(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 January 2012 (26.01.2012)

PCT

(10) International Publication Number
WO 2012/012484 A1

(51) International Patent Classification:
C12M 1/06 (2006.01)

(21) International Application Number:
PCT/US2011/044609

(22) International Filing Date:
20 July 2011 (20.07.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/365,947 20 July 2010 (20.07.2010) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) Title: IMPROVED IMPELLER ATTACHMENT METHOD

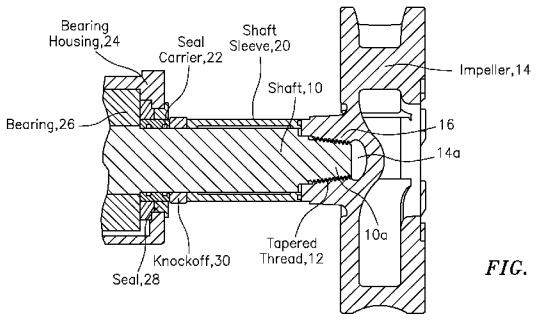

FIG. 1

(57) Abstract: A pump is provided having an impeller in combination with a power transmission shaft. The impeller has a tapered bore with impeller threads. The power transmission shaft has a shaft end with tapered threads configured to couple directly to the impeller threads of the tapered bore of the impeller, to transmit torque directly through the tapered threads, and to provide self axial or radial alignment even if the coupling of the tapered threads and the impeller threads of the tapered bore start out of alignment. The tapered thread configuration substantially reduces investment in lifting equipment and time by maintenance personnel because it eliminates the need for maintenance personnel to precisely align the impeller threads and the tapered threads before attaching or removing the impeller and the tapered threads release much more quickly from the impeller than a standard thread configuration, reducing the number of turns the power transmission shaft must be rotated by hand to free it from the impeller.

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IMPROVED IMPELLER ATTACHMENT METHOD

CROSS REFERENCE TO RELATED PATENT APPLICATION

This application claims benefit to patent application serial no. 61/365,947, filed 20 July 2010, which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a pump; and more particularly relates to a new technique for attaching an impeller to a shaft in a pump, including a centrifugal pump or a slurry-type pump.

2. Description of Related Art

Current pump designs use straight (cylindrical) threads of various forms to attach an impeller to a power transmission shaft in a pump. While inexpensive, this method of attachment presents several difficulties for maintenance personnel, including alignment requirements to start threads that are difficult to maintain in field conditions (large, heavy parts must be aligned precisely with inadequate lifting equipment), the tendency of standard thread forms to cross thread if slightly misaligned, and the large number of turns required to seat the shaft threads in the impeller.

By way of example, there are known techniques for attaching an impeller to a shaft in a pump, including that disclosed in United States Patent No. 2,364,168, which sets forth a connection of an impeller shaft to a motor shaft using a tapered thread connection having on one end an impeller, a threaded tapered shaft, and a threaded nut. However, in the technique disclosed in the '168 patent,

1) Torque is transmitted from the shaft to the impeller through a split hub on the impeller. A nut on a tapered thread tightens the hub against the motor shaft.

2) There is no "direct" connection of the impeller to the shaft as is accomplished in current threaded-shaft/threaded impeller bore designs.

3) While the front of the impeller uses a nut threaded on a tapered shaft, it appears to be used only for positioning the impeller.

See also the technique disclosed in United States Patent No. 6,663,343, which sets forth an impeller mounting system, wherein an impeller shaft has tapered threads for merely engaging a collar.

In view of this, there is a need in the industry for a technique for attaching the impeller to the power transmission shaft that reduces problems associated with alignment requirements to start threads that are difficult to maintain in field conditions (large, heavy parts must be aligned precisely with inadequate lifting equipment), the tendency of standard thread forms to cross thread if slightly misaligned, and the large number of turns required to seat the shaft threads in the impeller.

SUMMARY OF THE INVENTION

According to some embodiments, the present invention may take the form of apparatus, such as a pump, having an impeller in combination with a power transmission shaft. The impeller has a tapered bore with impeller threads. The power transmission shaft has a shaft end with tapered threads configured to couple directly to the impeller threads of the tapered bore of the impeller, to transmit torque directly through the tapered threads, and to provide self axial alignment even if the coupling of the tapered threads and the impeller threads of the tapered bore start out

of alignment. The tapered thread configuration substantially reduces investment in lifting equipment and time because it eliminates the need for maintenance personnel to precisely align the impeller's threads and the shaft's threads before attaching or removing the impeller, and the tapered threads release much more quickly from the impeller than a standard thread configuration, reducing the number of turns the power transmission shaft must be rotated by hand to free it from the impeller.

