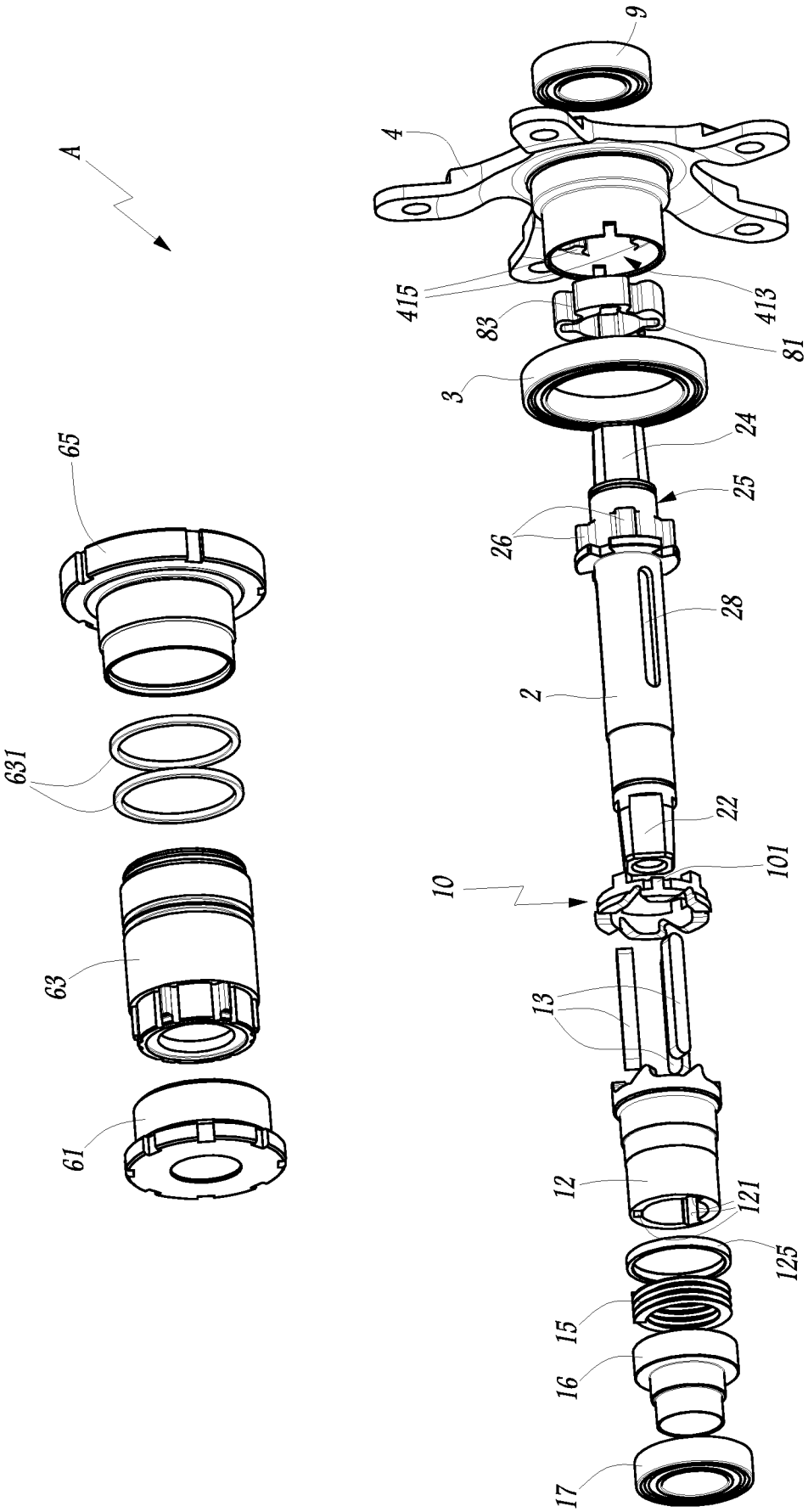
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Fig.2

