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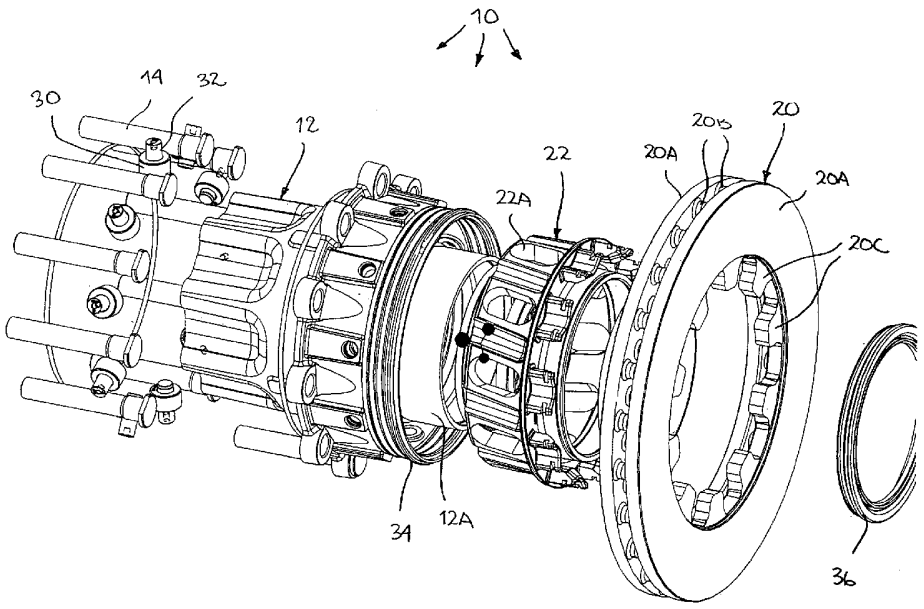
(54) **Title:** ROTOR DISK SUPPORT FOR A FULL CONTACT ANNULAR DISK BRAKE ASSEMBLY



(57) **Abstract:** The full contact annular disk brake assembly (10) comprises a hub (12) to be journaled on an axle of a vehicle. An annular rotor disk (20) is mounted around an interior section of the hub (12), the rotor disk (20) being in a sliding and torque-transmitting engagement with the hub (12). The rotor disk (20) is coaxially connected to an annular support (22) which provides the sliding and torque-transmitting engagement with the hub (12). The presence of the annular support (22) allows, among other things, to enhance the performances of the brake assembly (10), increases the precision of the movement of the rotor disk (20) and in some designs, increase the braking capacity.

WO 2006/047887 A1

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ROTOR DISK SUPPORT FOR A FULL CONTACT ANNULAR DISK BRAKE ASSEMBLY

This invention is concerned with a new design for supporting the rotor disk of a full contact annular disk brake assembly, and also a new method of assembling a full contact annular disk brake assembly.

The concept of full contact annular disk brake is described and shown in U.S. Patents Nos. 5,205,380 and 5,330,034, which are hereby incorporated by reference. One interesting feature of this concept is that the rotor disk of the brake assembly is axially movable with reference to the hub. The rotor disk is able to position itself between a set of fixed braking pads on one side, and a movable set of braking pads on the opposite side. The set of movable brake pads is pushed against the rotor disk by mean of a pneumatic actuator. Other kinds of actuators can also be used, including hydraulic actuators or electric actuators. Moreover, it is possible to design the brake assembly with more than one rotor disk.

The sliding connection between the rotor disk and the hub in previous versions of the disk brake assembly was made using a set of axial splines provided on the hub and which cooperates with corresponding inner teeth radially projecting on the interior opening of the rotor disk. This proved to be satisfactory for the most applications. However, since there are still opportunities to improve the brake assembly, continuous developments were conducted in order to further improve it. Improvements concerning the braking capacity of the disk brake assembly and the reduction of vibrations were also warranted.

