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(54) Title: LOCK NUT

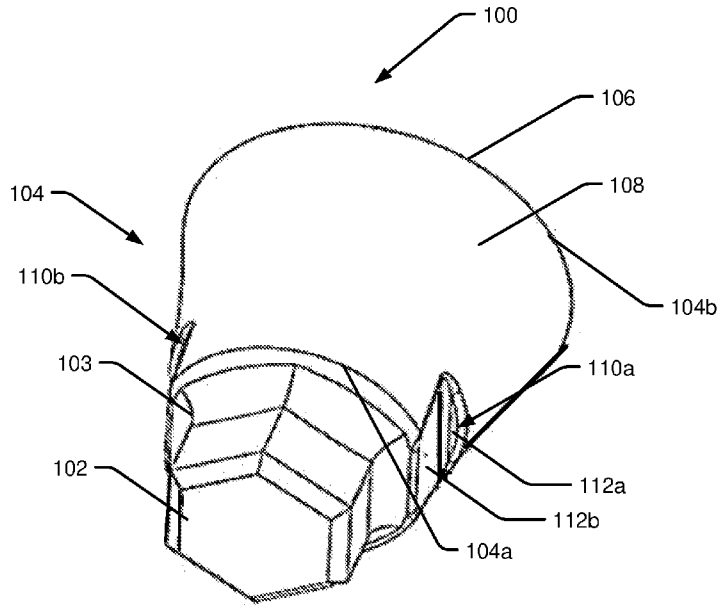

Fig. 1(a)

(57) Abstract: The present subject matter provides a lock nut (100) for engaging with a shaft (304). The lock nut can comprise a head portion (102) and a body portion (104). The body portion (104) can comprise a bottom face (106). The bottom face can have a bore (202) for receiving the shaft. The body portion can further comprise a threaded cavity (204) extending axially through the body portion. The bore of the bottom face extends into and is co-axial with the threaded cavity. The threaded cavity can engage with a threaded portion (308) of the shaft. An external surface (108) of the body portion can comprise a pair of flat cuts (110). A first flat cut (110a) of the pair of flat cuts can be opposite to a second flat cut (110b) of the pair of flat cuts.

[Continued on next page]

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LOCK NUT

TECHNICAL FIELD

[0001] The present subject matter relates, in general, to fasteners, and, in particular, relates to a lock nut.

BACKGROUND

[0002] A turbomachine is a machine which uses a rotating element, for example, an impeller, to impart energy to a fluid flowing through the machine. Turbines, compressors, and fans are some examples of a turbomachine. In turbomachines, the impeller is to be connected to a shaft such that there is negligible relative rotational or axial movement between the shaft and the impeller. A keyed connection or a splined portion is generally provided on the shaft to hold the impeller against rotational movement relative to the shaft. However, due to high speed of rotation of the impeller, additional fastening mechanisms, such as lock nuts, may be provided between the shaft and the impeller to further reduce relative rotational movement.

BRIEF DESCRIPTION

[0003] The detailed description is described with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the drawings to reference like features and components.

[0004] Fig. 1(a) illustrates an orthographic view of a lock nut, in accordance with an implementation of the present subject matter.

[0005] Fig. 1(b) illustrates a plan view of the lock nut, in accordance with an implementation of the present subject matter.

[0006] Fig. 2(a) illustrates a bottom face of the lock nut, in accordance with an implementation of the present subject matter.

[0007] Fig. 2(b) illustrates an enlarged view of the bottom face of the lock nut, in accordance with an implementation of the present subject matter.

[0008] Fig. 3(a) illustrates a shaft assembly comprising the lock nut, in accordance with an implementation of the present subject matter.

[0009] Fig. 3(b) illustrates an enlarged view of a portion of the shaft assembly, in accordance with an implementation of the present subject matter.

DETAILED DESCRIPTION

[0010] The present subject matter relates to fasteners used for coupling high speed rotational elements of turbomachines. More particularly, the present subject matter relates to a lock nut for coupling high speed rotational elements such as an impeller and a shaft of the turbomachines.