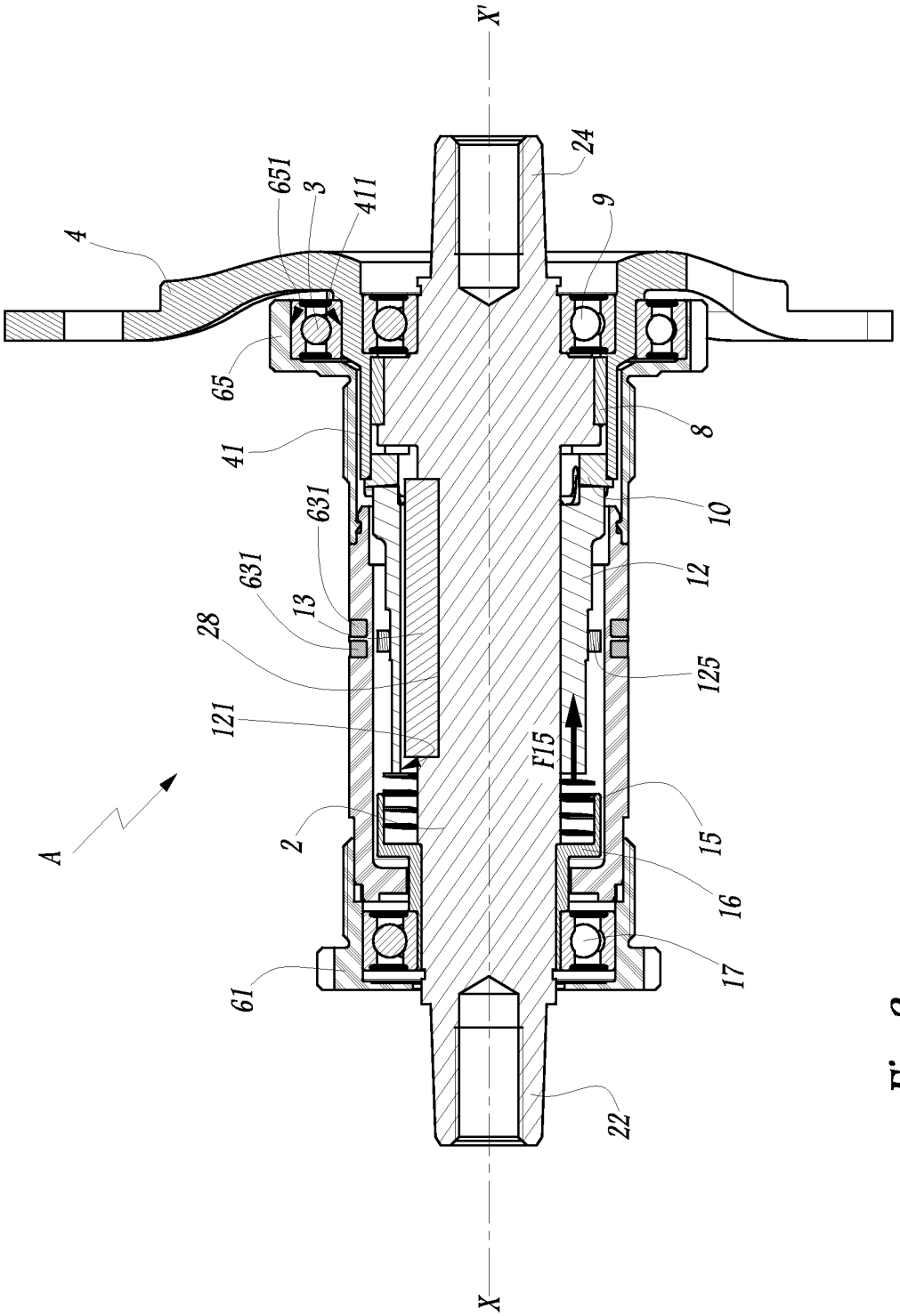
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Fig.3