It has been found that the performances of the brake assembly can be enhanced by mounting the rotor disk on a support located between the hub and the rotor disk. This rotor disk support increases the precision of the movement and in some designs, it may also increase the braking capacity.

One aspect of the improvements is to provide a full contact annular disk brake assembly for a vehicle, the brake assembly comprising: a hub to be journaled on an axle of the vehicle; and an annular rotor disk mounted around an interior section of the hub, the rotor disk being in a sliding and torque-transmitting engagement with the hub. In this assembly, the rotor disk is coaxially connected to an annular support which provides the sliding and torque-transmitting engagement with the hub.

Another aspect of the improvements is to provide a method of assembling a full contact annular disk brake assembly having a hub to be journaled on an axle of the vehicle, the method comprising: mounting an annular rotor disk around an interior section of the hub, the rotor disk being in a sliding and torque-transmitting engagement with the hub. The method is characterized in that: the rotor disk is connected to an annular support, the annular support being configured and disposed to provide the sliding and torque-transmitting engagement with the hub; the annular support is mounted around the interior section of the hub; and the rotor disk is mounted around the interior section of the hub.

These and other improvements will be better understood from the following detailed description and accompanying figures in which:

FIG. 1 is a perspective view of an example of a partial full contact annular disk brake assembly, as improved herein.

FIG. 2 is a perspective cross-section view of the brake assembly shown in FIG. 1.

FIG. 3 is a perspective and exploded view of the brake assembly shown in FIG. 1.

FIG. 4 is a cross section view of some of the parts of the brake assembly shown in FIG. 3.

FIG. 5 is a perspective and partially exploded view of the brake assembly shown in FIG. 1.

FIG. 6 is a perspective and cross-section view of some of the parts of the brake assembly shown in FIG. 5.

FIG. 7 is a perspective view showing the hub without the rotor disk attached to the annular support of the brake assembly of FIG. 1.

FIG. 8 is a perspective view showing the rotor disk connected on the annular support of the brake assembly of FIG. 1.

FIG. 9 is a view similar to FIG. 8, taken from an opposite side.

FIG. 10 is a perspective view showing one side of the annular support of the brake assembly of FIG. 1.

FIG. 11 is a view similar to FIG. 10, taken from an opposite side and without the C-clip.

FIG. 12 is a perspective view of the back of the hub of the brake assembly of FIG. 1.

FIG. 13 is a perspective and partially exploded view of what is shown in FIG. 12.

FIGS. 1 to 13 are views showing an example of a portion of a full contact annular disk brake assembly (10) as improved herein. The illustrated brake assembly (10) is designed to be used on the right side of a large vehicle, such as a truck or a bus. A brake assembly (10) to be used on the left side would be a mirror image of what is shown. A similar brake assembly (10) can also be used on another kind of vehicle with some minor modifications. The brake pads and other parts required in a complete fully assembled brake assembly (10), such as the actuator and the brake pads, are not shown and described in order to simplify and lighten the drawings.

FIG. 1 shows a brake assembly (10) comprising a hub (12) which is designed to be journaled around an axle of the vehicle. The hub (12) supports a plurality of mounting bolts (14) to be attached to a corresponding wheel or a set of juxtaposed wheels (not shown). The hub (12) is journaled around the axle of the vehicle by a set of spaced-apart bearings (16), as shown in FIG. 2. The hub (12) comprises an exterior section and an internal section. The exterior section somewhat projects inside the wheel of the vehicle. The opposite interior section of the hub (12) may also be located within the wheel of the vehicle, but this section will be located inside other parts of the brake assembly (10). A cap (not shown) is attached on the side of the exterior section of the hub (12) to prevent dirt or other contaminants from reaching the bearings (16).

The brake assembly (10) also comprises a rotor disk (20) coaxially mounted around the internal section of the hub (12). The illustrated rotor disk (20) comprises two opposite annular sections (20A) that are preferably maintained in a spaced apart relationship by mean of a plurality of interconnecting members (20B). These interconnecting members (20B) can also be in the form of blades to draw cooling air between the opposite sides of the rotor disk (20).