According to some embodiments, the present invention may take the form of apparatus such as a pump assembly, arrangement or combination, as well as other types or kinds of rotating machinery or equipment, including a compressor or fan, featuring an impeller in combination with a shaft, where the impeller has a tapered bore with impeller threads; and where the shaft has a shaft end with tapered threads configured to couple directly to the impeller threads of the tapered bore of the impeller, to transmit torque directly through the tapered threads, and to provide self alignment even if the coupling of the tapered threads and the impeller threads of the tapered bore starts out of alignment. The self alignment includes both axial and radial alignment. The tapered thread and the impeller threads are configured in combination to substantially eliminate the need to precisely align the impeller threads and the tapered threads before attaching or removing the impeller, and the tapered threads are configured to release quickly from the impeller threads when compared to a standard thread configuration, reducing the number of turns the shaft must be rotated to be removed from the impeller.

Use of a tapered thread according to the present invention reduces maintenance needs (time, training and equipment) by providing a method of attachment that will self align even if started out of alignment. The tapered thread reduces investment in lifting equipment and time because it eliminates the need for

maintenance personnel to precisely align the impeller and shaft threads before attaching or removing the impeller. Additionally, the tapered thread releases much more quickly from the impeller than a standard thread, reducing the number of turns a shaft must be rotated by hand to free it from the impeller.

By way of example, the pump or pump assembly, arrangement or combination may take the form of a slurry-type pump or centrifugal pump.

Some features and advantages of the present invention also include:

The torque required to drive the impeller is transmitted through the threads.

There is less movement of a potentially heavy part (impeller), thus

- Fewer turns to completely disengage the threads, and
- Less axial distance travelled.

The tapered threads allow the impeller to self-align, even if it is presented to the shaft

- Eccentrically, or
- Angularly.

Less time is required for both disassembly and reassembly, as the shaft will be reused many times during the lifetime of the unit, while impellers are used only once then discarded when worn out.

The eccentricity of the impeller relative to the shaft is reduced due to a turn on the shaft mating closely with a counterbore on the impeller. The reduction in eccentricity further manifests itself in reduced vibration of the operating unit. In general, reduced vibration leads to longer operating life.

One advantage of the present invention is that the impeller may disengage in as few as about 3-5 turns of the shaft, as opposed to having to travel the entire length of the thread of the shaft/impeller. Axial movement before disengaging is

approximately 1 inch. Experimentation has also indicated that, even when there is misalignment of the impeller and shaft angularly and longitudinally, the threads have typically engaged and aligned the impeller to the shaft.

These and other features, aspects, and advantages of embodiments of the invention will become apparent with reference to the following description in conjunction with the accompanying drawing. It is to be understood, however, that the drawing is designed solely for the purposes of illustration and not as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawing, which is not necessarily to scale, include the following Figures:

Figure 1 shows a diagram of a shaft having tapered threads coupled to an impeller with corresponding tapered threads according to some embodiments of the present invention.

Figure 2 shows a top perspective view of a powerframe having a shaft with tapered threads according to some embodiments of the present invention.

Figure 3 shows an exploded view of a pumping arrangement having an impeller with corresponding tapered impeller threads according to some embodiments of the present invention.

In the following description of the exemplary embodiment, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration of an embodiment in which the invention may be practiced. It is to be understood that other embodiments may be utilized, as structural and operational changes may be made without departing from the scope of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows the basic invention in the form of apparatus such as an assembly, arrangement or combination that includes a shaft 10 having an end 10a with tapered threads 12 coupled to an impeller 14 having a bore 14a with corresponding tapered impeller threads 16 formed therein, according to some embodiments of the present invention. The impeller shaft 10 and the impeller 14 form part of apparatus, such as a pump assembly, arrangement or combination consistent with that shown in Figures 2-3 herein. As shown, the impeller shaft 10 is coupled directly to the impeller 14 so that the tapered threads 12 of the shaft 10 rotationally mate and frictionally engage the corresponding tapered impeller threads 16 of the impeller 14 to transmit torque directly through the tapered threads 12, and to provide self alignment even if the coupling of the tapered threads 12 and the impeller tapered threads 16 of the tapered bore 14a start out of alignment. The tapered thread configuration substantially reduces investment in lifting equipment and time because it eliminates the need for maintenance personnel to precisely align the tapered impeller threads 16 and the tapered threads 12 before attaching or removing the impeller 14, and the tapered threads 12 release much more quickly from the impeller 14 than a standard thread configuration, reducing the number of turns the shaft 10, including for example, a power transmission shaft as discussed below, must be rotated by hand to free it from the impeller 14.

