(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 366 904 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.09.2011 Bulletin 2011/38

(21) Application number: **11158407.4**

(22) Date of filing: **16.03.2011**

(51) Int Cl.:
F04D 1/06 *(2006.01)* ***F04D 13/08*** *(2006.01)*
F04D 29/08 *(2006.01)* ***F04D 29/40*** *(2006.01)*
F04D 29/62 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **17.03.2010 IT VI20100071**

(71) Applicant: **CALPEDA S.p.A.**
I-36050 Montorso Vicentino (VI) (IT)

(72) Inventors:
- **Matteazzi, Giuliano**
  36040 Brendola (VI) (IT)
- **Zamberlan, Fiorenzo**
  36070 Trissino (VI) (IT)

(74) Representative: **Bonini, Ercole**
Studio Bonini Srl
Corso Fogazzaro, 8
36100 Vicenza (IT)

(54) **Compression device for the stator unit of a pump**

(57) The invention is a compression device (2) for compressing the stator unit (17) of a pump (1), comprising: a tubular case (3) defining a longitudinal axis (X), a locking ring (5), constraining means (4) suited to constrain the locking ring (5) inside the tubular case (3) according to the direction of the longitudinal axis (X), a thrust unit (7) provided with a reference surface (12a) that can be positioned against the locking ring (5), which is suited to be expanded in an expansion direction (Y) perpendicular to the reference surface (12a), a counteracting element (8) that can be positioned against the locking ring (5) on the side opposite to the thrust unit (7), connection means (9) for connecting the counteracting element (8) to the thrust unit (7), suited to move the counteracting element (8) towards the thrust unit (7) to arrange them against the opposite sides of the locking ring (5).

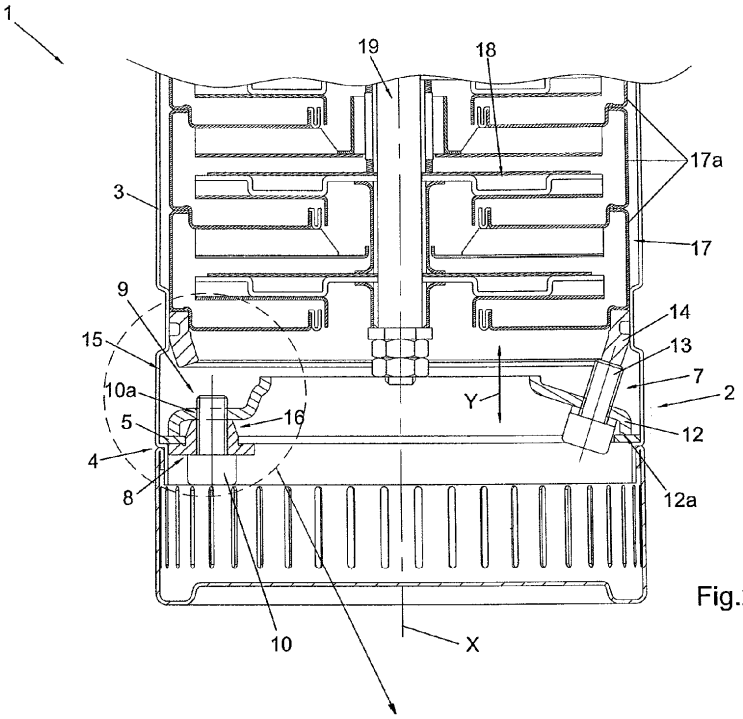


Fig.2

EP 2 366 904 A1

Description

DESCRIPTION

[0001] The present invention concerns a device for compressing the stator unit of a pump, particularly suited to be used in a multi-stage centrifugal pump for wells. As schematically shown in Figure 1, a multi-stage centrifugal pump **A** of known type comprises a tubular case **B** containing a stator unit **C** that typically consists of a plurality of stages stacked on top of each other.

[0002] In order to prevent the pumped fluid from leaking between one stage and the other, it is necessary to compress the stator unit so as to join the stages and ensure tightness.

[0003] According to a known technique, the above mentioned compression is achieved by means of a tubular element **D** that is arranged with one end **E** against the stator unit **C** and that is provided with a holed flange **F.**

[0004] The tubular case **B** is also provided with lateral through openings **G** suited to house corresponding shaped elements **H** provided with threaded holes that, when the shaped elements are inserted in the openings, are arranged so as to be aligned with the holes in the flange of the tubular element.