As shown in FIG. 2, the interior section of the hub (12) is provided with two concentric drum portions (12A, 12B). One is the inner drum portion (12A) and the other is an outer drum portion (12B).

FIG. 3 is an exploded view of the brake assembly (10) shown in FIG. 1. The rotor disk (20) of the illustrated embodiment comprises a plurality of inner teeth (20C) radially projecting inside its central opening. These inner teeth (20C) are configured and disposed to cooperate with an annular support (22). This annular support (22) will be further described hereafter. One of its functions is to maintain the rotor disk (20) in a radial position with reference to the central axis of the hub (12), and also allow the axial movement of the rotor disk (20). The annular support (22) works in conjunction with the

internal section of the hub (12) so as to provide a torque-transmitting engagement between the hub (12) and the rotor disk (20).

FIG. 4 is an exploded cross-sectional view of the parts shown in FIG. 3. FIG. 5 is a partially exploded view of the parts shown in FIG. 3. FIG. 6 is a cross-sectional view thereof but with the rotor disk (20) mounted on the annular disk (22). FIG. 7 is a perspective view showing the hub (12) without the rotor disk (20) attached to the annular support (22).

As shown in FIGS. 8 to 11, the annular support (22) comprises two sections. The first section is oriented towards the exterior and its end will be embedded in a recess located between the inner drum portion (12A) and outer drum portion (12B) of the hub (12), as shown for instance in FIG. 3. It comprises a plurality of oblong slots (22A) which are extending in a direction that is substantially parallel to the rotation axis of the hub (12). The opposite section of the annular support (22) comprises an inner ring (22B) around which is located a radial flange (22C) with a plurality of axially-projecting brackets (22D). These brackets (22D) are designed to cooperate with the inner teeth (20C) of the rotor disk (20), as shown in FIG. 9. The rotor disk (20) is installed on the second section of the annular support (22), more particularly with its inner teeth (20C) set between the brackets (22D). The various parts are configured and disposed so that all parts fit tightly. Each bracket (22D) preferably has a slightly V-shaped cross section, at least to improve its resistance to the braking torque that it will apply on the inner teeth (20C) on the rotor disk (20).

Each bracket (22D) also preferably has one or two circumferentially disposed slots (22E) which together form a continuous seat for a C-clip (24) or a similar item provided to secure the rotor disk (20) on the annular support (22).

It should be noted that this is also possible to secure together the annular support (22) and the rotor disk (20) using bolts or any other mechanical arrangement. However, the use of a more flexible arrangement, such as the

one using a C-clip, is preferred because in use, the friction of the brake pads with the rotor disk (20) during braking generates heat. Heat expands the rotor disk (20) outwards, thereby creating stresses in the material if there is a rigid connection between the annular support (22) and the rotor disk (20).

When assembling the brake assembly (10), the rotor disk (20) can be connected to the annular support (22) before or after the annular support (22) is mounted around the interior section of the hub (12).

The inner ring (22B) of the annular support (22) is designed to hold a bushing (26) that is in sliding engagement over the inner drum portion (12A) of the hub (12) once the parts are assembled. This bushing (26) will support most of the weight of the rotor disk (20) and that of the annular support (22).

The annular support (22) is also operatively connected to the hub (12) by mean of a plurality of radially disposed rollers (30). These rollers (30) are provided between the inner drum portion (12A) and the outer drum portion (12B), as best shown in FIG. 12. The parts are assembled so that the rollers (30) will be located in the slots (22A) of the annular support (22). The slots (22A) and the rollers (30) are dimensioned so that the diameter of the rollers (30) are very slightly less than the width of the slots (22A). The rollers (30) are then allowed to rotate on one of the sides of the slots (22A). Each roller (30) is maintained in its corresponding slot (22A) of the annular support (22) by mean of a radial axle (32), which axle (32) is preferably maintained in place by a C-clip (33), which is visible in FIG. 4. FIG. 13 also shows the rollers (30) and their axle (32). The rollers (30) are bushing-mounted or bearing-mounted on their axle (32). Other arrangements are possible.

