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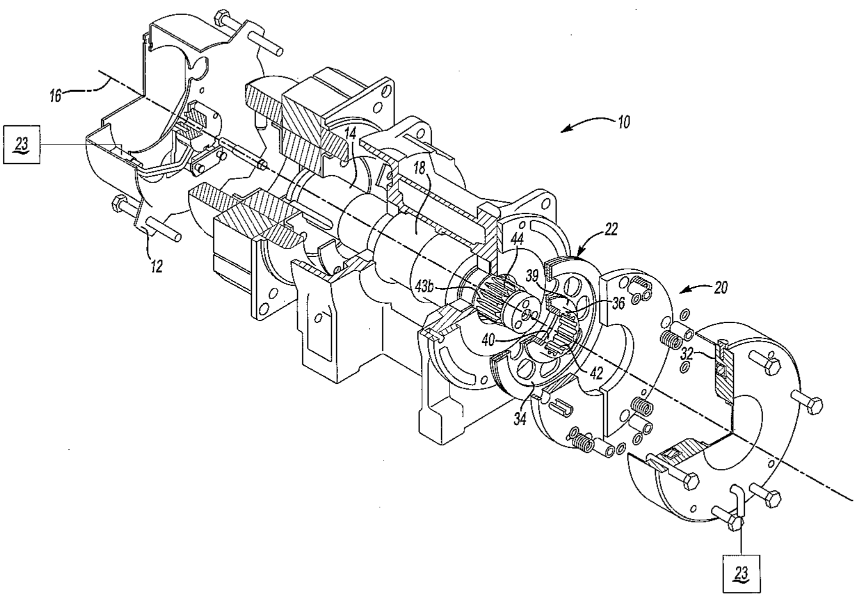
(54) **Title:** ELEVATOR BRAKE WITH COMPOSITE BRAKE HUB



(57) **Abstract:** An elevator brake (20) rotor for use in an elevator machine (10) includes a non-metallic elevator brake hub (36) and a metal flange (34), both of which have an opening with a splined portion for guiding axial movement of the rotor along a rotable shaft (14). This arrangement reduces metal-to-metal contact between the rotor and shaft and reduces noise.

WO 2008/033137 A1

ELEVATOR BRAKE WITH COMPOSITE BRAKE HUB

Field of the Invention

[0001] This invention generally relates to elevator systems and, more particularly to elevator machine brakes.

Description of the Related Art

[0002] Elevator machines, such as a gearless machine, typically include a machine shaft rotationally driven by a machine motor. A sheave is supported on the machine shaft and rotates with the machine shaft. Ropes or belts are typically tracked through the sheave such that the machine motor may rotate the sheave in one direction to lower the cab and rotate the sheave in the opposite direction to raise the cab.

[0003] Some elevator machines typically include a brake having a brake armature that engages a rotor that rotates with the machine shaft to hold the machine shaft and sheave when the cab is at a selected landing. Typical metal rotors include a splined section that engages a splined section of the machine shaft and a flange section that the brake clamps around to resist rotation of the rotor. The rotor slides along the splined section of the machine shaft as the brake clamps and releases the rotor. Undesirably, the metal-to-metal contact between the splined section of the rotor and the splined section of the machine shaft during sliding of the rotor often produces noise.

[0004] There is a need for a quieter elevator machine. This invention addresses that need and provides enhanced capabilities while avoiding the shortcomings and drawbacks of the prior art.

SUMMARY OF THE INVENTION

[0005] One example elevator brake apparatus for use in an elevator machine includes a rotor that is moveable along a rotatable shaft. A non-metallic elevator brake hub guides axial movement of the rotor along the shaft.

[0006] In one example, the non-metallic elevator brake hub is fixed to a flange portion of a rotor. The non-metallic elevator brake hub includes a splined hub opening that aligns with a splined rotor opening through the flange portion. The splined openings engage a corresponding splined portion of a shaft.

[0007] The above examples are not intended to be limiting. The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of a currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 illustrates selected portions of an example machine roomless elevator system.