[0011] Turbomachines, such as wind mills, water wheels, ship propeller, hydraulic, steam and gas turbines, centrifugal pumps, axial pumps, turbo compressors, and the like, are rotary machines which include at least one rotating element. The rotating element may be a rotor or an impeller. The rotor or impeller, used interchangeably hereinafter, can be mounted on a shaft.

[0012] During operation of turbomachines, the impeller and the shaft may rotate at higher speeds. The impeller has to be connected to the shaft such that there is no relative movement between the shaft and the impeller during the operation of the turbomachine. A keyed connection or a splined portion can be provided on the shaft to hold the impeller against rotational movement relative to the shaft. Additionally, a fastener, such as, a lock nut can also be used to secure the impeller and the shaft. A conventional lock nut can engage with a threaded portion of the shaft. The conventional lock nut can be screwed onto the threaded portion of the shaft by tightening a hexagonal profile of the conventional lock nut using tools, such as, a wrench. The hexagonal profile is generally provided towards a head portion of the conventional lock nut.

[0013] During periodic service and maintenance, the impeller is dismounted and re-mounted on the shaft by loosening and tightening the

hexagonal profile of the lock nut. Due to repeated loosening and tightening, the hexagonal profile may get disfigured or damaged. Further, due to the damage in the hexagonal profile, it may be difficult to assemble and disassemble the conventional lock nut from the shaft, thereby, reducing serviceability of the impeller and the shaft or requiring replacement of the lock nut.

[0014] Further, when conventional lock nuts are used, there may be a possibility of slippage of the conventional lock nut during reverse rotation of the shaft or when engaging the lock nut with the shaft as conventional lock nuts do not provide effective contact between the bottom face and the impeller at a hub. Alternately, some conventional lock nuts may have angular serrations on the bottom face to minimize the slippage of the lock nut. However, at high rotational speeds, there may still be a possibility of slippage. In addition, due to frequent slippage of the lock nut, the torsional load carrying capability of the shaft and the impeller may be reduced. Further, fabrication of angular serrations is time-consuming as the conventional lock nut has to be rearranged for formation of each set of angular serrations.

[0015] The present subject matter provides a lock nut for engaging with a shaft of a turbomachine. The lock nut can comprise a head portion and a body portion. The body portion can comprise a bottom face. The bottom face can have a bore for receiving the shaft. The body portion can further comprise a threaded cavity extending axially through the body portion. The bore of the bottom face extends into and is co-axial with the threaded cavity. The threaded cavity can engage with a threaded portion of the shaft.

[0016] An external surface of the body portion can comprise a pair of flat cuts. A first flat cut of the pair of flat cuts can be opposite to a second flat cut of the pair of flat cuts. In an example, the external surface of the body portion is curved. In an example, the body portion has a frustum geometry, for example, a conical frustum. The first flat cut and the second flat cut can have a substantially L-shaped structure with a first side parallel to the bottom face of the lock nut and a second side substantially perpendicular to the first side. The head portion of the lock nut can be a three-dimension hexagonal structure, an acorn, or a cap.

[0017] By using the pair of flat cuts, the lock nut may be loosened and tightened on the shaft without using the head portion of the lock nut. Thus, the impeller can be easily attached and removed from the shaft without disfiguring or damaging the head portion of the lock nut.

[0018] In an example, the bottom face of the body portion of the lock nut can comprise one of: spiral serrations and helical serrations. By using the spiral serrations or helical serrations, effective contact area of the lock nut with the impeller at a hub portion can be increased, thereby, preventing slippage of the lock nut during reverse rotation or during high speed rotation of the shaft and the impeller.

[0019] Thus, the present subject matter provides a lock nut which can be easily attached and detached from the shaft to reduce damage to the head portion of the lock nut. Further, even if the head portion of the lock nut is damaged or worn out, the pair of flat cuts may be used to attach and detach the lock nut from the shaft. The lock nut of the present subject also improves effective contact area, thereby, reducing chances of slippage.

[0020] The above and other features, aspects, and advantages of the subject matter will be better explained with regard to the following description and accompanying figures. It should be noted that the description and figures merely illustrate the principles of the present subject matter along with examples described herein and, should not be construed as a limitation to the present subject matter. It is thus understood that various arrangements may be devised that, although not explicitly described or shown herein, embody the principles of the present disclosure. Moreover, all statements herein reciting principles, aspects, and examples thereof, are intended to encompass equivalents thereof. Further, for the sake of simplicity, and without limitation, the same numbers are used throughout the drawings to reference like features and components.