In the illustrated embodiment, ten pairs of slots (22A) and rollers (30) are provided since there are ten mounting bolts (14) on the hub (12), which is a standard feature of some trucks. Other designs are possible as well, including not having the same number of pairs of slots (22A) and rollers (30) than the number of bolts (14).

As aforesaid, the slots (22A) are substantially parallel to the central axis of the hub (12), and preferably, as illustrated, they are set at a shallow angle in the order of a few degrees instead of being purely parallel to the central axis. Providing the slots (22A) with a shallow angle i increases the force applied by the rotor disk (20) on the fixed set of brake pads (not shown) which are located near the exterior side of the brake assembly (10). When braking, the movable set of brake pads applies a braking force on the side of the rotor disk (20). The rotor disk (20) then moves towards the set of fixed brake pads and one of the side surfaces of the rotor disk (20) is brought into frictional engagement therewith. Since both sets of brake pads are not rotating with reference to the wheels of the vehicle, the rotor disk (20) will be forced to slow down. At the same time, the hub (12) and the wheel or wheels will tend to overrun the rotor disk (20). Therefore, there will be an axial reaction on the annular support. Using the right orientation, the annular support (22) will tend to move inside the hub (12) towards the exterior side, thus more deeply between the inner drum portion (12A) and the outer drum portion (12B). This tendency increases the braking force being applied on the fixed set of braking pads, which are located in a part of the fixed housing (not shown) that is adjacent to the mounting bolts (14). A gain in braking capacity of up to 25% can be achieved, in part because of the slots (22A) being set at an angle, without the need of increasing the overall force generated by the actuator of the brake assembly (10).

Another advantage of providing an annular support (22) is that the centering of the rotor disk (20) with reference to the other parts of the brake assembly (10) is greatly improved. The losses due to the friction when the rotor disk (20) moves with reference to the hub (12) are significantly reduced. This is particularly noticeable during braking, when the torque on the rotor disk (20) is the greatest. The rotor disk (20) is also maintained more perfectly balanced with reference to the rotation axis when using the annular support (22). Overall, vibrations are reduced and the braking is quieter. The hysteresis of the system is also significantly reduced.

Using the new design, it is possible to change the natural frequency of the brake assembly (10) by changing the annular support (22), for instance changing the thickness of the part, the angle of its slots, etc. Modifying the hub (12) and/or the rollers (30) also changes the natural frequency of the brake assembly (10). Modifying the natural frequency can contribute to the reduction of the vibrations. A further advantage of the new design is that the annular support (22) and the rollers (30) can be protected from the outside environment. This is preferably achieved by providing one or more bellows on each side of the rotor disk (20). FIGS. 1 to 6 illustrate the brake assembly (10) being provided with one annular bellow (34) having one end crimped on the outer drum portion (12B) of the hub (12), and an opposite end attached to the rotor disk (20). Similarly, an opposite bellow (not shown) would be provided between the rotor disk (20) and the plate with the movable set of brake pads (not shown). Moreover, a seal (36) is advantageously provided around the free end of the inner drum portion (12A). This way, oil and grease can be applied on the rollers (30) without fearing contamination by liquid or solid foreign particles.