[0009] Figure 2 illustrates selected portions of an example elevator machine having a brake that resists rotation of a motor-driven shaft.

[00010] Figure 3 illustrates selected portions of the brake shown in Figure 2.

[00011] Figure 4 shows an isolated view of one side of an example rotor having a non-metallic hub.

[00012] Figure 5 illustrates the other side of the rotor shown in Figure 4.

[00013] Figure 6 illustrates an example rotor wherein the splined hub opening is larger than the splined rotor opening.

[00014] Figure 7 illustrates an example rotor having a space between the teeth of the splined rotor opening and the teeth of the splined hub opening.

[00015] Figure 8 illustrates an example rotor having a smaller teeth between the teeth of the splined rotor opening and the teeth of the splined hub opening.

DETAILED DESCRIPTION

[00016] Figure 1 illustrates selected portions of an example elevator car 6 that moves within a hoistway 8 between landings (not shown). The disclosed example illustrates a machine roomless elevator system in which an elevator machine 10 is mounted within the hoistway 8 to move the elevator car 6. One issue of concern with in such an arrangement with prior elevator machines is that noise produced by the elevator machine travels through the hoistway and may be heard by passengers in the elevator car. The elevator machine 10 of the disclosed examples, however, provides quieter operation, as will be described below. It is to be understood that the disclosed examples also contemplate use in other arrangements besides a machine roomless system.

[00017] Figure 2 illustrates an example elevator machine 10, such as a gearless machine. Although a gearless machine is shown in the illustrated example, the

disclosed examples are applicable to geared machines as well. In this example, the elevator machine 10 includes a motor 12 that rotationally drives a machine shaft 14 about an axis 16. A sheave 18 rotates with the machine shaft 14. An elevator machine brake 20 includes a rotor 22 that is coupled to the machine shaft 14. The elevator machine brake 20 selectively applies a braking force to the machine shaft 14 to prevent rotation of the machine shaft 14. In a geared machine, the machine shaft drives an output shaft on which a sheave is disposed via gears. For such an arrangement, the brake would be applied to the machine shaft, the output shaft, or an intermediate shaft associated with one of the gears in a known manner. In either arrangement, a controller 23 selectively operates the motor 12 and the elevator machine brake 20 to control movement of the elevator car 6 in the hoistway 8 in a known manner.

[00018] Figure 3 illustrates selected portions of the elevator machine brake 20. In this example, the elevator machine brake 20 includes an armature 24 for applying a braking force to the rotor 22. Bias members 26 bias the armature 24 in a brake-applying direction toward the rotor 22 to clamp the rotor 22 between the armature 24 and a fixed braking surface 28. In the illustrated example, the rotor 22 includes brake linings 30 for wear resistance. In one example, the brake linings 30 are molded directly on to the rotor 22.

[00019] In the illustrated example, the rotor 22 includes a flange portion 34 and a non-metallic hub 36 that is rigidly fixed to the flange portion 34. In the illustrated example, the non-metallic hub 36 is secured to the flange portion 34 using fasteners 38 that extend through an annular flange 39 of the non-metallic hub 36 and the flange portion 34. In one example shown in Figures 4 and 5, the fasteners 38 are evenly spaced about the annular flange 39 to uniformly secure the non-metallic hub 36 and flange portion 34 and to maintain rotational balance of the rotor 22.

[00020] In another example, the non-metallic hub 36 is over-molded onto the flange portion 30. In another example, the non-metallic hub 36 is bonded with an adhesive to the flange portion 34. Given this description, one of ordinary skill in the art will recognize other arrangements for securing the non-metallic hub 36 to the flange portion 34.

[00021] As can be appreciated from Figures 2-8, the flange portion 34 includes a splined rotor opening 40 and the non-metallic hub 36 includes a splined hub opening 42 that is axially aligned with the splined rotor opening 40. The splined rotor opening

40 and the splined hub opening 42 are received onto a splined portion 44 of the shaft 14.