[0021] Fig. 1(a) illustrates an orthographic view of a lock nut 100, in accordance with an implementation of the present subject matter. The lock nut 100 can comprise a head portion 102 and a body portion 104. The body portion 104 can be integrally formed with the head portion 102. In an example, a neck

portion 103 may be provided between the head portion 102 and the body portion 104. The neck portion 103 may be an inclined portion which interfaces between the head portion 102 and the body portion 104. In said example, the body portion 104, the neck portion 103, and the head portion 102 may be formed integrally.

[0022] The head portion 102 can be of various shapes or configurations, for example, a three-dimensional hexagon, an acorn, and a cap. Fig. 1(a) depicts the head portion 102 as a three-dimensional hexagon. However, as will be understood, the head portion 102 can have other shapes and configurations. The head portion 102 may be used to tighten and loosen the lock nut 100 to a shaft, for example, by using a wrench or a spanner. However, repeated tightening and loosening of the lock nut 100 by using the head portion 102 may damage or disfigure the head portion 102.

[0023] The body portion 104 can comprise a bottom face 106 and an external surface 108. The body portion 104 can also comprise a first end 104a towards the head portion 102 and a second end 104b towards the bottom face 106. A diameter of the second end 104b can be greater than a diameter at the first end 104a. The external surface 108 can taper between the first end 104a and the second end 104b.

[0024] In an example, the body portion 104 has a frustum geometry. As will be understood, a frustum is a portion of a solid that lies between two parallel planes. For example, the two parallel planes may be planes that bound the body portion 104 at the first end 104a and the second end 104b. Thus, the plane at the first end 104a can correspond to the plane where the neck portion 103 interfaces with the body portion 104 and the plane at the second end 104b can correspond to a plane of the bottom face 106. In an example, as shown in Fig. 1(a), the frustum geometry is a conical frustum. However, as will be understood, the frustum geometry may be a square pyramid frustum, hexagonal pyramid frustum, octagonal pyramid frustum and the like. In an example, the external surface 108 of the body portion 104 may be a curved surface.

[0025] The external surface 108 can comprise a pair of flat cuts 110a and 110b, hereinafter also referred to as the pair of flat cuts 110. The pair of flat cuts

108 can be formed in the external surface 108 substantially close to the first end 104a below the head portion 102. A first flat cut 110a of the pair of flat cuts 110 may be diametrically opposite to a second flat cut 110b of the pair of flat cuts 110 for easy gripping and so as not to cause any weight imbalance when the lock nut 100 is secured to the shaft. In an example, the first flat cut 110a and the second flat cut 110b can be symmetric about an axis of the lock nut 100. While Fig. 1(a) depicts a single pair of flat cuts 110, it is to be understood that the lock nut 100 can have multiple pairs of flat cuts 110. Fig. 1(b) depicts the pair of flat cuts in greater detail.

[0026] Fig. 1(b) illustrates a plan view of the lock nut 100, in accordance with an implementation of the present subject matter. Fig. 1(b) depicts the first flat cut 110a and the second flat cut 110b. For sake of discussion, structure of each flat cut is explained with reference to the first flat cut 110a. Each of the first flat cut 110a and the second flat cut 110b can have a substantially L-shaped structure.

[0027] The L-shaped structure of the first flat cut 110a can have a first side 112a and a second side 112b. The first side 112a can correspond to the base of the L-shaped structure and can be parallel to the bottom face 106 of the lock nut 100. The second side 112b can correspond to the stem of the L-shaped structure and can be along the length of the body portion 104, substantially perpendicular to the first side 112a. For example, the first flat cut 110a can be formed in the external surface 108 by machining a part of the external surface 108 at the first end 104a of the body portion 104. The second side 112b extends axially in the body portion 104 and the first side 112a projects radially outwards from the second side 112b.

[0028] In one example, the first side 112a and the second side 112b can have grooves complementary to those typically found on gripping surfaces of a wrench or tool facilitate tightening and loosening of the lock nut 100. By using the first flat cut 110a and the second flat cut 110b, the lock nut 100 can be tightened and loosened from the shaft without using the head portion 102, thereby, minimizing chances of damage and disfiguration to the lock nut 100 and

improving serviceability of the shaft and rotor and increasing the life of the lock nut 100.