By way of example, according to some embodiments of the present invention, the tapered threads 12 may be configured based at least partly on using an API regular tapered thread, although the scope of the invention is not intended to be limited to any particular size, type or kind of tapered thread. Embodiments of the present invention are also envisioned using other types or kinds of tapered threads

in addition to the aforementioned API tapered thread either now known or later developed in the future. By way of example, in some embodiments of the present invention a configuration having a pitch of 5 threads per inch may be used, although the scope of the invention is not intended to be limited to any particular number of threads per inch. Embodiments are envisioned using other configurations with other pitches depending on the particular application. By way of further example, in other embodiments of the present invention, a configuration having a 1 in 4 taper (i.e., 1 inch of diameter reduction for 4 inches of axial length), although the scope of the invention is not intended to be limited to any particular taper reduction. Embodiments are envisioned using other configurations with other taper reductions depending on the particular application.

In Figure 1, the arrangement, assembly or combination according to the present invention is shown in relation to other parts that do not form part of the underlying invention, including a shaft sleeve 20, a seal carrier 22, a bearing housing 24, a bearing 26, a seal 28 and a knockoff 30, which are parts that are known in the art, and that can be used in a pumping arrangement in relation to the shaft 10, as one skilled in the art would appreciate. The present invention is not intended to be limited to using the same in relation to these other parts 20, 22, ..., 30; and embodiments of the present invention are envisioned in which the present invention is used with, and forms parts of, other equipment, apparatus or devices having both the same parts 20, 22, ..., 30 in the same arrangement as, or in a different arrangement than, that shown in Figure 1, as well as different other parts in a corresponding different arrangement than that shown in Figure 1. The arrangement, assembly or combination according to the present invention may also work in relation to, or in cooperation with, other parts that are not shown herein, including

chamfers on the shoulder of the shaft behind the tapered threads and in the straight bore of the impeller to help guide the impeller onto the shaft and allow it to tighten properly.

By way of example, the present invention is described in relation to the pump assembly, arrangement or combination shown in Figures 2-3, although the scope of the invention is intended to include apparatus, such as other types or kinds of rotary equipment, assemblies, arrangements, devices or combinations having a rotating shaft coupled directly to an impeller, that are either now known or later developed in the future. For example, Figures 2-3 show apparatus in the form of a pump assembly, arrangement or combination, where Figure 2 shows a combination generally indicated as 100 of a power frame 102, a pedestal 104 and a power transmission shaft 106, and where Figure 3 shows a pumping assembly combination generally indicated as 200 having outer casing sub-components 202a and 202b, a pump or volute liner 204, an impeller 206, front and rear liners and/or covers 208a, 208b and a gasket 210. The power transmission shaft 106 has an end 106a with tapered threads 106b. The impeller 206 has a bore 206a having corresponding threads 206b. When assembled, the power transmission shaft 106 is coupled directly to the impeller 206 so that the tapered threads 106b of the power transmission shaft 106 rotationally mate and frictionally engage the corresponding tapered threads 206b of the impeller 206.

The power frame 102 has an end cover 102a having bores and turns (unlabeled). The pedestal 104 also has hold down plates 105 having wings 105a with holes that penetrate to allow threaded bolts or rods 110 to pass through. A bearing cartridge 103 is mounted in the pedestal 104 on wings (not shown) that mate with machined grooves or ways (not shown) in the pedestal 104. The combination

100 also includes threaded bolts or rods 110 arranged in holes of the end cover 102a and the corresponding holes in the wings 105a. The combination 100 also includes nuts 112 for adapting on the threaded bolts or rods 110, which may be loosened and tightened in a manner that would be appreciated by one skilled in the art without undue experimentation in order to move, slide or adjust the power frame 102 and bearing cartridge 103 in relation to the pedestal 104, and further in relation to the pumping assembly combination 200. The hold-down plates 105 are configured to clamp the bearing cartridge 103 in the pedestal 104 to prevent its movement after it has been appropriately adjusted, and are also configured with grooves machined therein (not shown). Appropriate pairs of nuts 112 are suitably tightened on both sides of the end plate 102a and the wings 105a in order to secure the bearing cartridge 103 in relation to pedestal 104 and the pumping assembly combination 200.