[00022] The splined rotor opening 40 and the splined hub opening 42 each have respective teeth 43a and 43a′ that interlock with corresponding teeth 43b of the splined portion 44 such that the three pieces rotate together. Interlocking between the splines functions to transfer torque between the rotor 22 and the machine shaft 14. In the illustrated example, the teeth 43a, 43a′, and 43b are shown with a particular geometric cross-sectional shape. The teeth 43a and 43a′ of the splined openings 40 and 42 match in number and geometry to the teeth 43b of the splined portion 44. In the disclosed example, the teeth 43a, 43a′, and 43b are designed with a tolerance to accommodate a difference in thermal expansion between the interlocking pieces, such as from thermal expansion differences between metallic and non-metallic materials. Given this description, one of ordinary skill will recognize alternative shapes to meet their particular needs.

[00023] The splined openings 40 and 42 and teeth 43a and 43a′ are formed in a known manner to achieve dimensional equality within a desired tolerance between the openings 40 and 42. In one example, the splined rotor opening 40 and its teeth 43a are formed by stamping, machining, casting, or other known method. The splined hub opening 42 and its teeth 43a′ are formed during molding of the non-metallic hub 36. In another example, the openings 40 and 42 and teeth 43a are formed in a single machining operation to obtain improved dimensional equality and alignment between the openings 40 and 42. In another example, the openings 40 and 42 are formed in a known manner to achieve a desired dimensional difference such that the non-metallic hub opening 42 is a desired amount larger in size than the rotor opening 40 and the teeth 43a are axially misaligned with the teeth 43a′ (Figure 6). This provides some play between the teeth 43a′ of the non-metallic hub opening 42 and the splined portion 44 of the machine shaft 14.

[00024] Alternatively, as illustrated in Figure 7, the rotor 22′ includes a space 45 between the teeth 43a and 43a′. In this example, the teeth 43a and 43a′ do not extend entirely through the thickness of the rotor 22′.

[00025] In another example, as illustrated in Figure 8, the rotor 22″ includes relatively smaller teeth 43a″ between the teeth 43a and 43a′ within the space 45. The smaller teeth 43a″ serve to reinforce the teeth 43a′ of the non-metallic hub 36 during a machining operation to form the teeth 43a and 43a′ but do not function to guide

movement of the rotor 22″. Thus, various rotor configurations are possible for accommodating, for example, friction, thermal expansion, or other variables associated with a particular design.

[00026] In the illustrated examples, the flange portion 34 is a circular disk made of a non-magnetic material. In some examples, the non-magnetic material is stainless steel, aluminum, or a reinforced plastic composite. In one example, the thickness of the flange portion 34 is about 4 mm. In another example, the thickness of the flange portion 34 is selected to withstand the entire braking load from the torque that results during braking.

[00027] In the disclosed examples, during operation of the brake 20, the rotor 22 (or alternatively rotor 22′ or 22″ in the examples hereforth) axially moves along the splined portion 44 of the machine shaft 14 as the armature 24 applies and releases braking force. For example, the controller 23 activates an electromagnet 32 to lift the armature 24 and remove the braking force. In this condition, the rotor 22 is spaced apart from the armature 24 and the fixed brake surface 28. Upon deactivating the electromagnet 32, the armature 24 moves the rotor 22 axially toward the fixed brake surface 28. As can be appreciated from this movement, the splined rotor opening 40 and splined hub opening 42 slide along the splined portion 44 of the machine shaft 14.

[00028] In the illustrated examples, the non-metallic hub 36 is of sufficient axial length to guide movement of the rotor 22 by maintaining rotor 22 stability and orientation. In the illustrated example, the axial length L_1 of the non-metallic hub 36 is greater than the axial length L_2 of the flange portion 34 to provide the desired stability and maintain a relative orientation between the rotor 22 and the machine shaft 14. The thickness L_2 of the flange portion 34 is selected to withstand the entire braking torque that is applied to the rotor 22. In this example, the thickness L_1 of the non-metallic hub 36 is chosen such that the overall rotor 22 thickness provides sufficient guidance. In the disclosed example, the total length of the rotor 22, L_1 plus L_2, is of similar total length as previously known entirely metallic rotors, although the lengths could be varied to meet the needs of a particular machine design.

