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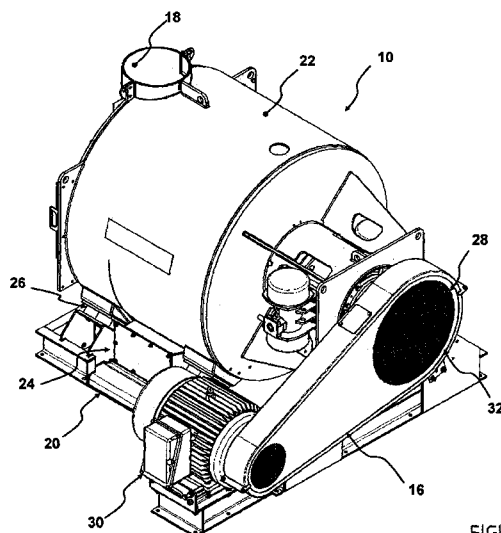


FIGURE 1

(57) Abstract: The present invention relates generally to a vibratory centrifuge (10) comprising a shaft assembly (12) mounted to a basket assembly (14) which is rotated by a drive mechanism (16). The shaft assembly (12) includes a shaft (38) rotationally mounted in a shaft housing (40) and adapted at opposing ends to connect to the basket assembly (14) and the drive mechanism (16), respectively. The shaft assembly (12) also includes a pair of preloaded thrust bearings (42A and 42B) mounted to the shaft (38) and designed to handle axial vibratory loads in the shaft (38). One of the preloaded thrust bearings (42A) is mounted to the shaft housing (40) and thus designed to also handle radial loads. The shaft assembly (12) further comprises biasing means in the form of disc springs (46) mounted between the pair of preloaded bearings (42A/B) to maintain a predetermined constant static preload under the axial vibratory loads.



WO 2013/000015 A1

VIBRATORY CENTRIFUGE

FIELD OF THE INVENTION

The present invention relates broadly to a vibratory centrifuge shaft assembly. The invention also relates generally to a vibratory centrifuge.

BACKGROUND TO THE INVENTION

Vibratory centrifuges are constructed from:

- i) conical baskets made from wire sieve segments that are rotated to achieve up to 100g of centrifugal acceleration for the purpose of solid/liquid separation to dewater coal, salt, sand and phosphate in mineral processing plants;
- ii) a solids transport system consisting of some form of mechanical excitation to vibrate the minerals along the basket.

In operation, the bulk material is fed through a chute onto the basket. The rotation of the basket speeds up the feed material to begin centrifugal dewatering. The rotating parts (the basket and shaft assembly) are vibrated to transport the mineral, such as coal. The effluent water is collected in the main housing and drained away, the dewatered solids vibrated off the basket to a discharge chute. The main housing is mounted on resilient vibration isolators above a base frame fixed to a foundation.

In most vibratory centrifuges on the market, the two bearings supporting the shaft are subjected to high axial loads due to the vibration of the shaft assembly, and also high radials loads from rotating imbalance forces generated by uneven distribution of feed material on the basket. Due to this, the bearings are exposed to high cyclic and/or shock loading degrading the condition and service life of the bearings.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a vibratory centrifuge shaft assembly comprising:

- a shaft rotationally mounted in a shaft housing and adapted at opposing ends to connect to a basket assembly and a drive mechanism, respectively;

- a preloaded thrust bearing mounted to the shaft and designed to handle axial vibratory loads in the shaft.

According to another aspect of the invention there is provided a vibratory centrifuge comprising:

- a shaft rotationally mounted in a shaft housing;

- a basket assembly mounted to one end of the shaft;

- a drive mechanism mounted to an opposite end of the shaft;

- a preloaded thrust bearing mounted to the shaft and designed to handle axial vibratory loads in the shaft.

Preferably the preloaded thrust bearing is one of a pair of preloaded thrust bearings mounted to the shaft proximate one another and located at or adjacent the drive mechanism. More preferably one only of the preloaded thrust bearings is mounted to the shaft housing and designed to also handle radial loads.