[0029] In an example, to improve the integrity of the lock nut 100 and to prevent slippage of the lock nut 100 during rotation and reverse rotation of the shaft, the bottom face 106 can comprise one of: spiral serrations and helical serrations. Fig. 2(a) depicts the bottom face 106 of the lock nut 100, in accordance with an implementation of the present subject matter. Fig. 2(b) depicts an enlarged view of portion A of the bottom face 106, in accordance with an implementation of the present subject matter.

[0030] In an example, as shown in Fig. 2(a) and Fig. 2(b), the bottom face 106 can have spiral serrations as indicated by arrow 206. In another implementation, the bottom face 106 can have helical serrations. Spiral serrations and helical serrations, hereinafter referred to as serrations, may be formed on a portion or entire surface of the bottom face 106.

[0031] The serrations, namely the spiral serrations or the helical serrations, may help in increasing effective contact area of the lock nut 100 when the lock nut 100 is mounted on the shaft. In an example, the bottom face 106 can comprise a bore 202 to receive the shaft. As will be understood, the bore 202 may be a circular hole in the bottom face 106 produced by drilling, turning, drawing, and the like.

[0032] The bore 202 can extend into a threaded cavity 204 of the body portion 104. The threaded cavity 204 can extend axially through the body portion 104. The bore 202 can be coaxial with the threaded cavity 204. The threaded cavity 204 can be used for engaging with a threaded portion of the shaft, for example, by complementary mating of threads within the threaded cavity and threads of a threaded portion of the shaft to form a shaft assembly. The shaft assembly is explained in detail with reference to Fig. 3(a) and Fig. 3(b).

[0033] Fig. 3(a) depicts a cross-sectional view of a shaft assembly 300, in accordance with an implementation of the present subject matter. Fig. 3(b) depicts an enlarged view of portion B of the shaft assembly 300, in accordance with an implementation of the present subject matter. In an example, the shaft assembly

300 may be a part of a turbomachine. The lock nut 100 of the present subject matter may be employed in different types of turbomachines, such as wind mills, water wheels, ship propeller, hydraulic, steam and gas turbines, centrifugal and axial pumps, turbo compressors, and the like. However, it is to be understood that the shaft assembly 300 may be a part of other devices as well.

[0034] The shaft assembly 300 of the turbomachine, for example, a centrifugal pump, shown in the Fig. 3(a) can comprise the lock nut 100, an impeller 302, and a shaft 304. The shaft assembly 300 can comprise additional components, such as a volute casing and a bearing housing as will be understood. The additional components are not explained herein for the sake of brevity.

[0035] The shaft 304 can comprise a keyed portion 306 and a threaded portion 308. The impeller 302 may be mounted co-axially on the shaft 304 and may be secured on the keyed portion 306 to prevent relative rotational motion of the impeller 302 with respect to the shaft 304. The shaft 304 can be coupled to a drive unit (not shown), for example, an electric motor. The impeller 302 can be driven by the shaft 304, which is powered by the drive unit.

[0036] The impeller 302 can include an impeller hub 310 and plurality of vanes (not shown). The impeller hub 310 can have an annulus to receive the threaded portion 308 of the shaft 304 when the impeller 302 is mounted onto the shaft 304. After the impeller 302 is mounted on the shaft 304, the lock nut 100 may be engaged with the threaded portion 308 of the shaft 304 to hold the impeller 302 and prevent rotational movement of the impeller 302 relative to the shaft 304. Although the lock nut 100 and the impeller 302 are shown adjacent to each other in the Fig. 3(a), it is to be understood that the lock nut 100 may not be in direct contact with the impeller 302. The lock nut 100 may interface with the impeller 302 via other components, such as, a washer.

[0037] In an example, a profile of the body portion 104 of the lock nut 100, indicated by line 313, can match a path of an impeller profile 311. The path of the impeller profile 311 is indicated by a line 312. The impeller profile 311 may be understood as an outline of a side of the impeller 302. The impeller profile 311 may taper towards the annulus through which the shaft 304 may be received.