[00029] In the disclosed example, the non-metallic hub 36 maintains the flange portion 34 in a desired orientation, which in this example is generally perpendicular to the axis 16. The term "perpendicular" is not meant to be limiting in a strict geometrical sense. For example, in the disclosed example there is some play between the rotor 22, non-metallic hub 36 and shaft 14 that permits the flange portion 34 not to

be exactly perpendicular. In other words, the non-metallic hub 36 resists out-of-plane rotation of the rotor 22 (i.e., in a direction transverse to a plane of the rotor 22).

[00030] In the disclosed example, the flange portion 34 functions to transfer torque load between the rotor 22 and the machine shaft 14, while the non-metallic hub 36 functions to maintain a desired orientation and guide axial movement of the rotor 22. The flange portion 34 is of suitable strength for torque transfer during braking and withstands significant deformation under the torque load. In the disclosed example, the non-metallic material of the non-metallic hub 36 is of suitable strength for axially guiding the rotor 22 and is not meant to transfer a large portion of the torque load. By bearing the torque load, the flange portion 34 reduces or eliminates torque load on the non-metallic hub 36.

[00031] In the disclosed example, the non-metallic hub 36 is formed from a plastic material. In another example, the non-metallic hub 36 is formed from a stronger material, such as a composite material. In a further example, the composite material is a reinforced plastic. Using a reinforced plastic provides the non-metallic hub 36 with enough strength to transfer at least a portion of the torque load. Other non-metallic composite materials, not limited to polymers, are also contemplated.

[00032] Using the non-metallic hub 36 in combination with the flange portion 34 instead of previously known, entirely metallic rotors, provides several benefits. One drawback of entirely metallic rotors is that the metal-to-metal contact with the shaft produces noise. The non-metallic hub 36, however, reduces the amount of metal-to-metal contact between the rotor 22 and the shaft 14 compared to previously known entirely metallic rotors. This reduces or eliminates the metal-to-metal noise produced as the rotor 22 slides along the shaft 14. In one particular example, the non-metallic hub 36 is made of a noise-dampening material, such as a plastic material, to further reduce the occurrence of noise.

[00033] In some examples, the rotor 22 and non-metallic hub 36 also provide the further advantage of being easier to make and less expensive than previously known, entirely metallic rotors. Entirely metallic rotors are typically machined to final shape, which is time consuming and wastes material that is removed during machining. In one example, the flange portion 34 of the rotor 22 is made from a metal plate and requires little or no machining to achieve final shape. The non-metallic hub 36 can be molded in a known manner to final or near final shape. This

provides the advantage of eliminating the machining and waste material associated with producing entirely metallic rotors.

[00034] The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiment may become apparent to those skilled in the art that do not necessarily depart from the essence of this invention. The scope of legal protection given to this invention can only be determined by studying the following claims.

CLAIMS

We claim:

1. An elevator brake rotor for transmitting a braking force to a shaft of an elevator machine, comprising:

a rotor flange that is moveable along a rotatable shaft; and

a non-metallic elevator brake hub portion that guides axial movement of the rotor flange along the rotatable shaft.

2. The elevator brake rotor as recited in claim 1, wherein the non-metallic elevator brake hub portion includes a hub opening having a splined portion for engaging a corresponding splined portion of the shaft.

3. The elevator brake rotor as recited in claim 2, wherein the splined portion of the hub opening includes hub teeth that extend in an axial direction and the corresponding splined portion includes shaft teeth that extend in the axial direction and intermesh with the hub teeth.

4. The elevator brake rotor as recited in claim 3, wherein the rotor opening includes a second splined portion for engaging the corresponding splined portion of the shaft, the second splined portion having rotor teeth that extend in the axial direction.

5. The elevator brake rotor as recited in claim 4, wherein the hub opening is about equal in size to the rotor opening such that the rotor teeth are axially aligned with the hub teeth.

6. The elevator brake rotor as recited in claim 4, wherein the hub opening is larger in size than the rotor opening such that the rotor teeth are axially misaligned with the hub teeth.