[0005] The shaped elements rest on the edge of the openings, so as to remain axially constrained to the tubular case.

[0006] The shaped elements and the flange of the tubular element are connected by means of corresponding screws **L** that when screwed in push the tubular element against the stator unit, which therefore is compressed.

[0007] This known technique poses a drawback lying in that the compression force of the stator unit is supported by the edges of the lateral openings which have a reduced surface.

[0008] Therefore, even if said technique is appropriate when the compression force remains below a given limit, beyond said limit the lateral openings would collapse, causing the loss of compression of the stator unit and consequently the leakage mentioned above, which would affect the pump performance.

[0009] Due to the above mentioned compression loss, the stages may also be set rotating by the pumped fluid, damaging the pump to the extent that it may be necessary to replace it.

[0010] As the required compression force substantially increases in proportion to the pump head, it is clear that the above mentioned known technique is suitable for pumps whose maximum head is below a given limit.

[0011] In order to overcome these drawbacks, according to a further known technique, not illustrated herein, the compression force is supported by means of an elastic locking ring that is housed into an annular seat created inside the tubular case.

[0012] When the elastic locking ring is at rest, its outer diameter is larger than the minimum diameter of the seat, so that it can be introduced in the tubular case and then expand at the level of the seat.

[0013] The compression of the stator unit is achieved using a thrust unit that is interposed between the elastic locking ring and the stator unit and that can expand in the axial direction so as to compress the stator unit.

[0014] The compression force is discharged on the locking ring and the annular seat, whose surface is much larger than that of the edge of the lateral openings that are present in the known technique described above.

[0015] Therefore, this technique makes it possible to distribute the compression stress on the tubular case in a more uniform way compared to the previous solution, thus avoiding any deformation of the tubular case.

[0016] This second technique, however, poses some drawbacks.

[0017] In fact, in order to avoid oxidation of the elastic locking ring over time, this must be made with stainless steel that, however, has reduced elasticity.

[0018] Consequently, in order to obtain an elastic locking ring that can be inserted in the tubular case and that can successively expand in the corresponding seat, it is necessary to limit the deformation of the elastic locking ring required to introduce it in the seat or, alternatively, to limit the thickness of the elastic locking ring.

[0019] However, an elastic locking ring with reduced thickness can bear a reduced compression force and, as explained above, can be used in pumps whose maximum head is below a given limit.

[0020] In fact, a higher compression force would cause the axial deformation of the elastic locking ring, which may come off the seat.

[0021] Therefore, in these cases it is necessary to increase the thickness of the elastic locking ring.

[0022] However, as explained above, this makes it necessary to use an elastic locking ring that when at rest has an outer diameter that is slightly larger than the inner diameter of the seat, so as to avoid, during insertion, an excessive radial compression of the ring that would plastically deform it and make it unusable.

[0023] In this case, however, there is a drawback represented by the fact that the usable resting surface defined by the seat, included between the outer diameter of the elastic locking ring when at rest and the inner diameter of the seat, is reduced, which in any case limits the applicable compression force.

[0024] The present invention intends to overcome the drawbacks of the known art as outlined above.

[0025] In particular, it is the object of the invention to provide a device for compressing the stator unit of a pump that is more efficient and reliable than the devices of known type described above.

[0026] The object described above is achieved by a compression device according to claim 1.

[0027] The same object is also achieved by a pump according to claim 15.

[0028] Further characteristics and details of the invention are described in the corresponding dependent claims.

[0029] Advantageously, the invention makes it possible to use an elastic locking ring that is thinner than required in the pumps of known type, while being able to achieve the same compression force.

[0030] Advantageously, a thinner elastic locking ring is very elastic and can therefore be coupled with a seat having a large resting surface.

[0031] Still advantageously, the invention does not require openings to be made in the tubular case of the pump.

[0032] The said object and advantages, and others which are better highlighted below, will be illustrated in detail in the description of a preferred embodiment of the invention which is provided by way of non-limiting example with reference to the attached drawings, wherein:

- Figure 1 shows a longitudinal sectional view of a pump according to the known art;
- Figure 2 shows a cross section of the pump that is the subject of the invention;
- Figure 3 shows a detail of Figure 2;
- Figure 4 shows an exploded axonometric view of some components of the pump of Figure 2.

[0033] The pump of the invention is partially shown in Figure 2, where it is indicated as a whole by the reference number 1.