The tapering outline is referred to as the path of the impeller profile 311. The profile of the lock nut 100 may be understood as an outline of a side of the lock nut 100, particularly of the external surface 108 of the body portion 104. The profile of the lock nut 100 may taper to match the path of the impeller profile 311. For example, the external surface 108 of the body portion 104 may have a taper that matches the taper of the impeller profile 311 so that, on assembly, the profile of the lock nut 100 appears as an extension of the impeller profile 311. In an example, a diameter of the bottom face 106 of the lock nut 100 matches an outer diameter of the impeller profile 311 at a hub where the impeller 302 contacts the shaft 304.

[0038] In operation, with reference to Fig.(s) 1(a), 1(b), 2(a), 2(b), to assemble the shaft assembly 300, the impeller 302 may receive the shaft 304 at the annulus of the impeller 302. The impeller 302 and the shaft 304 may be secured at the keyed portion 306. The lock nut 100 may then be engaged with the threaded portion 308 of the shaft 304. For this, the bore 202 of the bottom face 106 of the lock nut 100 can receive the shaft 304. The lock nut 100 may be tightened on the threaded portion 308 so that the threaded cavity of the lock nut 100 engages with the threaded portion 308 of the shaft 304. The lock nut 100 may be tightened by using a wrench at the pair of the flat cuts 110 to prevent any damage to the head portion 102 of the lock nut 100.

[0039] In one example, the pair of flat cuts 110 may be provided on a lock nut comprising a damaged head portion. For example, if the lock nut 100 is tightened or loosened by applying a tool, such as a wrench, to the head portion 102 then the head portion 102 may get damaged. The pair of flat cuts 110 may be fabricated on the body portion 104 of such a damaged lock nut also, for example, by machining or any other technique known in the art. In this example, presence of the pair of flat cuts 110 can help in tightening or loosening the lock nut 100 despite any damage caused to the head portion 102 of the lock nut 100.

[0040] Therefore, the lock nut 100 of the present subject matter allows for minimizing damage and disfiguration to the head portion 102. Further, the pair of flat cuts 110 can help in tightening or loosening the lock nut despite the head

portion 102 being damaged. Further, the helical or spiral serrations on the bottom face 106 of the lock nut 100 helps in preventing of slippage of the lock nut 100.

[0041] Although embodiments for lock nut with flat cuts have been described in language specific to structural features, it is to be understood that the present subject matter is not necessarily limited to the specific features described. Rather, the specific features are disclosed as example embodiments.

I/We claim:

1. A lock nut (100) comprising:

a head portion (102); and

a body portion (104) comprising:

a bottom face (106) comprising a bore (202) for receiving a shaft (304);

a threaded cavity (204) extending axially through the body portion (104), wherein the bore (202) extends into and is coaxial with the threaded cavity (204), wherein the threaded cavity (204) is for engaging with a threaded portion (308) of the shaft (304); and

an external surface (108) comprising a pair of flat cuts (110), wherein a first flat cut (110a) of the pair of flat cuts (110) is opposite to a second flat cut (110b) of the pair of flat cuts (110).

2. The lock nut (100) as claimed in claim 1, wherein the bottom face (106) comprises one of spiral serrations and helical serrations.

3. The lock nut (100) as claimed in claim 1, wherein the head portion (102) is one of a three-dimensional hexagon, an acorn, and a cap.

4. The lock nut (100) as claimed in claim 1, wherein the body portion (104) has a frustum geometry.

5. The lock nut (100) as claimed in claim 4, wherein the frustum geometry is a conical frustum.

6. The lock nut (100) as claimed in claim 1, wherein each of the first flat cut (110a) and the second flat cut (110b) have a substantially L-shaped structure comprising:

a first side (112a) parallel to the bottom face (106); and

a second side (112b) substantially perpendicular to the first side (112a).

7. The lock nut (100) as claimed in claim any one of claims 1 to 5, wherein the external surface (108) of the body portion (104) is curved.

8. The lock nut (100) as claimed in claim 1, wherein body portion (104) comprises a first end (104a) towards the head portion (102) and a second end (104b) towards the bottom face (106), wherein a diameter of the second end (104b) is greater than a diameter at the first end (104a), and wherein the external surface (108) tapers between the first end (104a) and the second end (104b).