The other parts of the pumping assembly combination 200 shown in Figure 3, including the outer casing sub-components 202a and 202b, the pump or volute liner 204, the front and reap liners and/or covers 208a, 208b and the gasket 210 do not form part of the underlying invention, are known in the art, and are not described in detail herein.

SCOPE OF THE INVENTION

Although described in the context of particular embodiments, it will be apparent to those skilled in the art that a number of modifications and various changes to these teachings may occur. Thus, while the invention has been particularly shown and described with respect to one or more preferred embodiments

thereof, it will be understood by those skilled in the art that certain modifications or changes, in form and shape, may be made therein without departing from the scope and spirit of the invention as set forth above.

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I CLAIM:

1. A pump or pump assembly, arrangement or combination comprising:

an impeller having a tapered bore with impeller threads; and

a shaft having a shaft end with tapered threads configured to couple directly to the impeller threads of the tapered bore of the impeller, to transmit torque directly through the tapered threads, and to provide self alignment even if the coupling of the tapered threads and the impeller threads of the tapered bore starts out of alignment,

the tapered thread and the impeller threads being configured in combination to substantially eliminate the need to precisely align the impeller threads and the tapered threads before attaching or removing the impeller, and

the tapered threads being configured to release quickly from the impeller threads when compared to a standard thread configuration, reducing the number of turns the shaft must be rotated to be removed from the impeller.

2. A pump or pump assembly, arrangement or combination according to claim 1, wherein the shaft is a power transmission shaft.

3. A pump or pump assembly, arrangement or combination according to claim 1, wherein the self alignment includes an axial or radial alignment.

4. A pump or pump assembly, arrangement or combination according to claim 1, wherein the pump or pump assembly, arrangement or combination includes a slurry-type pump or centrifugal pump.

5. Apparatus, comprising:

an impeller having a tapered bore with impeller threads; and

a power transmission shaft having a shaft end with tapered threads configured to couple directly to the impeller threads of the tapered bore of the impeller, to transmit torque directly through the tapered threads, and to provide self alignment even if the coupling of the tapered threads and the impeller threads of the tapered bore starts out of alignment,

the tapered thread and the impeller threads being configured in combination to substantially eliminate the need to precisely align the impeller threads and the tapered threads before attaching or removing the impeller, and

the tapered threads being configured to release quickly from the impeller threads when compared to a standard thread configuration, reducing the number of turns the shaft must be rotated to be removed from the impeller.

6. Apparatus according to claim 5, wherein the self alignment includes an axial or radial alignment.

7. Apparatus according to claim 5, wherein the apparatus takes the form of a pump or pump assembly, arrangement or combination.

8. Apparatus according to claim 5, wherein the pump or pump assembly, arrangement or combination takes the form of a slurry-type pump or centrifugal pump.

9. Apparatus according to claim 5, wherein the apparatus takes the form of rotating machinery or equipment, including a compressor or fan.