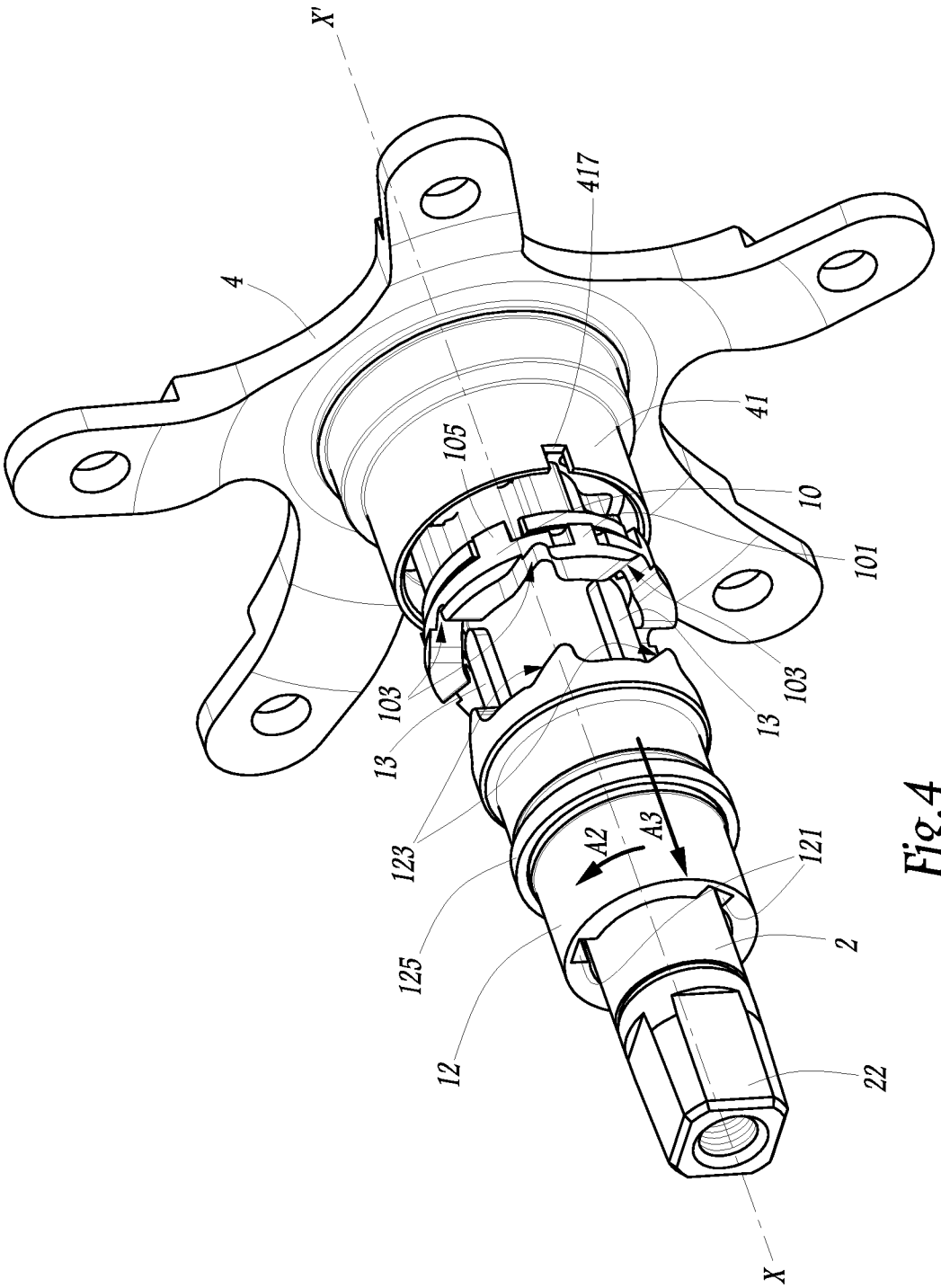

Fig.4

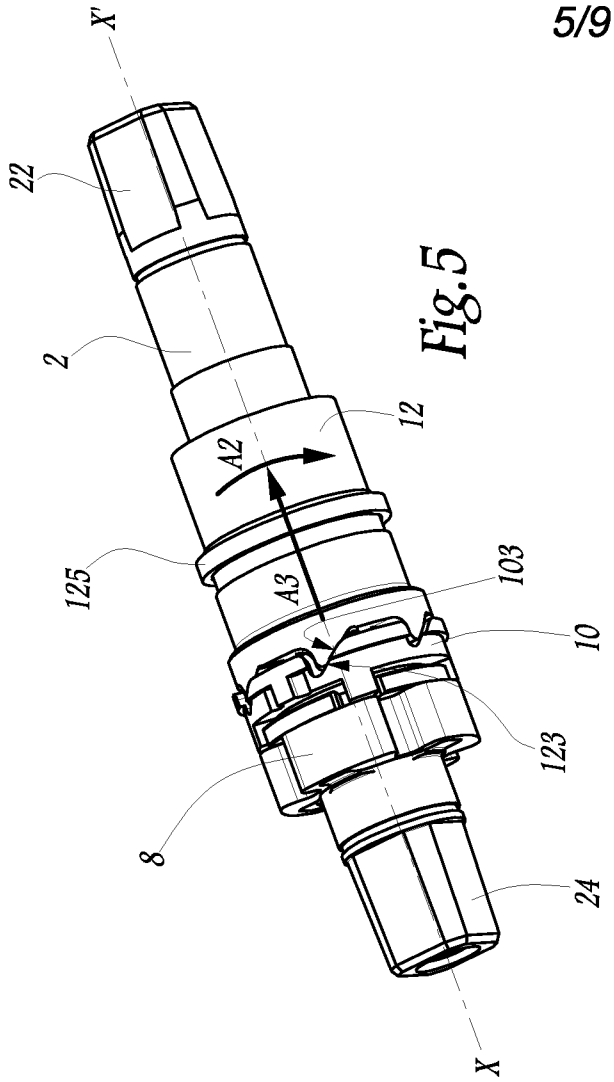

Fig.5

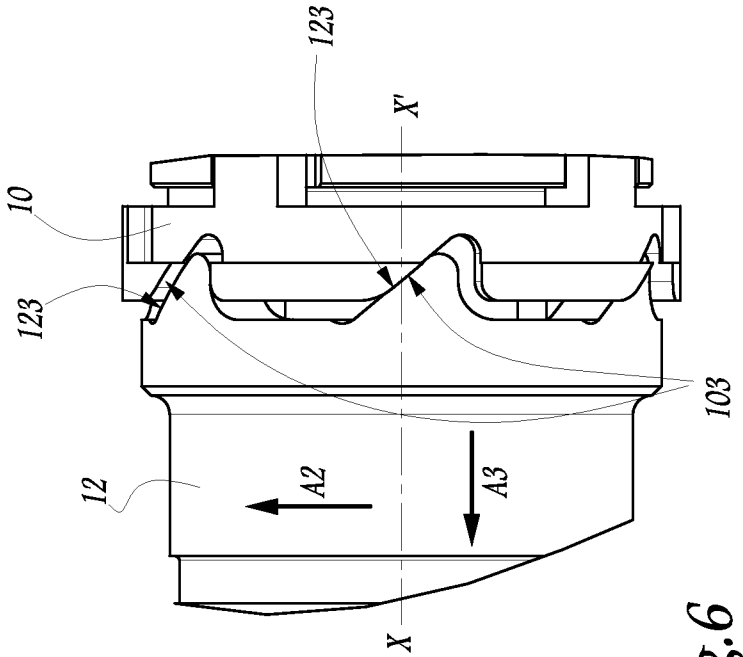

Fig.6

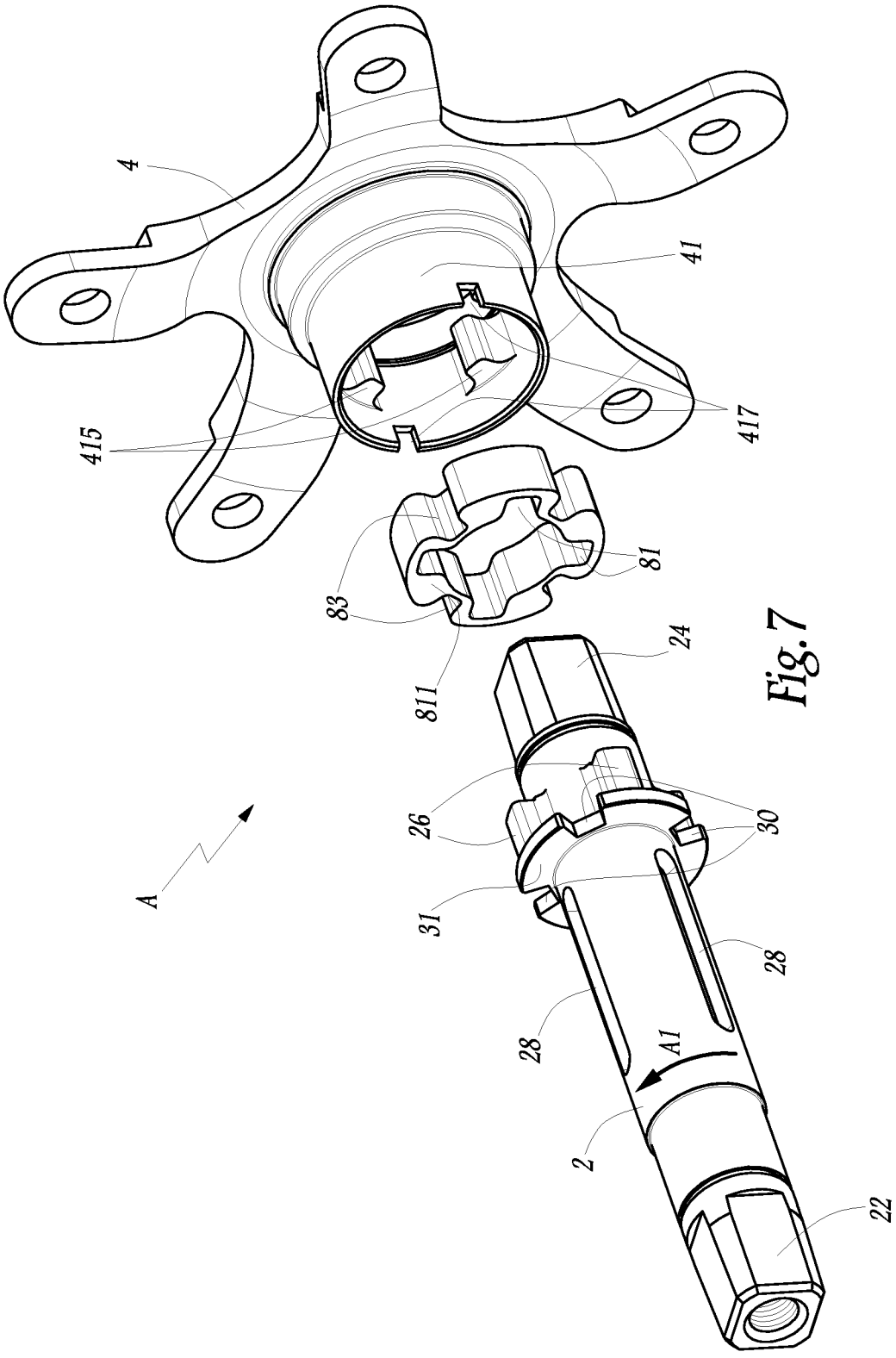

Fig.7

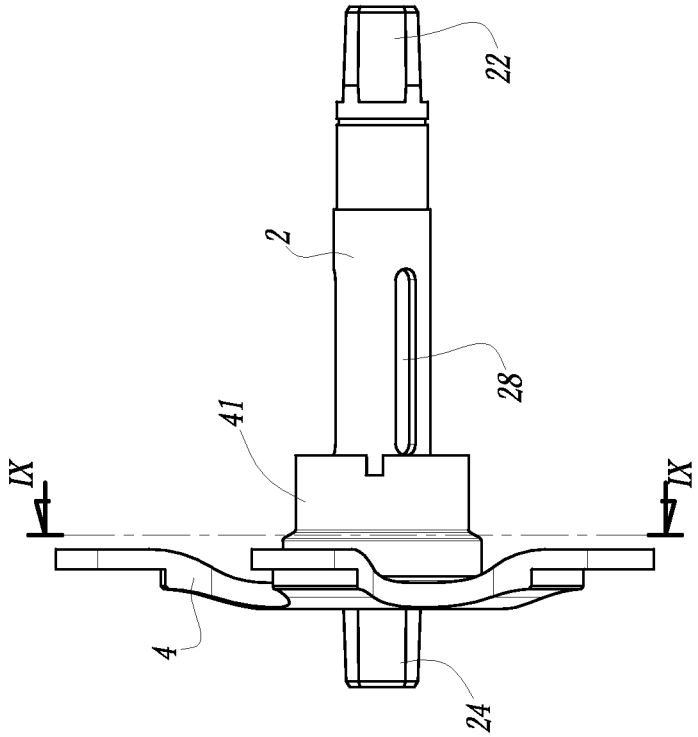