[0034] The pump 1 is provided with a compression device 2 comprising a tubular case **3** that defines a longitudinal axis **X** and serves as an external jacket for the pump **1.**

[0035] The stator unit **17** is arranged coaxially inside the tubular case **3,** said stator unit consisting of a plurality of stacked stages **17a** and a rotor unit **18** connected to a shaft **19** operatively associated with drive means, not illustrated herein but known per se, suited to set the rotor unit **18** rotating around the longitudinal axis **X.**

[0036] The compression device **2** also comprises a locking ring **5** that can be associated with the inner surface **15** of the tubular case **3** via constraining means **4** that constrain the locking ring **5** according to the direction of the longitudinal axis **X** so that the ring **5** faces the stator unit **17.**

[0037] The invention also comprises a thrust unit **7** that is arranged between the locking ring **5** and the stator unit **17.**

[0038] The thrust unit **7** is provided with a reference surface **12a,** that is positioned against the locking ring 5, and can also expand in an expansion direction **Y** that is perpendicular to the above mentioned reference surface **12a** that, during operation, is preferably parallel to the longitudinal axis **X.**

[0039] The expansion of the thrust unit **7** allows one end of the stator unit **17** to be thrust according to the longitudinal axis **X,** so that the stator unit, being constrained to the tubular case **3** at the opposite end, is compressed.

[0040] The compression device **2** also comprises a counteracting element **8** that is positioned against the locking ring **5,** on the side opposite to the thrust unit **7.**

[0041] The counteracting element **8** is associated with the thrust unit **7** via connection means **9** that are suited to move the counteracting element **8** towards the thrust unit **7,** preferably according to a direction parallel to the longitudinal axis **X,** in such a way as to arrange them against corresponding opposite sides of the locking ring **5.**

[0042] The approach of the counteracting element **8** to the thrust unit **7** causes the locking ring **5** to be locked between them, so that the locking ring **5** is stiffened and its axial deformation is hindered.

[0043] Consequently, with the same compression force being exerted on the stator unit **17,** the locking ring **5** is deformed less than in the compression devices used in the pumps of known type, thus achieving the object of the invention. Furthermore, the compression force corresponding to a pre-established deformation of the locking ring **5** exceeds that required in the known art, the thickness of the locking ring **5** being the same.

[0044] Therefore, to advantage, the locking ring **5** can be used in pumps provided with a larger number of stages than the number that the same ring would allow to be used in the known art.

[0045] The connection means **9** preferably but not necessarily comprise screw means **10, 10a.**

[0046] In particular, and as shown in greater detail in Figure 3, the above mentioned screw means comprise a first screw **10** arranged inside the locking ring **5** and passing through the counteracting element **8,** suited to be associated with a nut screw **10a** present in the thrust unit **7.**

[0047] In variant embodiments of the invention not illustrated herein, the first screw **10** may form a single body with the counteracting element **8.**

[0048] The counteracting element **8** is preferably a shaped washer **11** provided with a through hole suited to house said first screw **10.**

[0049] The compression device **2** can clearly comprise any number of shaped washers **11,** preferably at least three washers arranged at regular intervals along a circumference, or four washers spaced by 90 degrees, as shown in Figure 4.

[0050] According to a variant embodiment of the invention not illustrated herein, the counteracting element **8** is an annular element that is preferably but not necessarily connected to the thrust unit **7** by means of at least three screws arranged at regular intervals along a circumference.

[0051] The thrust unit **7** preferably comprises a supporting body **12** that defines the above mentioned reference surface **12a,** which can be positioned against the locking ring **5.**

[0052] Obviously, as shown in Figure 2, the above mentioned supporting body **12** has a maximum diameter that exceeds the inner diameter of the locking ring **5,** so as to prevent the supporting body **12** from slipping off the

tubular case **3.**

[0053] The thrust unit **7** also comprises a threaded element **13** that can be screwed onto said supporting body **12** so that it projects from the supporting body **12** from the side opposite the reference surface **12a.**

[0054] The threaded element **13** is preferably a screw that passes through a corresponding threaded hole provided in the supporting body **12.**

[0055] The threaded elements **13** can be present in any number, even if it is preferable to use three or more of them, arranged at regular intervals along a circumference, as shown in Figure 4.