9. A shaft assembly (300) comprising:

a shaft (304) comprising a threaded portion (308);

an impeller (302) mounted axially on the shaft (304); and

a lock nut (100) engaged with the threaded portion (308) of the shaft (304) to prevent rotation of the impeller (302) relative to the shaft (304), wherein the lock nut (100) comprises:

a head portion (102); and

a body portion (104) comprising:

a bottom face (106) comprising a bore (202) for receiving the shaft (304);

a threaded cavity (204) extending axially through the body portion (104), wherein the bore (202) extends into and is coaxial with the threaded cavity (204), wherein the threaded cavity (204) is engaged with the threaded portion (308) of the shaft (304); and

an external surface (108) comprising a pair of flat cuts (110), wherein a first flat cut (110a) of the pair of flat cuts (110) is opposite to a second flat cut (110b) of the pair of flat cuts (110).

10. The shaft assembly (300) as claimed in claim 9, wherein the body portion (104) has a frustum geometry.

11. The shaft assembly (300) as claimed in claim 9, wherein the external surface (108) of the body portion (104) is curved.

12. The shaft assembly (300) as claimed in claim 9, wherein a profile of the external surface (108) of the body portion (104) matches a path of an impeller profile (311) at a hub of the impeller (302).

13. The shaft assembly (300) as claimed in claim 9, wherein the bottom face (106) comprises one of spiral serrations and helical serrations.

14. The shaft assembly (300) as claimed in claim 9, wherein each of the first flat cut (110a) and the second flat cut (110b) have a substantially L-shaped structure comprising:

a first side (112a) parallel to the bottom face (106); and

a second side (112b) substantially perpendicular to the first side (112a).

15. The lock nut (100) as claimed in claim 9, wherein body portion (104) comprises a first end (104a) towards the head portion (102) and a second end (104b) towards the bottom face (106), wherein a diameter of the second end (104b) is greater than a diameter at the first end (104a), and wherein the external surface (108) tapers between the first end (104a) and the second end (104b).

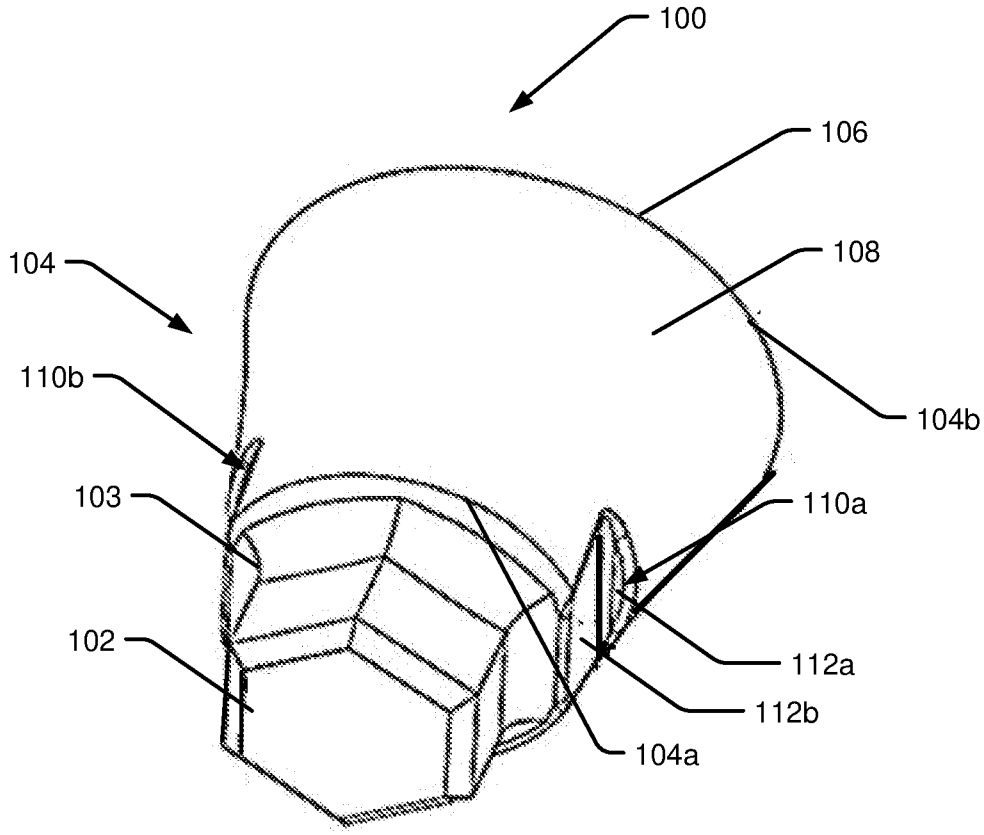
100
106
104
108
110b
104b
103
110a
102
112a
112b
104a