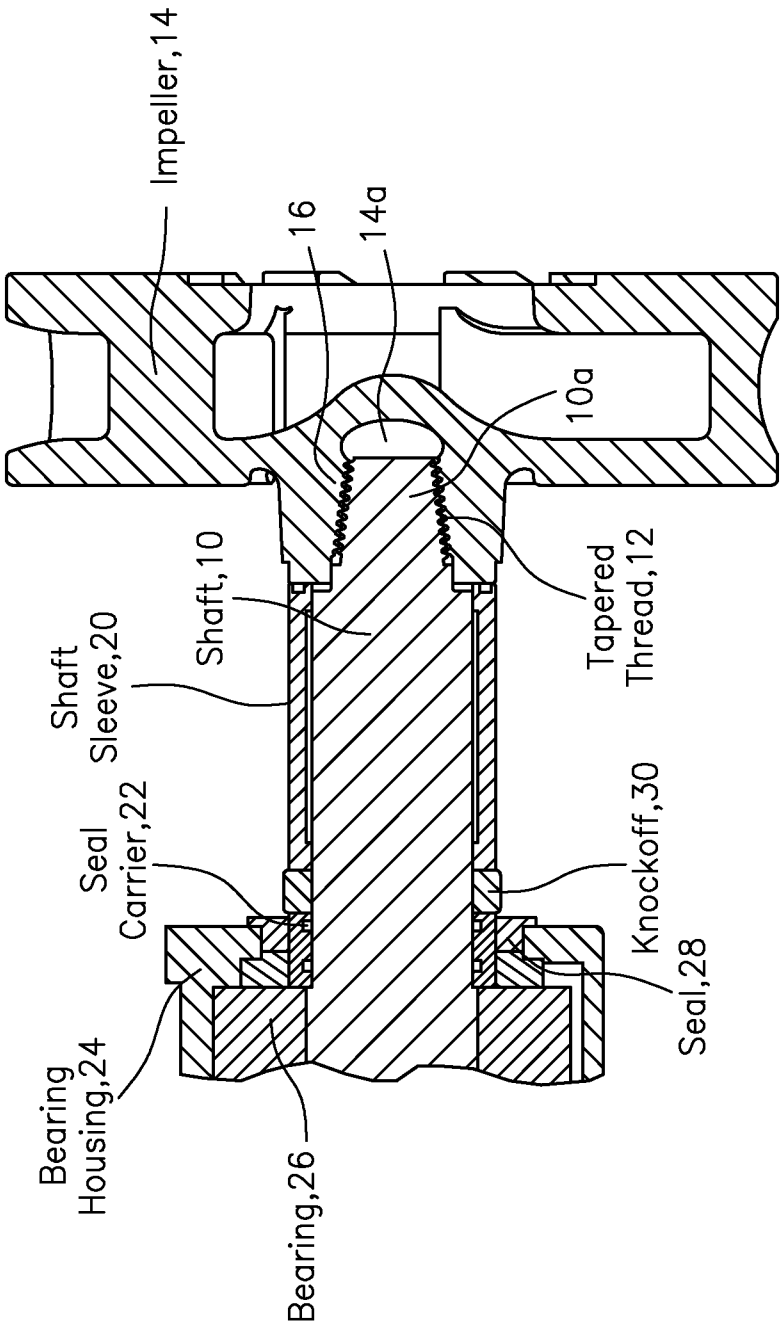
Impeller,14
16
14a
10a
Shaft,10
Shaft Sleeve,20
Tapered Thread,12
Seal Carrier,22
Knockoff,30
Seal,28
Bearing Housing,24
Bearing,26

FIG. 1

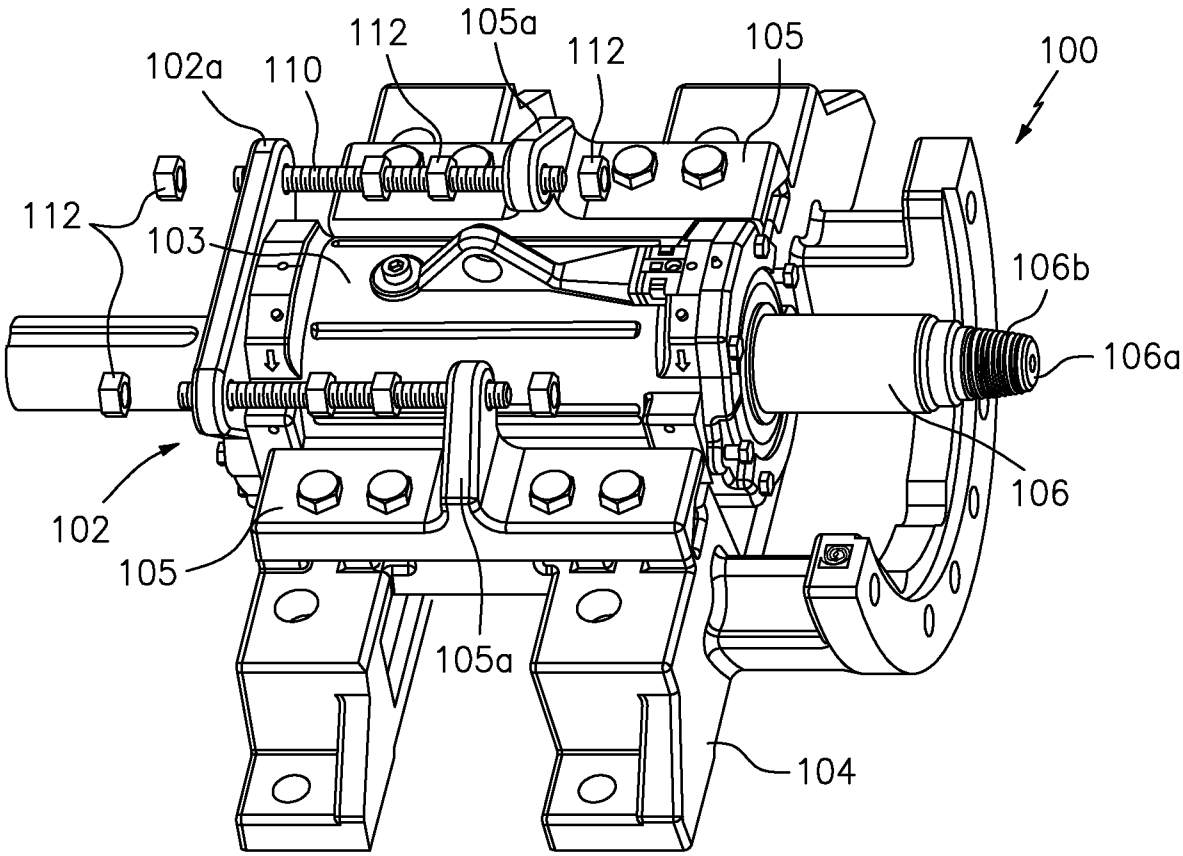
102a
110
112
105a
112
105
100
112
103
106b
106a
102
105
105a
106
104