Fig.8

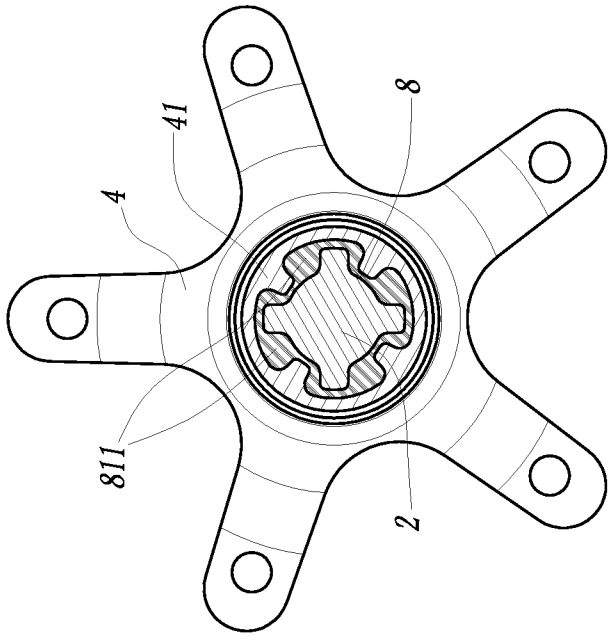

Fig.9

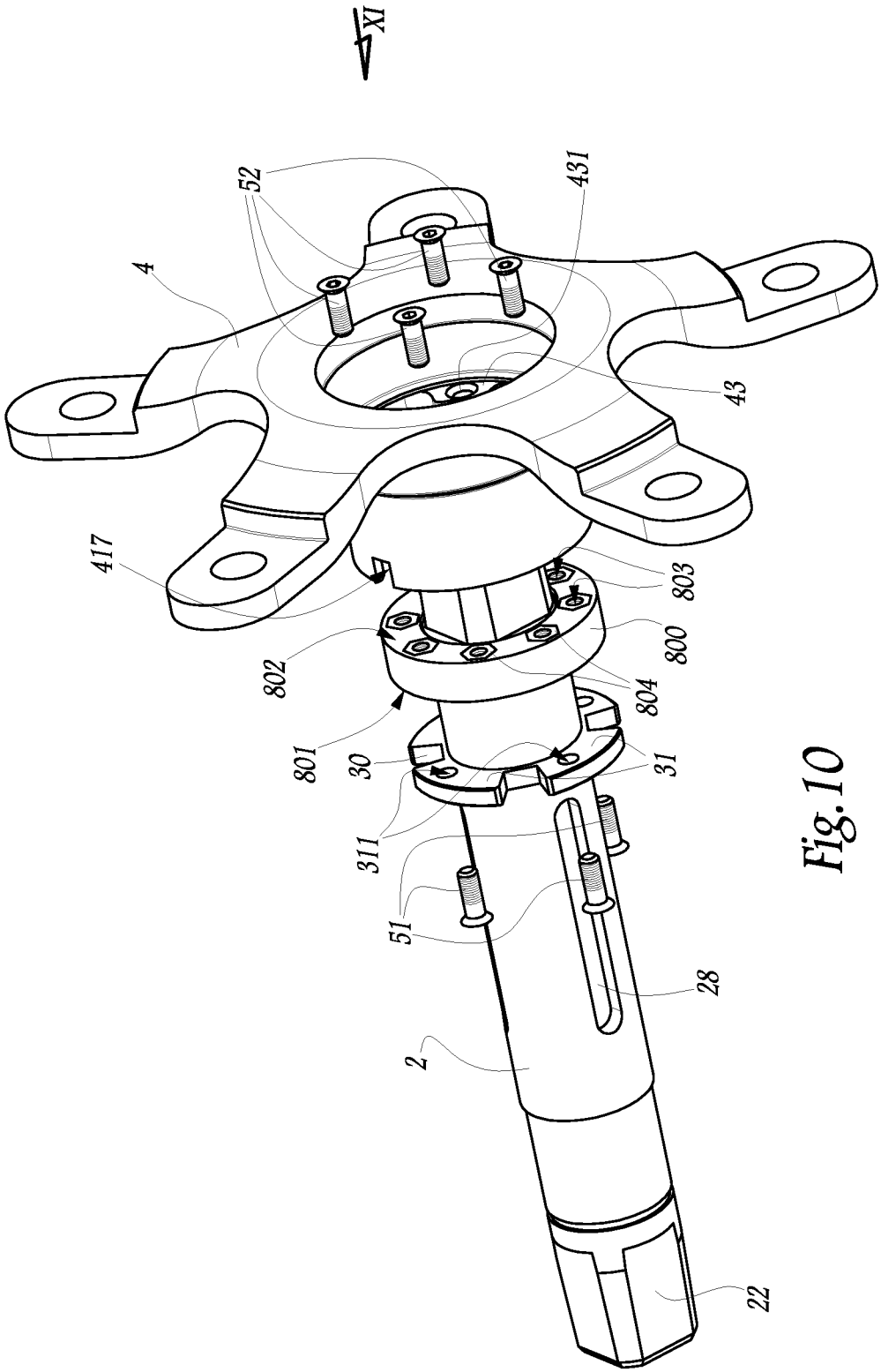

Fig. 10

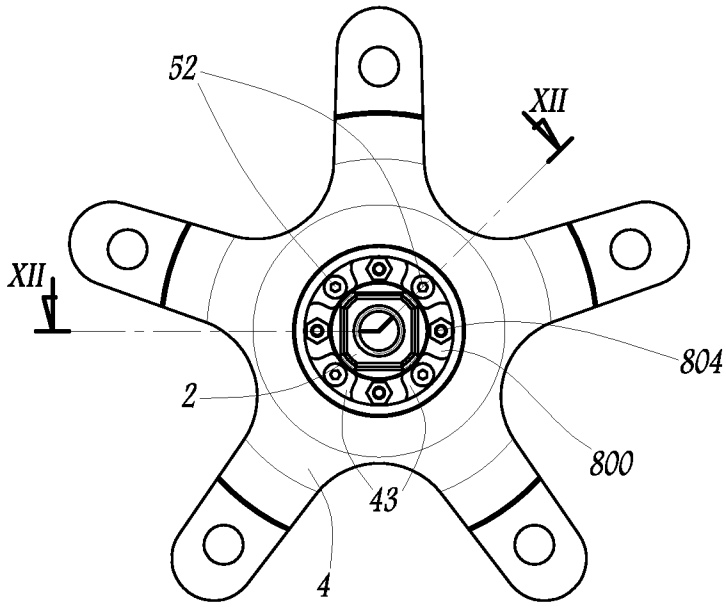

Fig.11

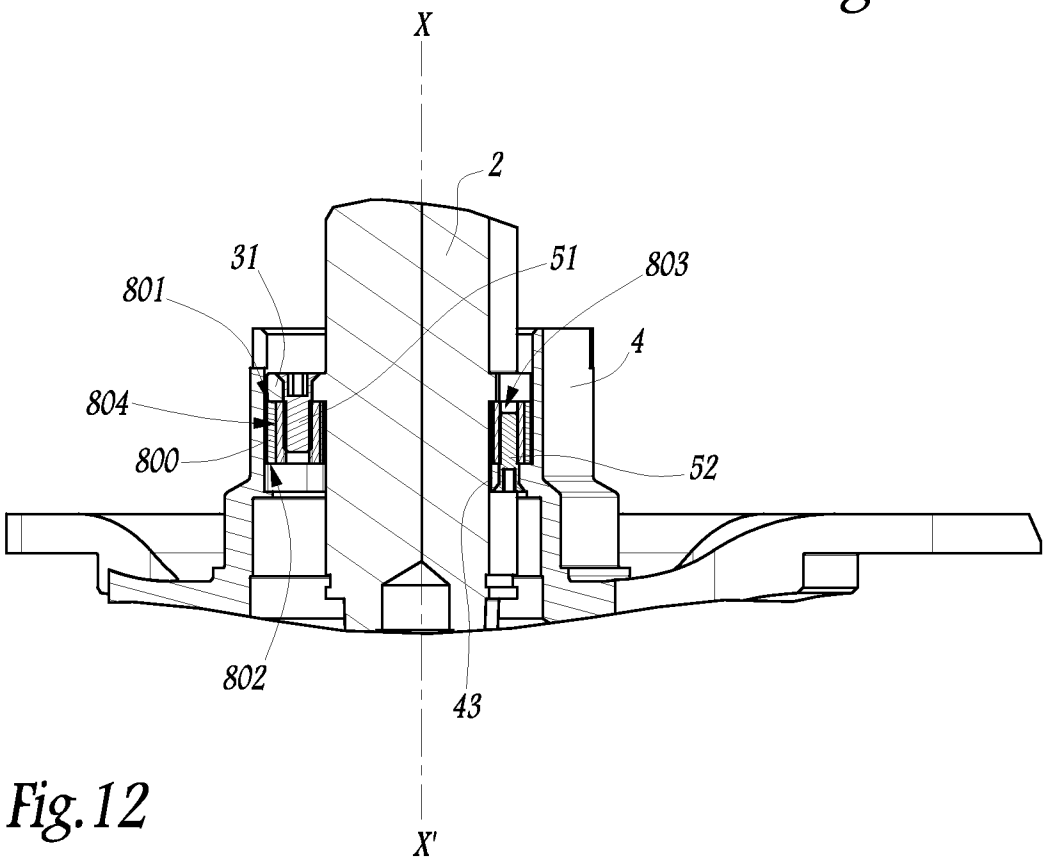

Fig.12

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/002581

A. CLASSIFICATION OF SUBJECT MATTER
INV. B62M3/00 B62M6/45 B62M6/50
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)
B62M B62K G01L

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 6 651 489 B1 (YANG MORGAN [TW]) 25 November 2003 (2003-11-25)	1-3,19
A	column 2, line 40 - column 3, line 30	4-18

X	EP 0 832 816 A1 (MITSUBISHI HEAVY IND LTD [JP]) 1 April 1998 (1998-04-01) column 10, line 30 - column 14, line 17	1

A	US 2011/006760 A1 (GLUECK STEFAN [DE] ET AL) 13 January 2011 (2011-01-13) cited in the application the whole document	1-19

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 July 2012	10/07/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Denicolai, Giovanni

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2011/002581

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		WO 2009079980 A1	02-07-2009