Fig. 1(a)

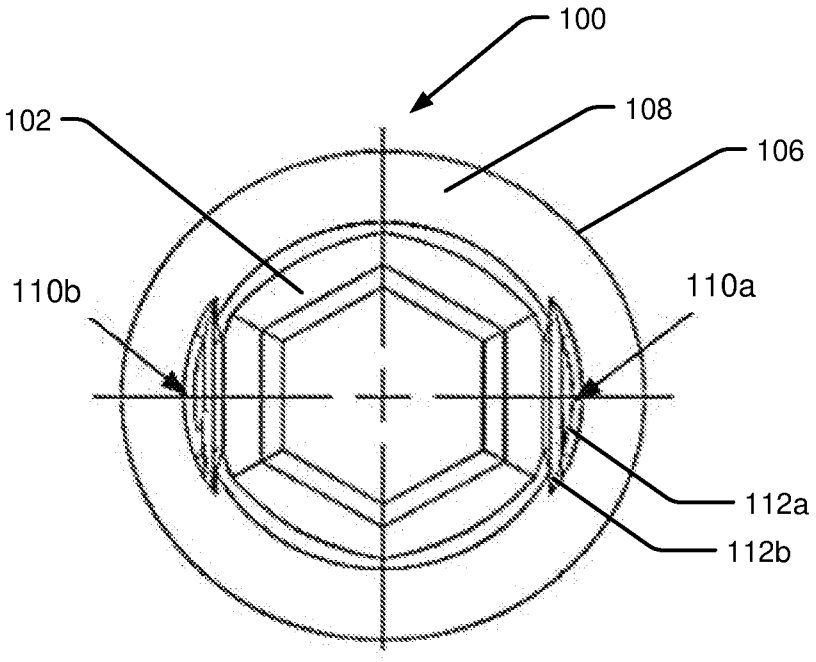
100
102
108
106
110b
110a
112a
112b

Fig. 1(b)

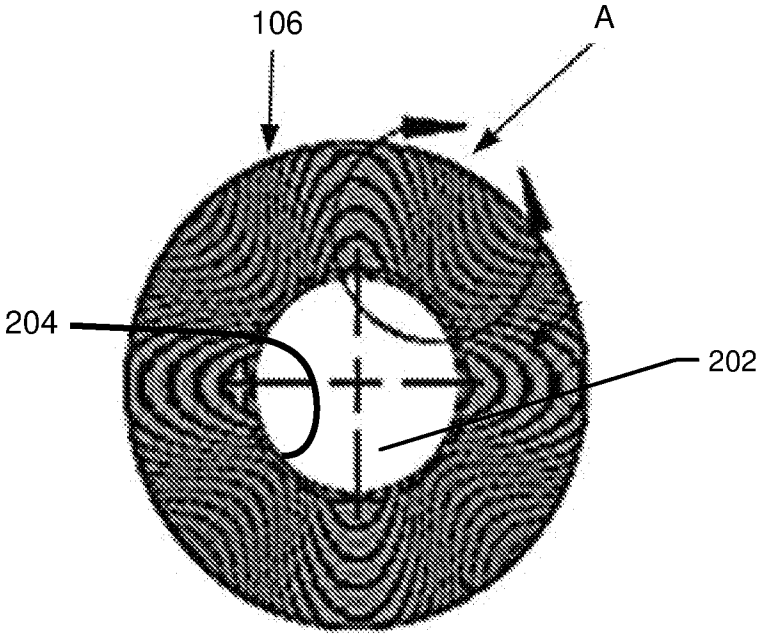

Fig. 2(a)