It should be noted that the design of the brake assembly (10) can be different from what is shown in the drawings. For instance, it is possible to design the annular support (22) with the slots (22A) being located inside the rotor disk (20). Two or a double-sided annular support (22) can also be provided to fully support the rotor disk (20) on both sides thereof. It is further possible to manufacture the annular support (22) and rotor disk (20) in one piece, although using two separate pieces is preferred because it reduces the heat conduction from one part to another. Another possible variant is to design the rollers (30) with a conical shape or to provide slots (22A) with an axially curved shape. This latter feature would vary the braking force resulting from the self tightening effect of the rotor disk (20) against the fixed brake pads in function of the distance. Using cam shaped rollers is another possibility. Inverting the positions of the slots (22A) and the rollers (30) compared to what is shown in the drawings is also possible, as well as mixing them

around the circumference. The rotor disk (20) can be made a single annular section (20A) or even more than two spaced-apart annular sections (20A). When using a shallow angle for the slots (22A), the longitudinal walls of the slots (22A) can be curved so that the angle be variable. The bushing (26) between the hub (12) and the annular support (22) can include more than one segment and can be provided on the hub (12).

Still, other modifications can be effected therein without departing from the scope of the present invention, as defined in the appended claims.

CLAIMS:

1. A full contact annular disk brake assembly (10) for a vehicle, the brake assembly (10) comprising:

a hub (12) to be journaled on an axle of the vehicle; and

an annular rotor disk (20) mounted around an interior section of the hub (12), the rotor disk (20) being in a sliding and torque-transmitting engagement with the hub (12);

characterized in that the rotor disk (20) is coaxially connected to an annular support (22) which provides the sliding and torque-transmitting engagement with the hub (12).

2. The brake assembly (10) as defined in claim 1, characterized in that the torque-transmitting engagement between the annular support (22) and the hub (12) includes a set of spaced-apart rolls (30) movable in corresponding oblong slots (22A) extending in a direction substantially parallel to an axis of rotation of the hub (12), each roll (30) forming a pair with one of the slots (22A), the roll (30) or the slot (22A) of each pair being provided on the annular support (22) while the other among the roll (30) and the slot (22A) of the pair being provided on the hub (12).

3. The brake assembly (10) as defined in claim 2, characterized in that the slot (22A) of each pair is provided on the annular support (22), the roll (30) of each pair being provided on the hub (12).

4. The brake assembly (10) as defined in claim 2 or 3, characterized in that the interior section of the hub (12) comprises an inner drum portion (12A) and an outer drum portion (12B), both being spaced-apart and coaxially disposed, the drum portions (12A, 12B) being configured and

disposed so that the annular support (22) is slidable on the inner drum portion (12A) and one end of the annular support (22) is movable in an annular space between the drum portions (12A, 12B).

5. The brake assembly (10) as defined in claim 2, characterized in that the slot (22A) of each pair is provided on the annular support (22), the roll (30) of each pair being provided on the hub (12), each roll (30) being mounted in the annular space on an axle (32) having one end connected to the inner drum portion (12A) and an opposite end connected to the outer drum portion (12B).

6. The brake assembly (10) as defined in any one of claims 2 to 5, characterized in that the slots (22A) extend in a direction defining a shallow angle with the axis of rotation of the hub (12), whereby the angle of the slots (22A) increases the braking force during braking.

7. The brake assembly (10) as defined in any one of claims 1 to 6, characterized in that the rotor disk (20) is connected to the annular support (22) at one end of the annular support (22).

8. The brake assembly (10) as defined in any one of claims 1 to 7, characterized in that the rotor disk (20) comprises a plurality of spaced-apart and radially-extending inner teeth (20C), the annular support (22) comprising a plurality of corresponding spaced-apart and axially-projecting brackets (22D), the inner teeth (20C) and the brackets (22D) cooperating together.

9. The brake assembly (10) as defined in claim 8, characterized in that the brackets (22D) have a V-shaped cross section.

10. The brake assembly (10) as defined in claim 8 or 9, characterized in that each bracket (22D) comprises at least one circumferentially-disposed

slot (22E) which together form a continuous seat for a C-clip (24) provided to secure the rotor disk (20) on the annular support (22).

11. The brake assembly (10) as defined in any one of claims 1 to 10, characterized in that the sliding engagement between the annular support (22) and the interior section of the hub (12) includes a bushing (26).