Preferably the shaft assembly further comprises biasing means mounted intermediate the pair of preloaded thrust bearings to maintain a predetermined constant static preload under the axial vibratory loads. More preferably the biasing means includes disc springs mounted between the preloaded thrust bearing and an internal annular flange of the shaft housing. Even more preferably the other of the pair of the preloaded thrust bearings is located on an opposite side of and abuts the internal annular flange at the predetermined constant static preload.

Preferably the shaft assembly also comprises a radial bearing mounted to the shaft and the shaft housing at or adjacent the basket assembly. More preferably the radial bearing together with said one only of the preloaded thrust bearings handle radial imbalance loads in the shaft.

Preferably the basket assembly includes a frusto-conical basket connected at its smaller diameter end to a basket mount connected to the shaft. More preferably the basket is fabricated at least in part from a mesh or sieve material.

Preferably the drive mechanism includes a pulley connected to the shaft and coupled to a drive motor via a continuous belt.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to achieve a better understanding of the nature of the present invention a preferred embodiment of a vibratory centrifuge shaft assembly, and a vibratory centrifuge will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is an isometric view of a vibratory centrifuge according to an embodiment of the invention;

Figure 2 is an isometric sectioned view of the vibratory centrifuge of figure 1;

Figure 3 is a side sectioned view of the vibratory centrifuge of figures 1 and 2;

Figure 4 is an isometric sectioned view of a shaft assembly taken from the vibratory centrifuge of the preceding figures;

Figure 5 is a side sectioned view of the vibratory centrifuge shaft assembly of figure 4; and

Figure 6 is a schematic of the shaft assembly of figures 4 and 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As best shown in figures 1 to 3 there is a vibratory centrifuge 10 comprising a shaft assembly 12 mounted to a basket assembly 14 which is rotated by a drive

mechanism depicted generally as 16. The vibratory centrifuge 10 also comprises a chute 18 which is operatively coupled to the basket assembly 14 to provide it with a solid/liquid feed such as coal, salt, sand and phosphate to be dewatered in a mineral processing plant. It should however be understood that the vibratory centrifuge has other applications besides solid/liquid separation.

As shown in figure 1 the vibratory centrifuge 10 otherwise comprises a baseframe 20 to which a main housing 22 is connected via support mounts such as 24 (see figure 3) and vibration isolators such as 26 (see figure 1). The vibration isolators such as 26 of this embodiment are oriented as inclined mounts to handle high axial vibratory loading together with high rotating imbalance loads. The inclined vibration isolators such as 26 are designed to handle all dynamic loads, both axial/thrust and radial loads, prevalent in vibratory centrifuges of this type. The drive mechanism 16 of this embodiment includes a pulley 28 connected to the shaft assembly 12 and coupled to a drive motor 30 (see figure 1) via a continuous belt 32. As shown in figures 2 and 3 the basket assembly 14 includes a frusto-conical basket 34 connected at its smaller diameter end to a basket mount 36 connected to the shaft assembly 12. The basket 34 is about its tapered or conical surface fabricated from a mesh or in this example wire sieve segments.

As best shown in figures 4 and 5 the shaft assembly 12 includes a shaft 38 rotationally mounted in a shaft housing 40 and adapted at opposing ends to connect to the basket assembly 14 and the drive mechanism 16, respectively (see figures 2 and 3). The shaft assembly 12 also includes a pair of preloaded thrust bearings 42A and 42B mounted to the shaft 38 and designed to handle axial vibratory loads in the shaft 38. One of the preloaded thrust bearings 42A is mounted to the shaft housing 40 and thus designed to also handle radial loads. The pair of preloaded bearings 42A/B are located on the shaft 38 adjacent its connection to the drive mechanism 16. The shaft assembly 12 also comprises a radial bearing 44 mounted to the shaft 38 and the shaft housing 40 adjacent the basket assembly 14. The preloaded bearing 42A together with the radial bearing 44 handle radial loads in the shaft from rotating imbalance forces generated by uneven distribution of feed material on the basket 34.