[0056] The thrust unit **7** preferably but not necessarily comprises a thrust body **14** that can be positioned against the threaded elements **13** when these are screwed onto the supporting body **12** and suited to be arranged in contact with the stator unit **17** on the opposite side.

[0057] The screwing of the threaded elements **13** clearly causes the thrust body **14** to be moved away from the supporting body **12,** so that the thrust unit **7** is expanded and thus thrusts the stator unit **17** and compresses it. Advantageously, the threaded elements **13** make it possible to adjust the expansion of the thrust unit **7** in a simple manner.

[0058] Furthermore, the thrust body **14** makes it possible to distribute the compression force exerted by the threaded elements **13** on the entire circumference of the stator unit **17.**

[0059] It is also evident that the thrust body **14** can also be omitted, arranging instead the threaded elements **13** directly in contact with the stator unit **17** in order to compress it.

[0060] The threaded elements **13** have a screwing axis that is preferably inclined with respect to the expansion direction **Y,** as shown in Figure 2.

[0061] Advantageously, this makes it possible to direct the expansion force towards the outer diameter of the stator unit **17,** where this features its maximum rig id ity.

[0062] It is evident, however, that in variant embodiments of the invention the screwing axis of the threaded elements **13** may be parallel to the expansion direction **Y.**

[0063] Going back to Figure 3, it can be observed that the constraining means **4** comprise a stop surface **6** belonging to the inner surface **15** of the tubular case **3,** substantially at right angles to the longitudinal axis **X** and preferably annular in shape.

[0064] The above mentioned stop surface **6** can be obtained, for example, by bending towards the inside the metal sheet that makes up the tubular case **3.**

[0065] The above mentioned bending operation advantageously makes it possible to obtain a stop surface **6** whose surface area is larger than the surface area that can be obtained, for example, by making a recess within the thickness of the tubular case **3.**

[0066] Clearly, the stop surface **6** can be in a shape different from the annular shape, for example the shape of a sector of a circle, provided that it is suited to support the locking ring **5.**

[0067] As shown in Figure 4, the locking ring **5** is preferably an elastic locking ring of the open type, whose outer diameter when it is at rest is larger than the diameter of the inner edge of the above mentioned stop surface **6** and can be elastically compressed so as to reduce its outer diameter so that it is smaller than the above mentioned inner diameter.

[0068] Preferably, the elastic locking ring **5** is substantially laminate in order to advantageously obtain a high elastic range and thus be able to exploit a stop surface **6** with a large surface area.

[0069] Furthermore, the locking ring **5** is preferably made of stainless steel, so that it can advantageously resist the oxidative action of the pumped liquid without releasing residues in the liquid itself, in particular when this is water for human consumption.

[0070] In order to ensure the perfect expansion of the elastic locking ring **5,** even in case of undesired plastic deformation of the same, caused for example by wrong fitting, it is preferable to use a counteracting element **8** provided with a shaped surface **16** configured so as to force the radial expansion of the elastic locking ring **5** during connection to the thrust unit **7,** as shown in Figure 3.

[0071] This can be obtained using a shaped washer **11** with increasing cross section in the direction opposite the direction of connection to the thrust unit **7,** for example in the shape of a truncated cone, so that it is arranged in contact with the inner diameter of the elastic locking ring **5** during connection of the counteracting element **8.**

[0072] The shaped washer **11** is preferably provided, at one end of its truncated cone-shaped portion, with a collar **11a** suited to come against the elastic locking ring **5,** on the opposite side with respect to the thrust unit **7.**

[0073] Obviously, the cross section described above for the shaped washer **11** can be used also for a counteracting element **8** in the shape of a ring.

[0074] From the operational point of view, the pump **1** is assembled by inserting, in the following order, the stator unit **17,** the thrust unit **7** and the locking ring **5** inside the tubular case **3,** aligned according to the longitudinal axis **X.**

[0075] Successively, the counteracting elements **8** are connected to the thrust unit **7** by tightening the screws **10,** thus obtaining the stiffening of the locking ring **5.** Finally, screwing the threaded elements **13** compresses the stator unit **17.**

[0076] For the reasons explained above, it is clear that the compression device described herein achieves the object of the invention.

[0077] In fact, the use of counteracting elements makes it possible to stiffen the locking ring that, therefore, can withstand a higher compression force on the stator than in the known art.