FIG. 2

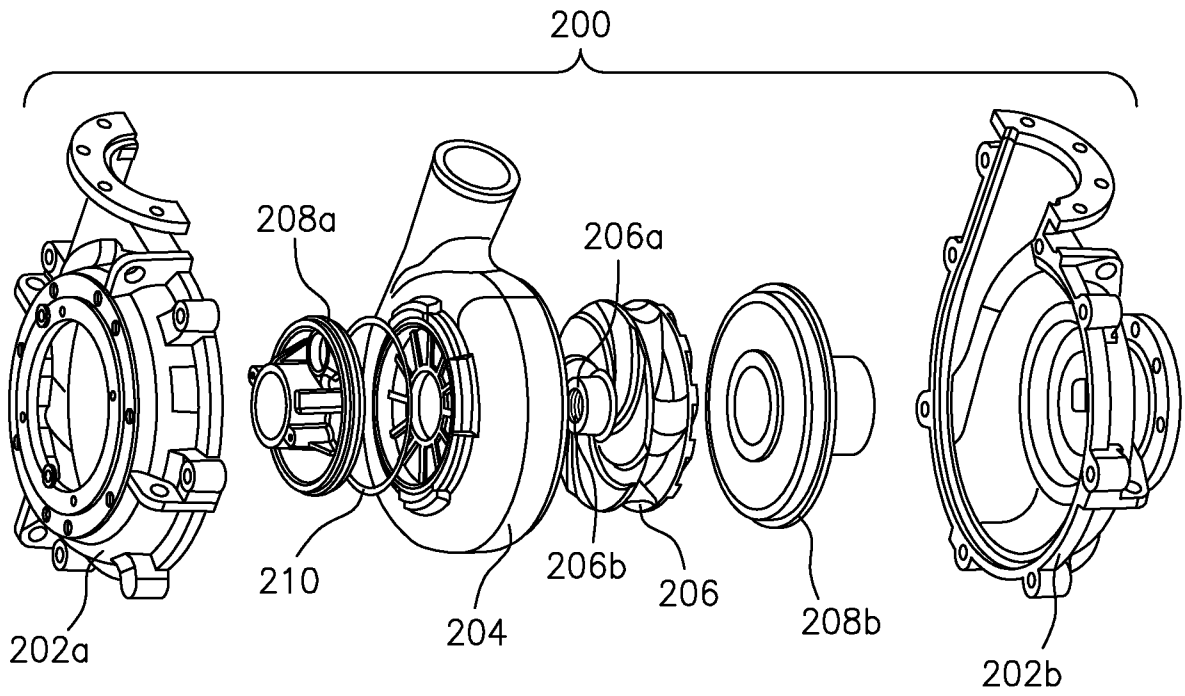
200
208a
206a
210
204
206b
206
208b
202a
202b

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/044609

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - C12M 1/06 (2011.01)
USPC - 266/235
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)
IPC(8) - A47L 15/06; C12M 1/06; D06F 17/08 (2011.01)
USPC - 266/233, 235; 416/147

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)
PatBase, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,689,310 B1 (COOPER) 10 February 2004 (10.02.2004) entire document	1-9
A	US 5,597,289 A (THUT) 28 January 1997 (28.01.1997) entire document	1-9
A	US 6,303,074 B1 (COOPER) 16 October 2001 (16.10.2001) entire document	1-9

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 December 2011	22 DEC 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774