The shaft assembly 12 further comprises biasing means in the form of disc springs such as 46 mounted between the pair of preloaded bearings 42A/B to maintain a predetermined constant static preload under the axial vibratory loads. In this embodiment the disc springs 46 are mounted between the other of the preloaded thrust bearings 42B and an internal annular flange 48 of the shaft housing 40. The preloaded thrust bearing 42A is located on an opposite side of and abuts the internal annular flange 48 at the predetermined constant static preload. The preloaded bearings 42A/B are a tolerance fit on the shaft 38 and are preloaded before operation by hydraulic pressure in applying a compression on the disc springs 46 inside the shaft assembly 12. This preload is maintained by a combination of a lock nut 50 and the tolerance fit of the preloaded bearings 42A/B on the shaft 38. The preloaded thrust bearing 42B has radial clearance from the shaft housing 40 and thus has no applied radial loads. Therefore, two of the three bearings 42A and 44 handle radial imbalance loads, and two of the three bearings 42A/B handle preload and axial/thrust vibration loads.

The shaft assembly 12 and associated bearing arrangement of this embodiment maintains a set preload force on the bearings to avoid high cyclic and/or shock loading degrading the condition and service life of the bearings. In its application in centrifugal dewatering the disc springs 46 and associated pair of preloaded thrust bearings 42A/B are preloaded to between 100 to 120 kN with axial vibratory loads at around 60 kN. The preloaded bearings 42A/B are effectively balanced either side of the annular flange 48 to handle the vibratory axial loads produced by the solids transport system (not shown). Figure 6 is a schematic illustration of the shaft assembly 12 showing the described arrangement of bearings 42A/B and 44, disc springs 46, shaft 38 and shaft housing 40.

Now that a preferred embodiment of the present invention has been described in some detail it will be apparent to those skilled in the art that the vibratory centrifuge has at least the following advantages over the admitted prior art:

1. The expected service life of the bearing assembly is extended;

2. The shaft and more particularly bearing assembly is understood to produce significantly less heat compared to traditional systems which may heat up to and in excess of 90°C;
3. The inclined vibration isolators simplify the baseframe whereas traditional designs having several vertical, horizontal and axial isolators are necessarily quite large and complex to accommodate multiple isolators.

Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. For example, the specific bearing arrangement may vary from that described and possibly be limited to a single preloaded thrust bearing. The main or shaft housing, basket assembly, and/or drive mechanism may vary from the specific design described and illustrated. All such variations and modifications are to be considered within the scope of the present invention the nature of which is to be determined from the foregoing description.

CLAIMS

1. A vibratory centrifuge shaft assembly comprising:
 - a shaft rotationally mounted in a shaft housing and adapted at opposing ends to connect to a basket assembly and a drive mechanism, respectively;
 - a preloaded thrust bearing mounted to the shaft and designed to handle axial vibratory loads in the shaft.
2. A vibratory centrifuge comprising:
 - a shaft rotationally mounted in a shaft housing;
 - a basket assembly mounted to one end of the shaft;
 - a drive mechanism mounted to an opposite end of the shaft;
 - a preloaded thrust bearing mounted to the shaft and designed to handle axial vibratory loads in the shaft.
3. A vibratory centrifuge shaft assembly or a vibratory centrifuge as defined in claim 1 or 2 respectively wherein the preloaded thrust bearing is one of a pair of preloaded thrust bearings mounted to the shaft proximate one another and located at or adjacent the drive mechanism.
4. A vibratory centrifuge shaft assembly or a vibratory centrifuge as defined in claim 3 wherein one only of the preloaded thrust bearings is mounted to the shaft housing and designed to also handle radial loads.
5. A vibratory centrifuge shaft assembly or a vibratory centrifuge as defined in either of claims 3 or 4 wherein the shaft assembly further comprises biasing means mounted intermediate the pair of preloaded thrust bearings to maintain a predetermined constant static preload under the axial vibratory loads.
6. A vibratory centrifuge shaft assembly or a vibratory centrifuge as defined in claim 5 wherein the biasing means includes disc springs mounted between the preloaded thrust bearing and an internal annular flange of the shaft housing.
7. A vibratory centrifuge shaft assembly or a vibratory centrifuge as defined in claim 6 wherein the other of the pair of the preloaded thrust bearings is located on an

opposite side of and abuts the internal annular flange at the predetermined constant static preload.