12. A method of assembling a full contact annular disk brake assembly (10) having a hub (12) to be journaled on an axle of the vehicle, the method comprising:

mounting an annular rotor disk (20) around an interior section of the hub (12), the rotor disk (20) being in a sliding and torque-transmitting engagement with the hub (12);

characterized in that:

the rotor disk (20) is connected to an annular support (22), the annular support (22) being configured and disposed to provide the sliding and torque-transmitting engagement with the hub (12);

the annular support (22) is mounted around the interior section of the hub (12); and

the rotor disk (20) is mounted around the interior section of the hub (12).

13. The method as defined in claim 12, characterized in that the rotor disk (20) is connected to the annular support (22) after having mounted the annular support (22) around the interior section of the hub (12).

14. The method as defined in claim 13, characterized in that the rotor disk (20) is removably connected to the annular support (22).

15. The method as defined in claim 12, 13 or 14, characterized in that the torque-transmitting engagement between the annular support (22) and the hub (12) includes a set of spaced-apart rolls (30) movable in corresponding oblong slots (22A) extending in a direction substantially parallel to an axis of rotation of the hub (12), each roll (30) forming a pair with one of the slots (22A), the roll (30) or the slot (22A) of each pair being provided on the annular support (22) while the other among the roll (30) and the slot (22A) of the pair being provided on the hub (12).

16. The method as defined in claim 15, characterized in that the slot (22A) of each pair is provided on the annular support (22), the roll (30) of each pair being provided on the hub (12).

17. The method as defined in claim 15 or 16, characterized in that the interior section of the hub (12) comprises an inner drum portion (12A) and an outer drum portion (12B), both being spaced-apart and coaxially disposed, the drum portions (12A, 12B) being configured and disposed so that the annular support (22) is slidable on the inner drum portion (12A) and one end of the annular support (22) is movable in an annular space between the drum portions (12A, 12B).

18. The method as defined in claim 15, characterized in that the slot (22A) of each pair is provided on the annular support (22), the roll (30) of each pair being provided on the hub (12), each roll (30) being mounted in the annular space on an axle (32) having one end connected to the inner drum portion (12A) and an opposite end connected to the outer drum portion (12B).

19. The method as defined in any one of claims 12 to 18, characterized in that the method comprises:

increasing a braking force of the assembly during braking using the torque-transmitting engagement between the hub (12) and the annular support (22).