[0078] Upon implementation, the device that is the subject of the invention may be subjected to further changes or variations that, even if not described herein and not illustrated in the drawings, must all be considered

protected by the present patent, provided that they fall within the scope of the following claims. Where technical features mentioned in any claim are followed by reference signs, those reference sings have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the protection of each element identified by way of example by such reference signs.

Claims

1. Compression device (2) for compressing the stator unit (17) of a pump (1), comprising:

- a tubular case (3) defining a longitudinal axis (X) and suited to house said stator unit (17) in a predefined fitting position;
- a locking ring (5);
- constraining means (4) suited to constrain said locking ring (5) inside said tubular case (3) according to the direction of said longitudinal axis (X);
- a thrust unit (7) provided with a reference surface (12a) that can be positioned against said locking ring (5), said thrust unit (7) being suited to be expanded in an expansion direction (Y) perpendicular to said reference surface (12a), in such a way as to thrust one end of said stator unit (17) when arranged in said fitting position;

characterized in that it comprises:

- a counteracting element (8) that can be positioned against said locking ring (5) on the side opposite to said thrust unit (7);
- connection means (9) for connecting said counteracting element (8) to said thrust unit (7), suited to move said counteracting element (8) towards said thrust unit (7) in order to arrange them against opposite sides of said locking ring (5).

2. Compression device (2) according to claim 1), **characterized in that** said connection means (9) comprise screw means (10, 10a).

3. Compression device (2) according to claim 2), **characterized in that** said screw means (10, 10a) comprise a first screw (10) associated with said counteracting element (8) and suited to be screwed into a nut screw (10a) belonging to said thrust unit (7).

4. Compression device (2) according to claim 3), **characterized in that** said first screw (10) is integral with said counteracting element (8).

5. Compression device (2) according to any of the preceding claims, **characterized in that** said counteracting element (8) is a shaped washer (11).

6. Compression device (2) according to any of the claims from 1) to 4), **characterized in that** said counteracting element (8) is an annular body.

7. Compression device (2) according to any of the preceding claims, **characterized in that** said thrust unit (7) comprises a supporting body (12) to which said reference surface (12a) belongs, and threaded elements (13) that can be screwed onto said supporting body (12) so as to project from said supporting body (12) from the opposite side with respect to said reference surface (12a).

8. Compression device (2) according to claim 7), **characterized in that** said threaded elements (13) define a screwing axis that is inclined with respect to said expansion direction (Y).

9. Compression device (2) according to claim 7) or 8), **characterized in that** said thrust unit (7) comprises a thrust body (14) that can be positioned against said threaded elements (13) when said threaded elements (13) are screwed onto said supporting body (12).

10. Compression device (2) according to any of the preceding claims, **characterized in that** said constraining means (4) comprise a stop surface (6) belonging to the inner surface (15) of said tubular case (3), substantially at right angles to said longitudinal axis (X).

11. Compression device (2) according to claim 10), **characterized in that** said locking ring (5) is an elastic ring whose outer diameter, when it is at rest, is larger than the inner diameter of said stop surface (6) and can be elastically compressed so that its outer diameter is smaller than said inner diameter of said stop surface (6).

12. Compression device (2) according to claim 11), **characterized in that** said elastic locking ring (5) is laminate.

13. Compression device (2) according to claim 11) or 12), **characterized in that** said counteracting element (8) comprises a shaped surface (16) configured so as to force the expansion of said elastic locking ring (5) when said counteracting element (8) is connected to said thrust unit (7).

14. Compression device (2) according to any of the preceding claims, **characterized in that** said locking ring (5) is made of stainless steel.

15. Pump (1) comprising a compression device (2) according to any of the preceding claims and a stator unit (17) suited to be inserted in the tubular case (3) of said compression device (2) against said thrust unit (7).