7. The elevator brake rotor as recited in claim 1, wherein the rotor comprises a disk-shaped flange that is secured to the non-metallic elevator brake hub portion.

8. The elevator brake rotor as recited in claim 7, wherein the non-metallic elevator brake hub portion includes an annular hub flange that extends from the splined portion and comprises a plurality of fasteners that secure the non-metallic elevator brake hub portion to the disk-shaped flange.

9. The elevator brake rotor as recited in claim 7, wherein the plurality of fasteners are evenly spaced apart about the annular flange.

10. The elevator brake rotor as recited in claim 7, wherein the non-metallic elevator brake hub portion includes a first axial length and the disk-shaped flange includes a second axial length that is less than the first axial length.

11. The elevator brake rotor as recited in claim 7, wherein the disk-shaped flange comprises a material selected from at least one of a stainless steel, aluminum, or a reinforced plastic.

12. The elevator brake rotor as recited in claim 1, wherein the non-metallic elevator brake hub portion comprises a plastic material.

13. The elevator brake rotor as recited in claim 1, wherein the non-metallic elevator brake hub portion comprises a reinforced plastic material.

14. A brake that includes the elevator brake rotor as recited in claims 1-13, wherein the brake comprises an axially moveable armature that selectively applies a braking force to the brake rotor.

15. The brake as recited in claim 14, comprising a motor for rotating the shaft, and a sheave that is rotated by the shaft.