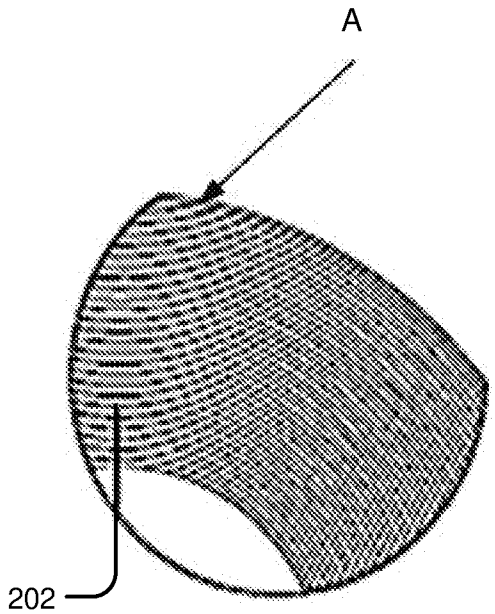

Fig. 2(b)

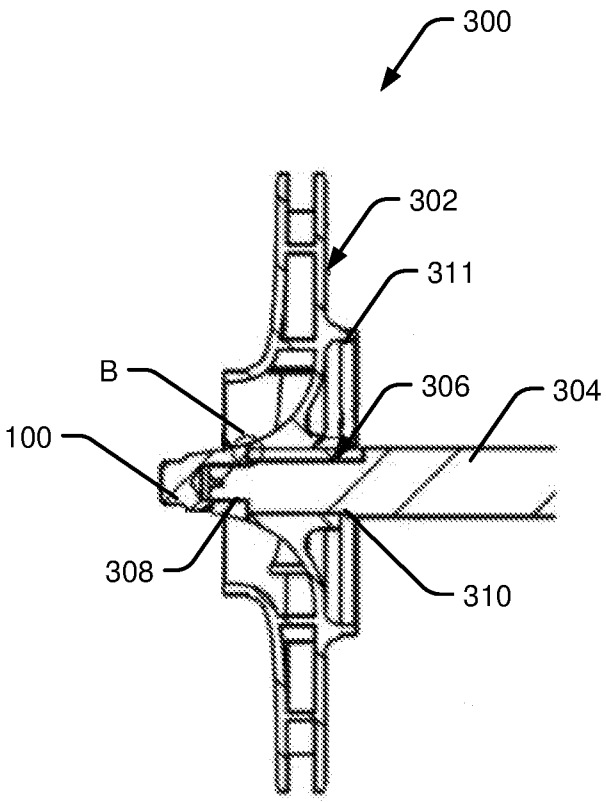

Fig. 3(a)

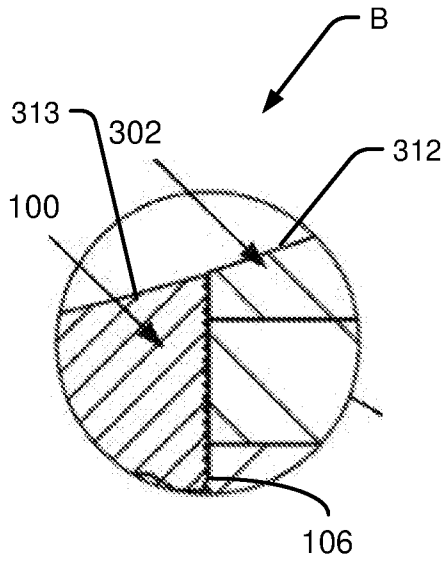

Fig. 3(b)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2018/050708

A. CLASSIFICATION OF SUBJECT MATTER
F16B39/00 Version=2019.01

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)

F16B

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)

Total Patent One, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US3301298A, LAMSON AND SESSIONS CO, 13 JANUARY 1967 (13/01/1967) Figs. (1,4), claim-1, (column-8, lines-(13-34)).	1-15
A	US3522830A, SPS TECHNOLOGIES INC, 04 AUGUST 1970 (04/08/1970) Figs.(1-3), (column-1, line-44 to column-2, line-5).	1-15

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

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Citation	Pub.Date	Family	Pub.Date
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