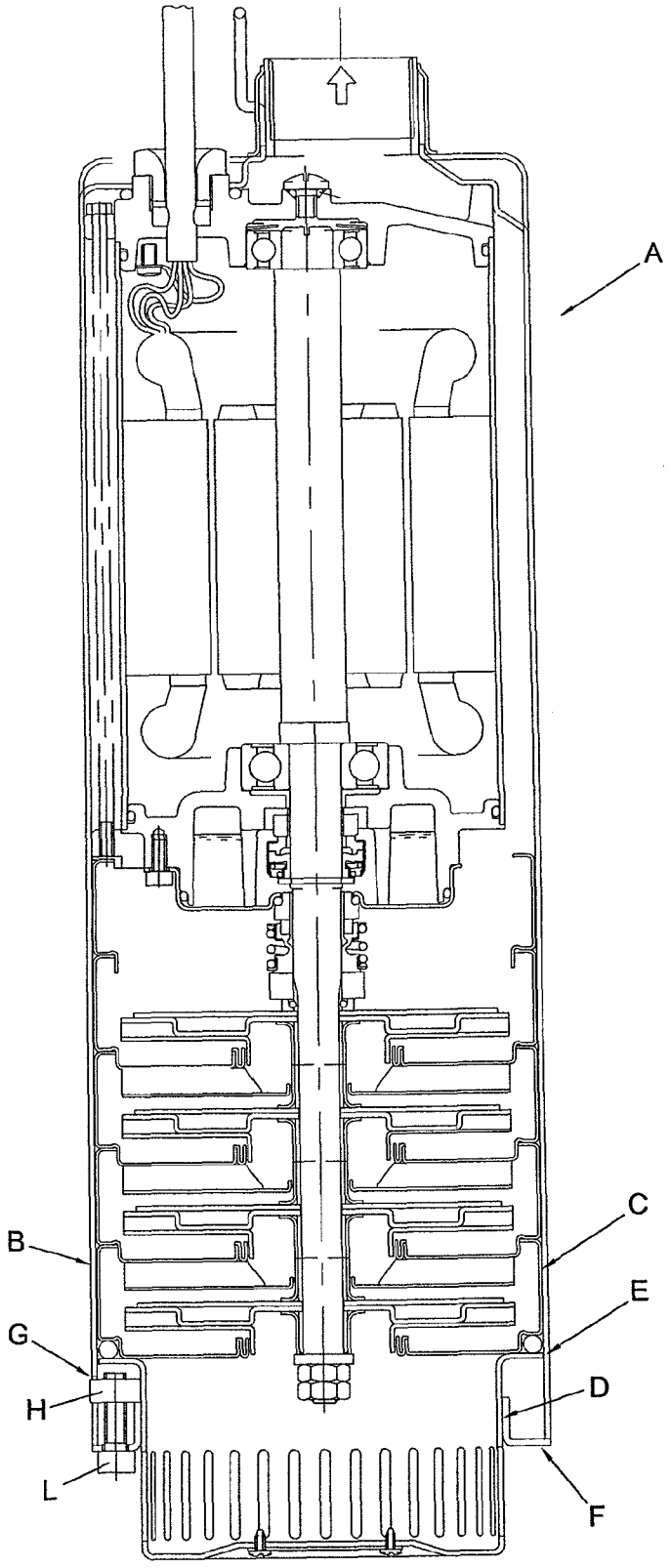


Fig.1

PRIOR ART

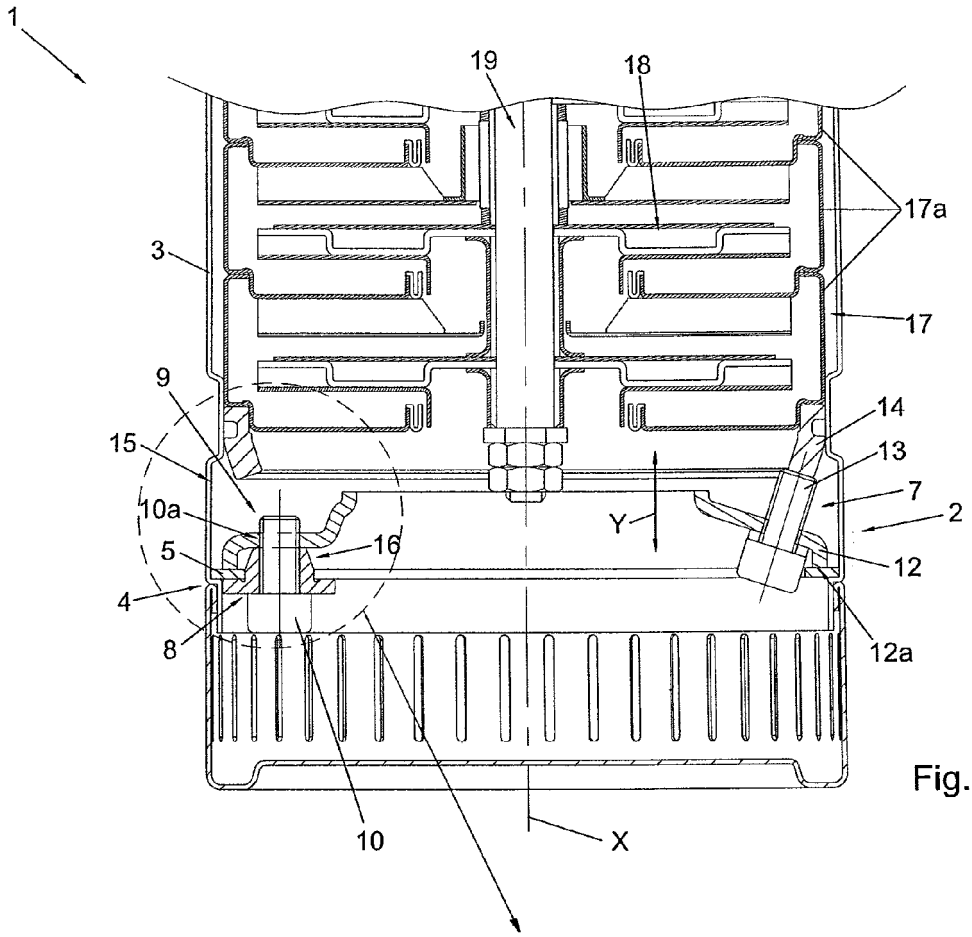

1
19
18
17a
3
17
9
14
15
13
7
10a
Y
2
5
16
12
4
8
12a
10
X

Fig.2

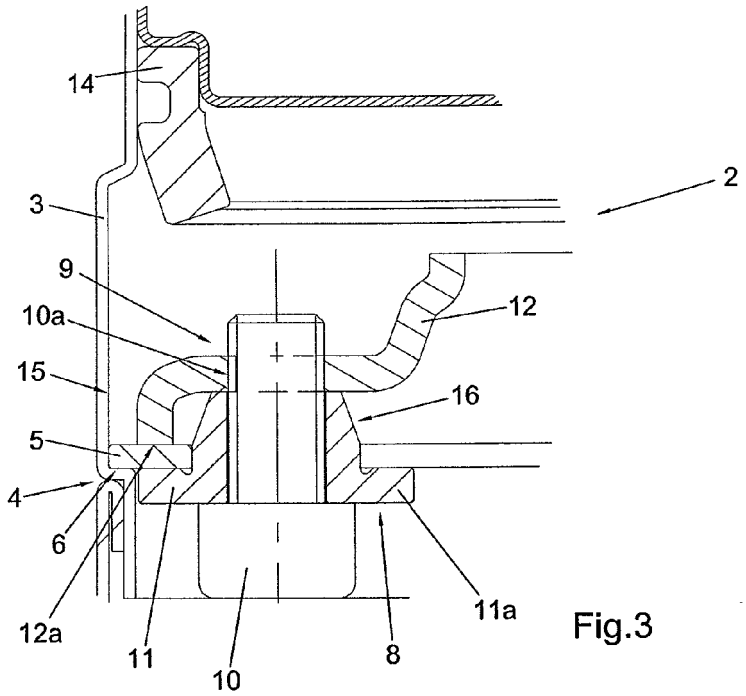

14
2
3
9
12
10a
15
16
5
4
6
12a
11
10
8
11a

Fig.3

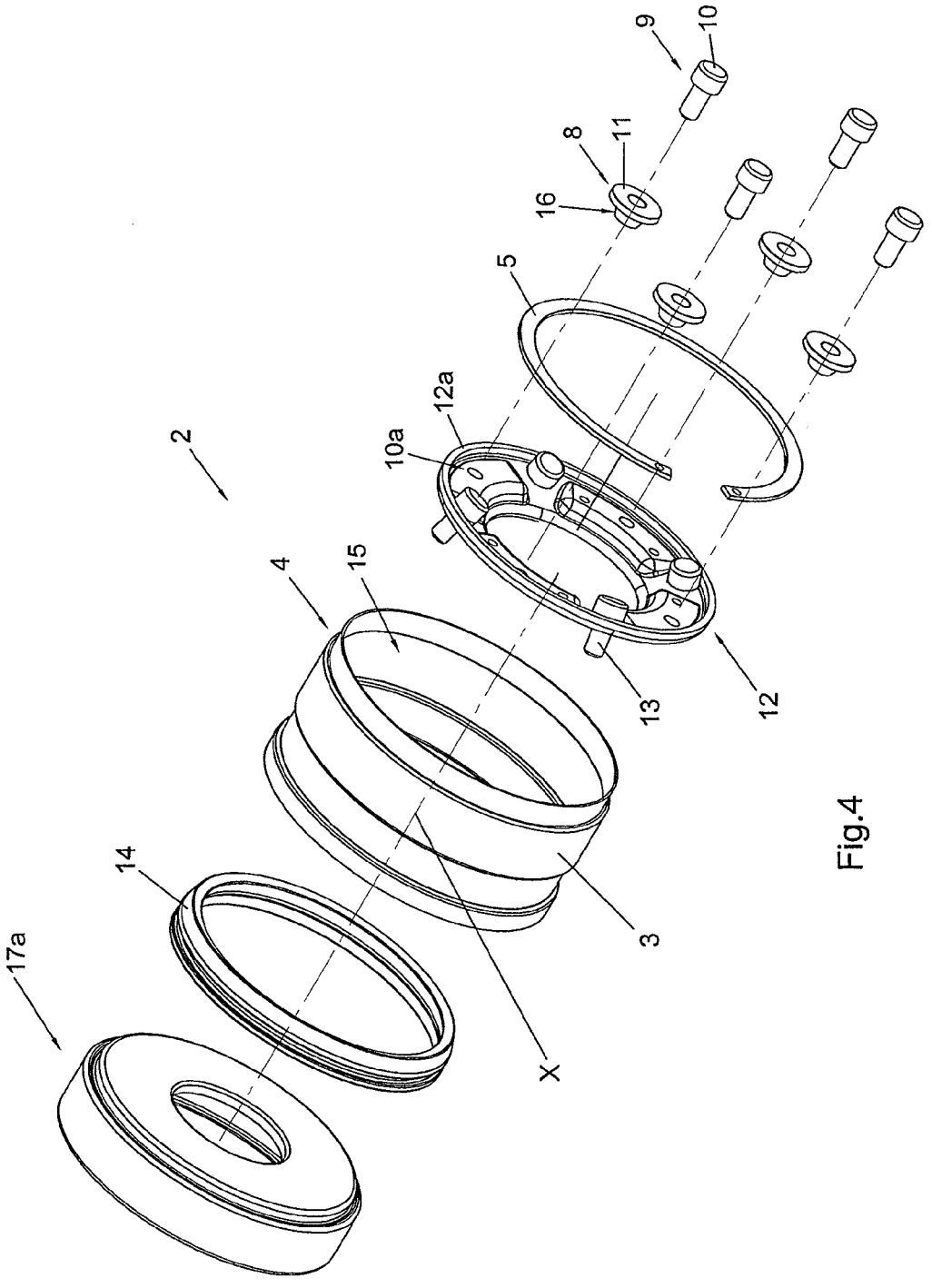


Fig.4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 11 15 8407

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2009/125363 A1 (PEDROLLO SPA [IT]; PEDROLLO SILVANO [IT]) 15 October 2009 (2009-10-15) * paragraph [0022]; figure 2 * * paragraph [0029] - paragraph [0035]; figure 3 *	1,2,5,6, 14,15	INV. F04D1/06 F04D13/08 F04D29/08 F04D29/40 F04D29/62
A	US 2003/185676 A1 (JAMES MARK CHRISTOPHER [US] ET AL) 2 October 2003 (2003-10-02) * paragraph [0020] - paragraph [0024]; figures 1,3 *	1,2,7,15	
A	US 3 676 013 A (ALBERTSON ROBERT V) 11 July 1972 (1972-07-11) * column 2, line 25 - column 3, line 24; figure 1 *	1,6,7,15	
A	GB 827 590 A (HAYWARD TYLER COMPANY LTD; THOMAS HETHERINGTON) 10 February 1960 (1960-02-10) * page 3, line 56 - line 97; figure 1 *	1,7,15	

TECHNICAL FIELDS SEARCHED (IPC)

F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 June 2011	Di Giorgio, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 15 8407

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-06-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009125363 A1	15-10-2009	CN 101990602 A	23-03-2011
		CO 6270165 A2	20-04-2011
		EP 2300717 A1	30-03-2011
US 2003185676 A1	02-10-2003	CA 2422414 A1	18-09-2003
		GB 2387876 A	29-10-2003
US 3676013 A	11-07-1972	NONE	
GB 827590 A	10-02-1960	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82