8. A vibratory centrifuge shaft assembly or a vibratory centrifuge as defined in any one of the preceding claims wherein the shaft assembly also comprises a radial bearing mounted to the shaft and the shaft housing at or adjacent the basket assembly.

9. A vibratory centrifuge shaft assembly or a vibratory centrifuge as defined in the claim 8 (when it depends on claim 4) wherein the radial bearing together with said one only of the preloaded thrust bearings handle radial imbalance loads in the shaft.

10. A vibratory centrifuge as defined in any one of claims 2 to 9 wherein the basket assembly includes a frusto-conical basket connected at its smaller diameter end to a basket mount connected to the shaft.

11. A vibratory centrifuge as defined in claim 10 wherein the basket is fabricated at least in part from a mesh or sieve material.

12. A vibratory centrifuge as defined in any one of claims 2 to 11 wherein the drive mechanism includes a pulley connected to the shaft and coupled to a drive motor via a continuous belt.

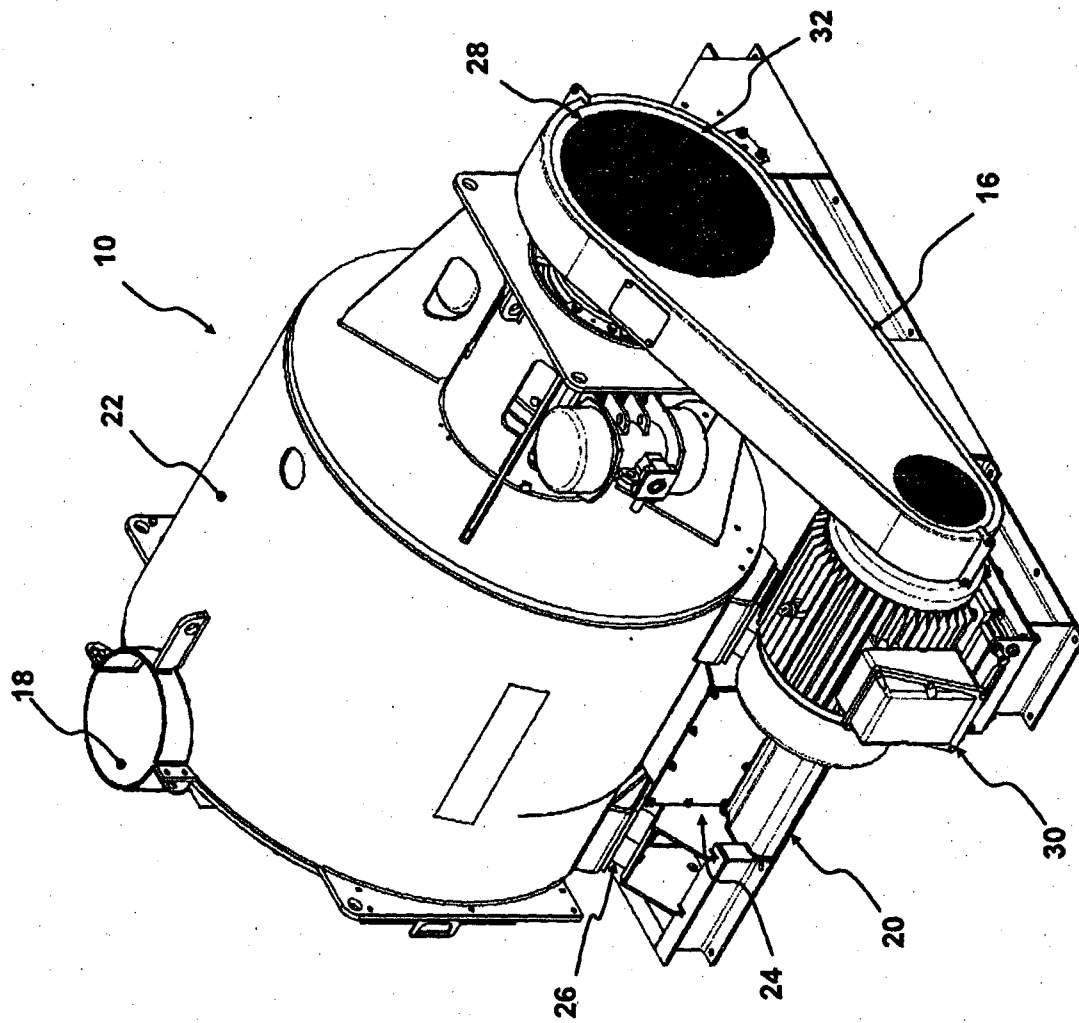


FIGURE 1

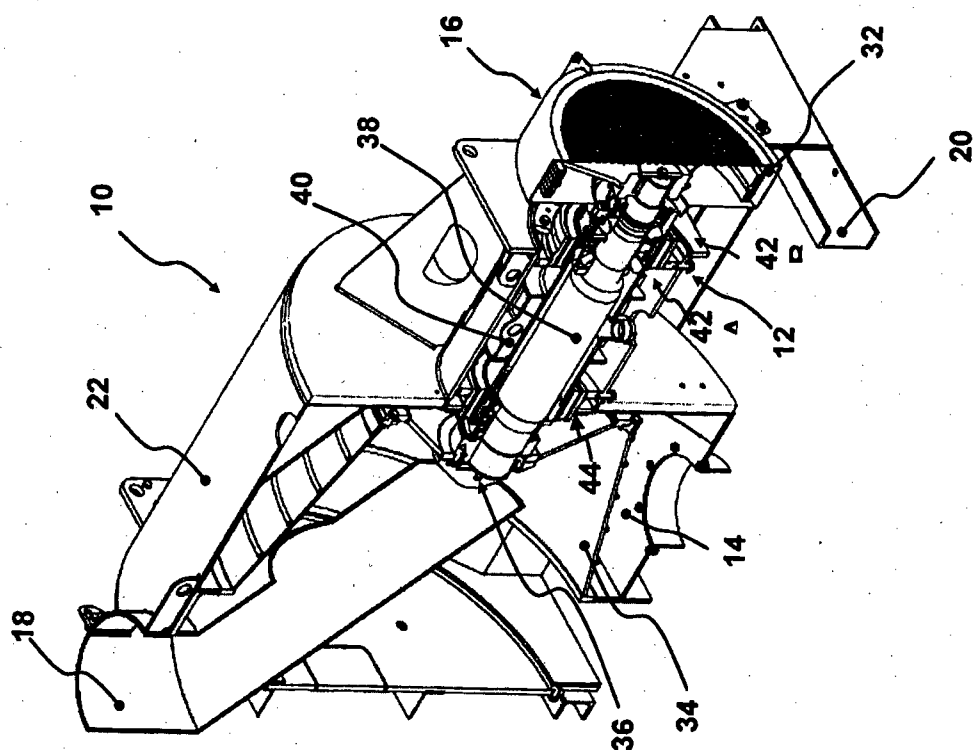


FIGURE 2

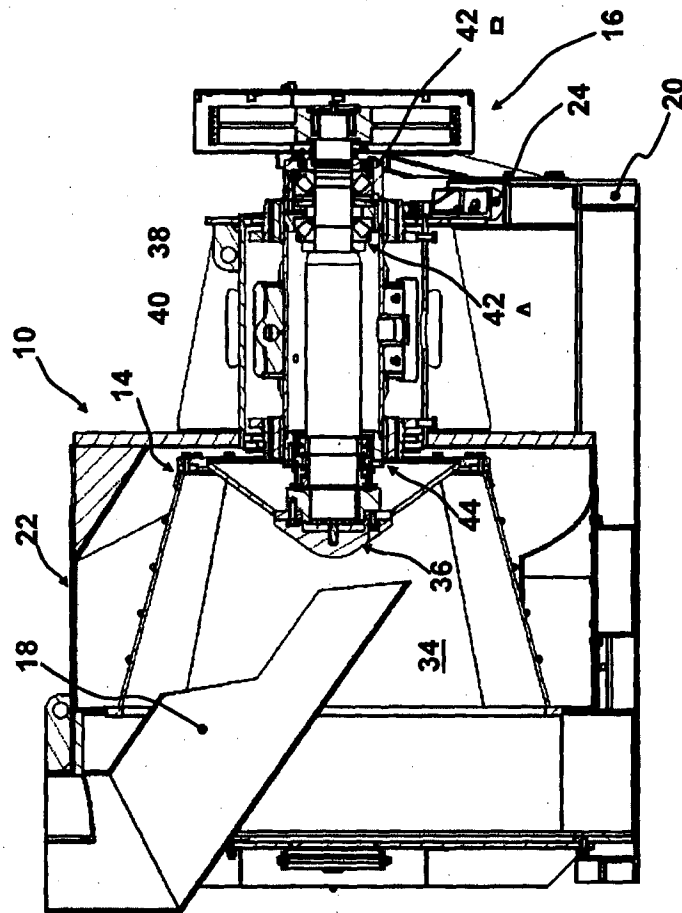