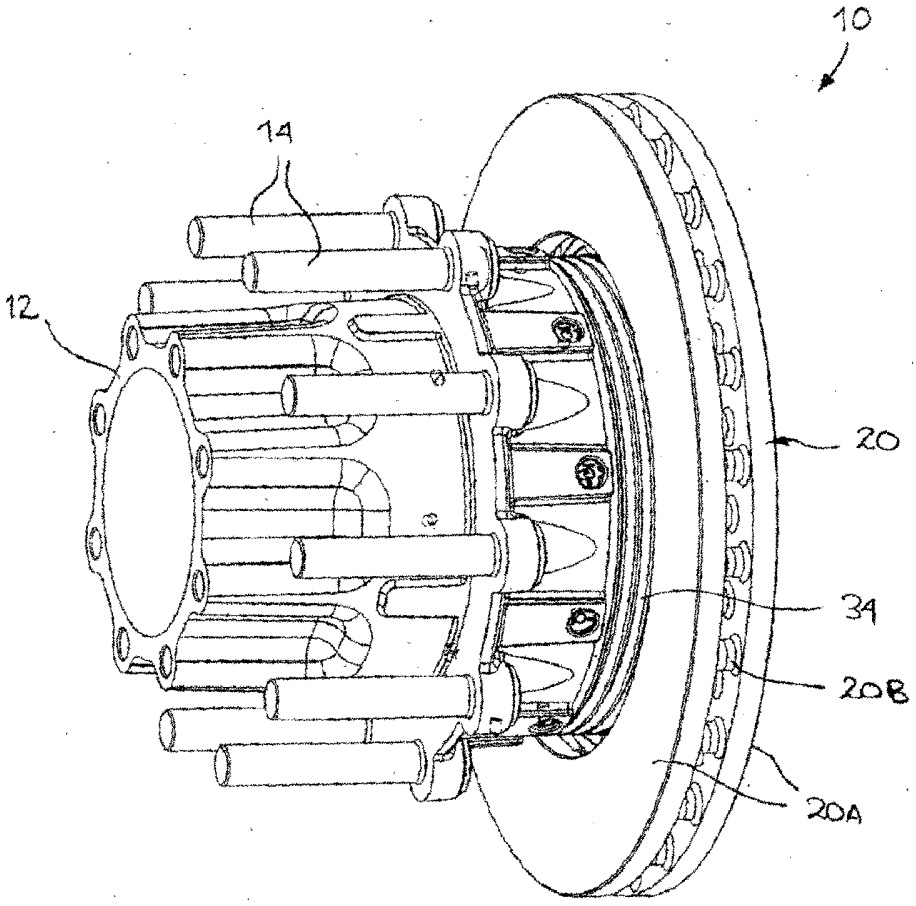

FIG.1

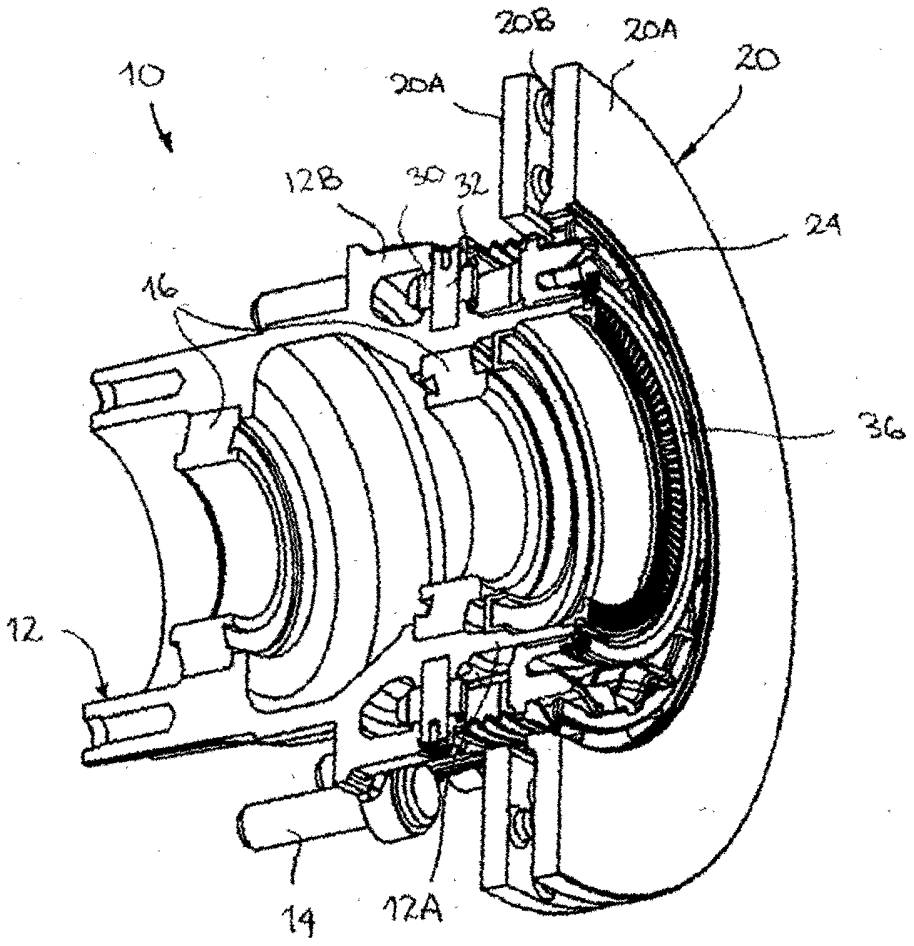