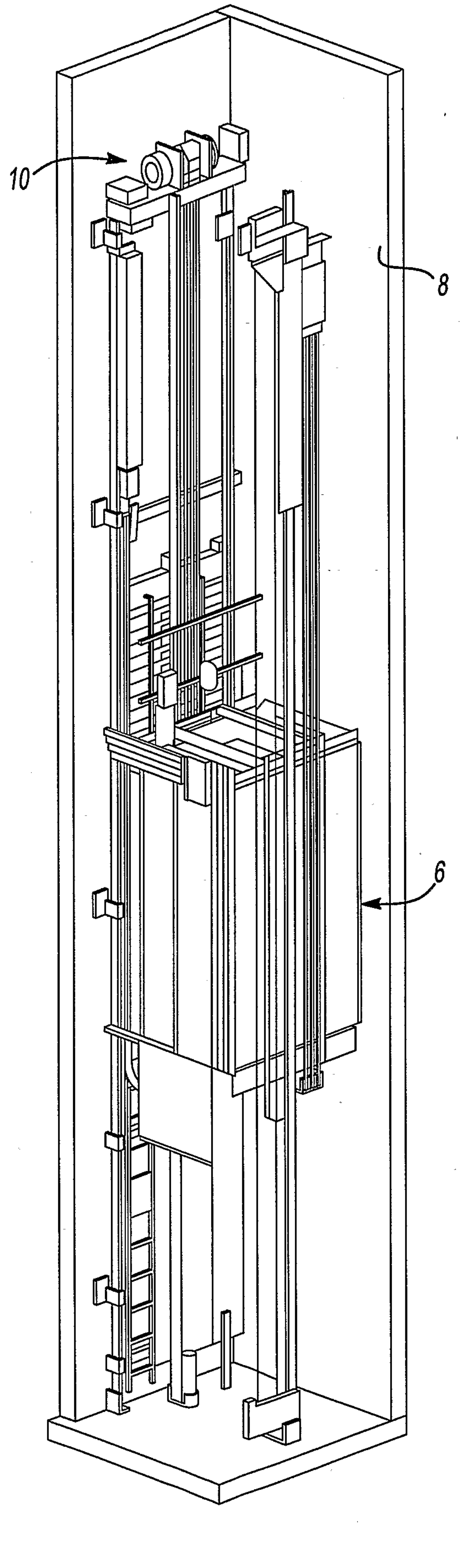


Fig-1

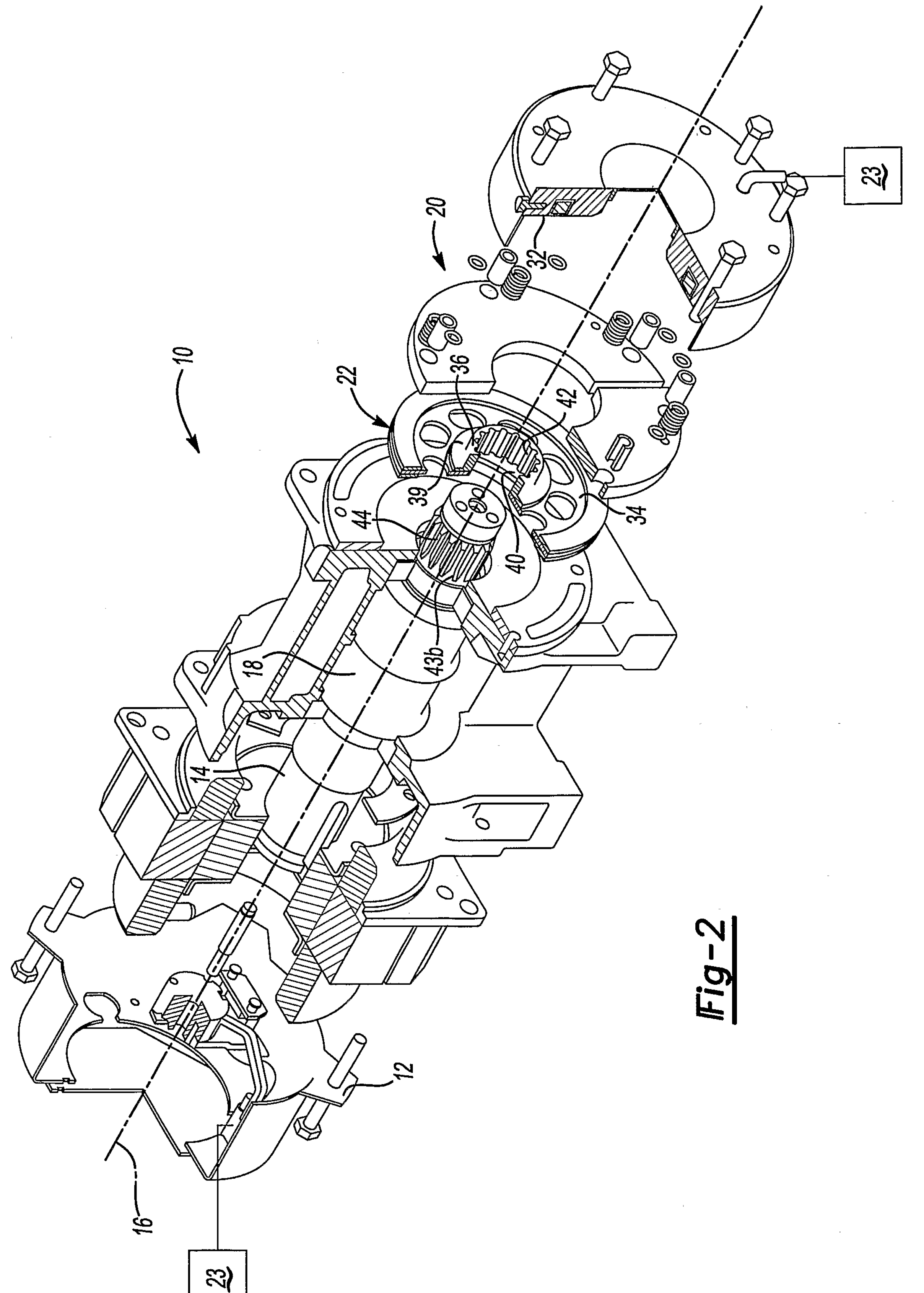


Fig-2

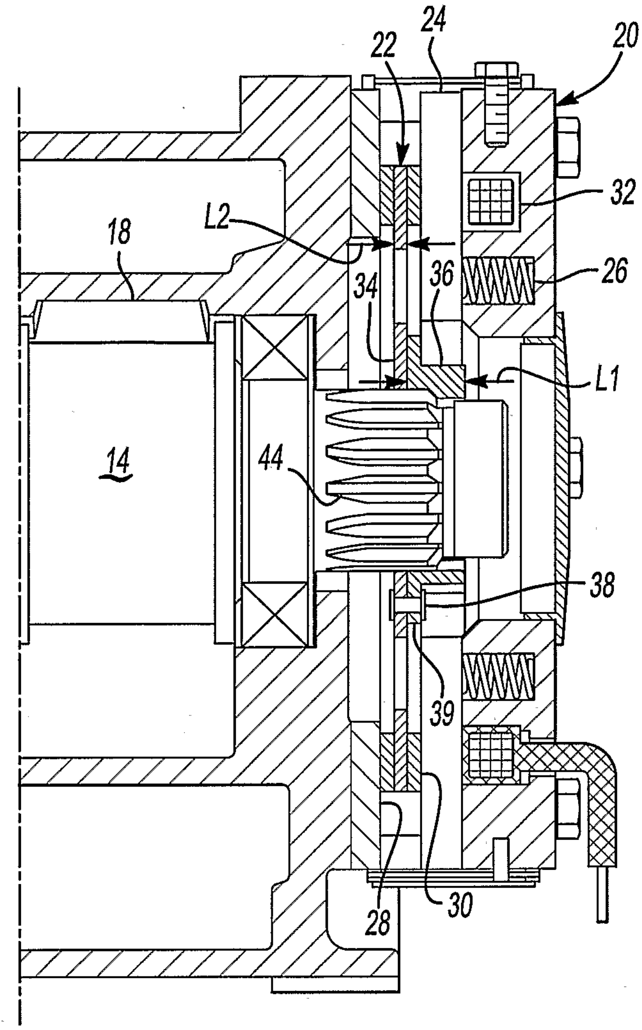


Fig-3

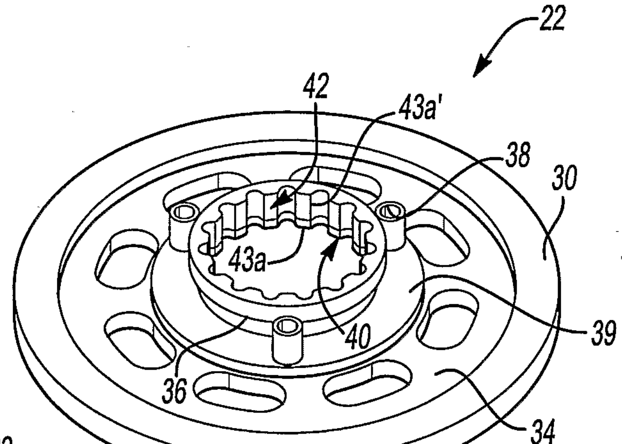


Fig-4

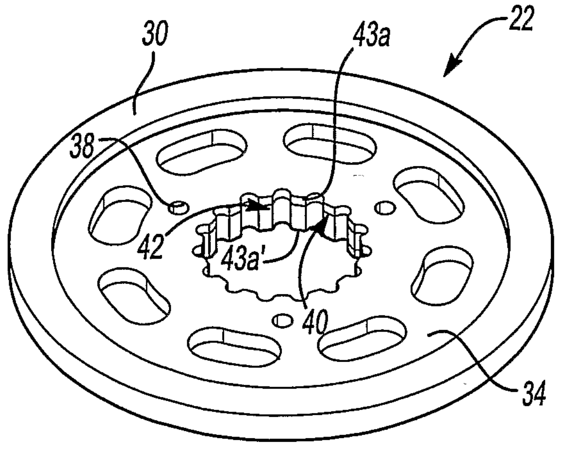


Fig-5

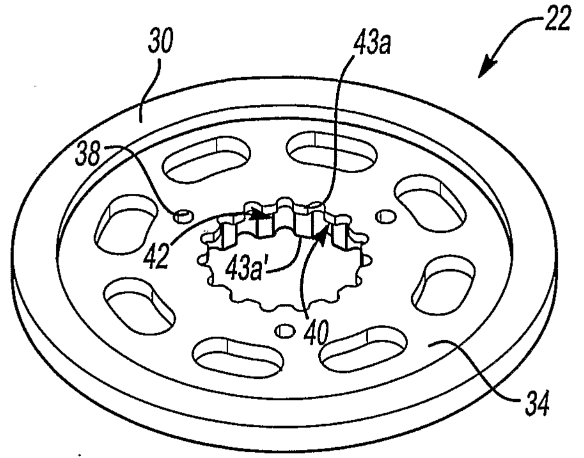


Fig-6

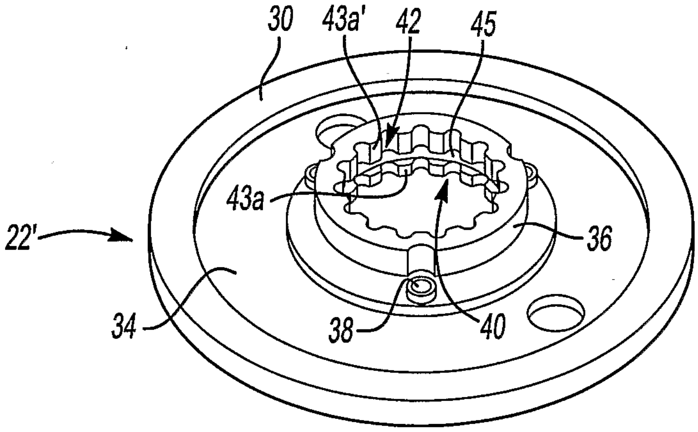


Fig-7

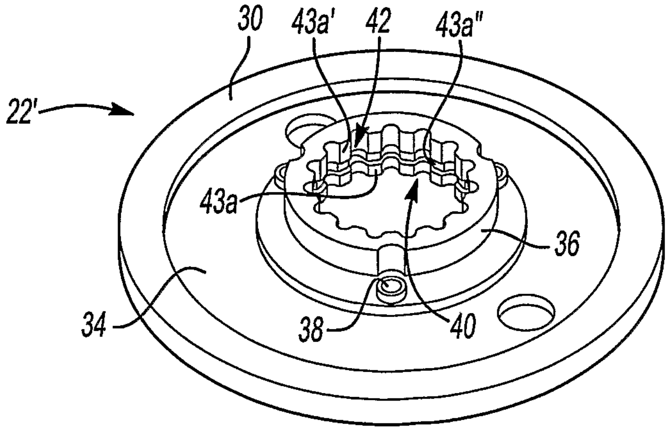


Fig-8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/035963

A. CLASSIFICATION OF SUBJECT MATTER
INV. B66D5/14

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)
B66D F16D

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 practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 631 510 A (FLAIG HEINZ [DE] ET AL) 20 May 1997 (1997-05-20) abstract column 2, line 24 - line 32 column 3, line 5 - column 4, line 11 figures 1,6,7	1-3,7-15
A	GB 2 236 623 A (HITACHI LTD [JP]) 10 April 1991 (1991-04-10) abstract page 4, last paragraph - page 5, paragraph 1 figures 1,2	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2007	06/06/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Sheppard, Bruce

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/035963

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 796 728 A (KANENGIETER GLENN G [US] ET AL) 10 January 1989 (1989-01-10) abstract column 4, last paragraph - column 6, paragraph 2 figures 4,5	1,4,8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/035963

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 5631510	A	20-05-1997	DE	4338570	A1	24-05-1995
			EP	0652625	A1	10-05-1995
			JP	7135746	A	23-05-1995
GB 2236623	A	10-04-1991	CN	1050362	A	03-04-1991
			HK	31195	A	17-03-1995
			JP	2003564	C	20-12-1995
			JP	3079819	A	04-04-1991
			JP	7035829	B	19-04-1995
			US	5154261	A	13-10-1992
US 4796728	A	10-01-1989	NONE			