FIGURE 3

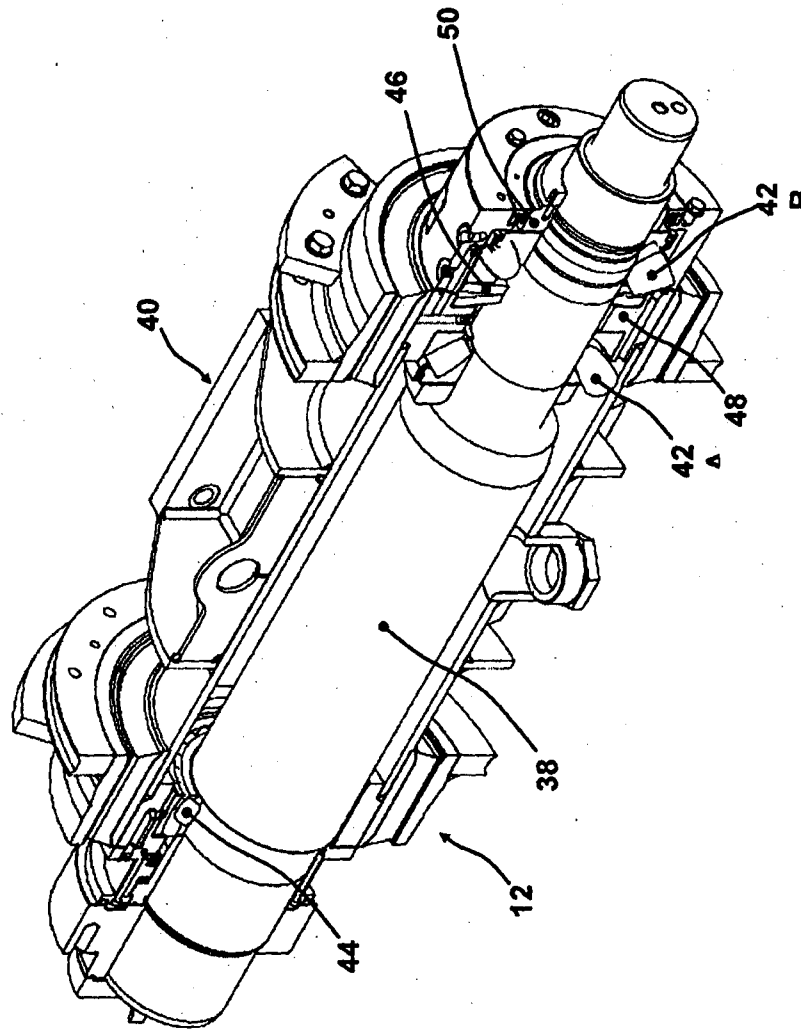


FIGURE 4

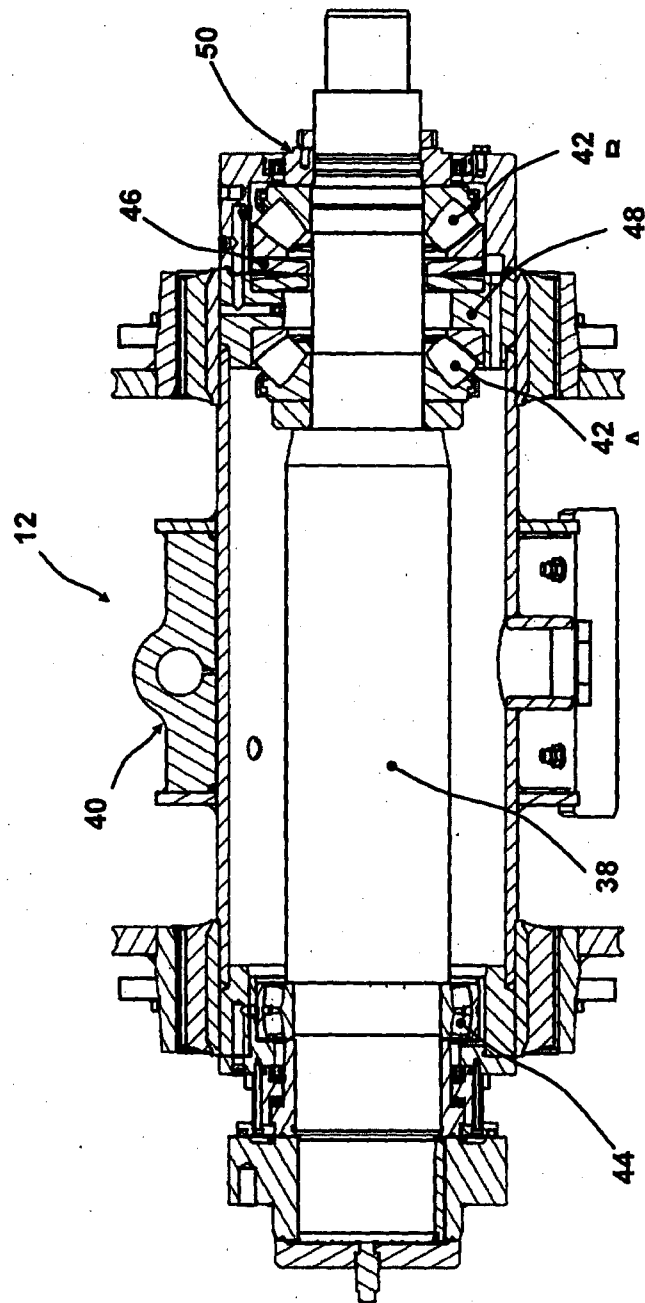


FIGURE 5

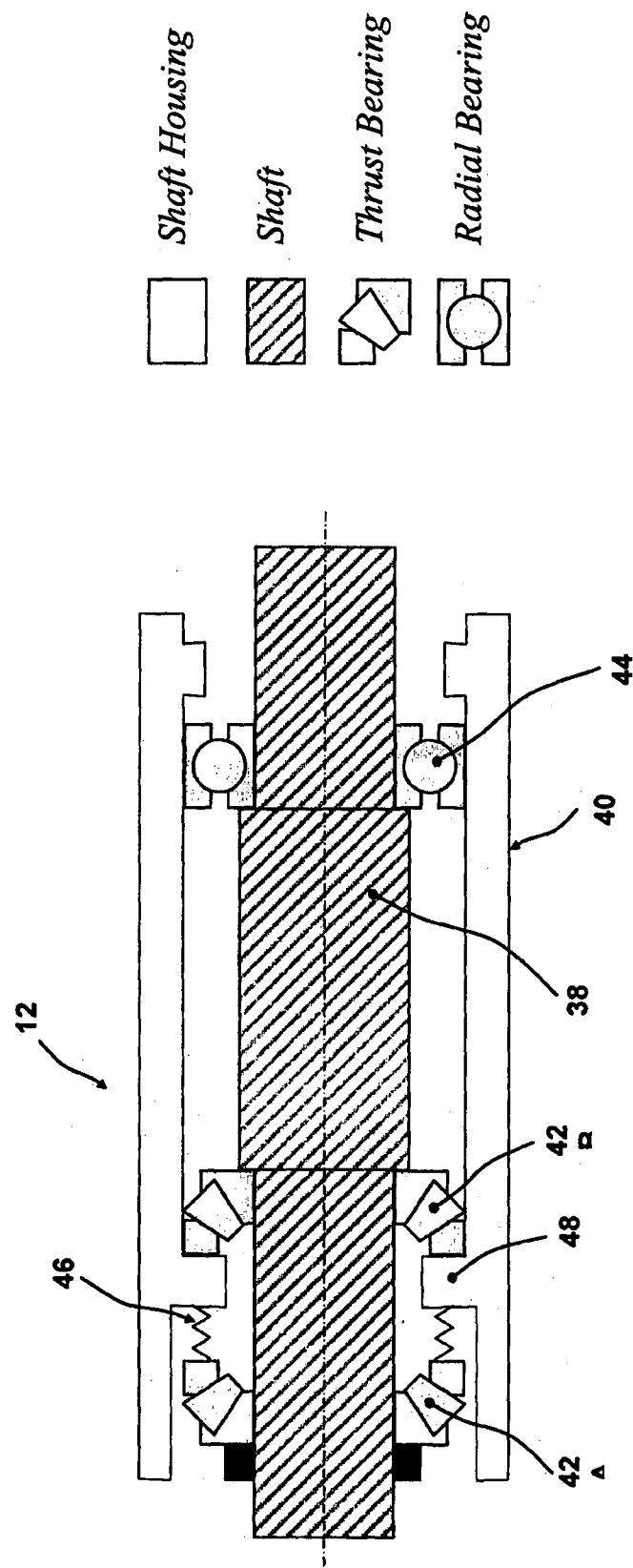


FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER B04B 3/06 (2006.01) B04B 9/00 (2006.01)		
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)		
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) WPI and EPODOC: (IPC or ECLA B04B, F16F, F16C) & Keywords (VIBRATE, CENTRIFUGE, SHAFT, HOUSING, BASKET, MOUNT, THRUST, AXIAL, BEARING, ROTATE, DRIVE, SLIDE, SECURE, CLAMP, RING, BLOCK, PRELOAD, SPRING, BIAS, STATIC, CONSTANT, PRIOR, LOAD) and similar terms		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	
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* 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 5 October 2012		Date of mailing of the international search report 05 October 2012
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustalia.gov.au Facsimile No.: +61 2 6283 7999		Authorised officer Rajeev Deshmukh AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0399359622

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2012/000749
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	Figures 1-2; page 2, lines 2-30; page 1, lines 69-74	11
A	Figures 1-2; page 2, lines 2-30; page 1, lines 69-74	4-9
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A	US 2002/0030024 A1 (LEUNG, W.W.F. et al.) 14 March 2002 Figures 6-7; paragraph [0055]	1-12
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Information on patent family members		PCT/AU2012/000749	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
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End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			