FIG.2

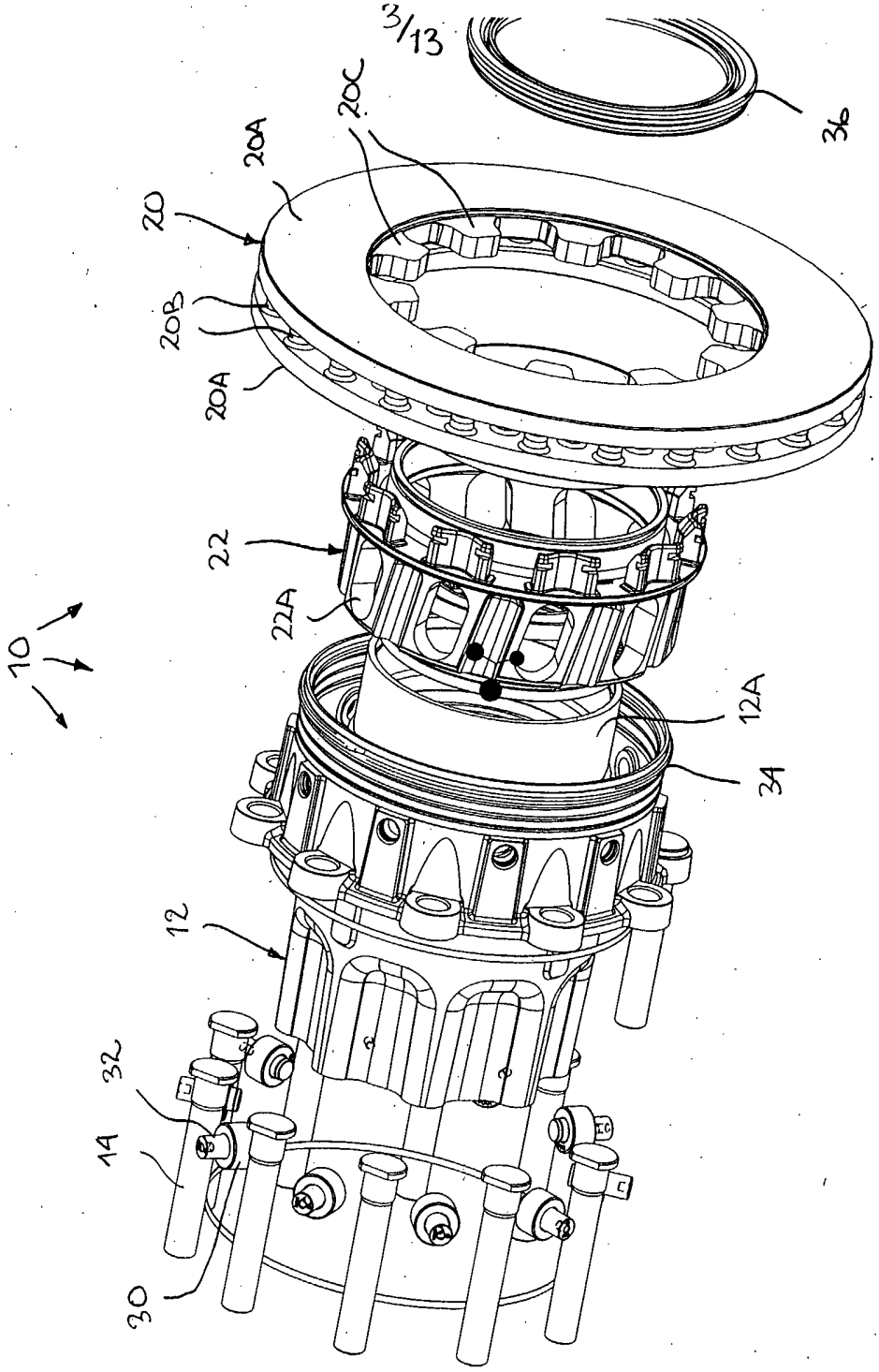

FIG.3

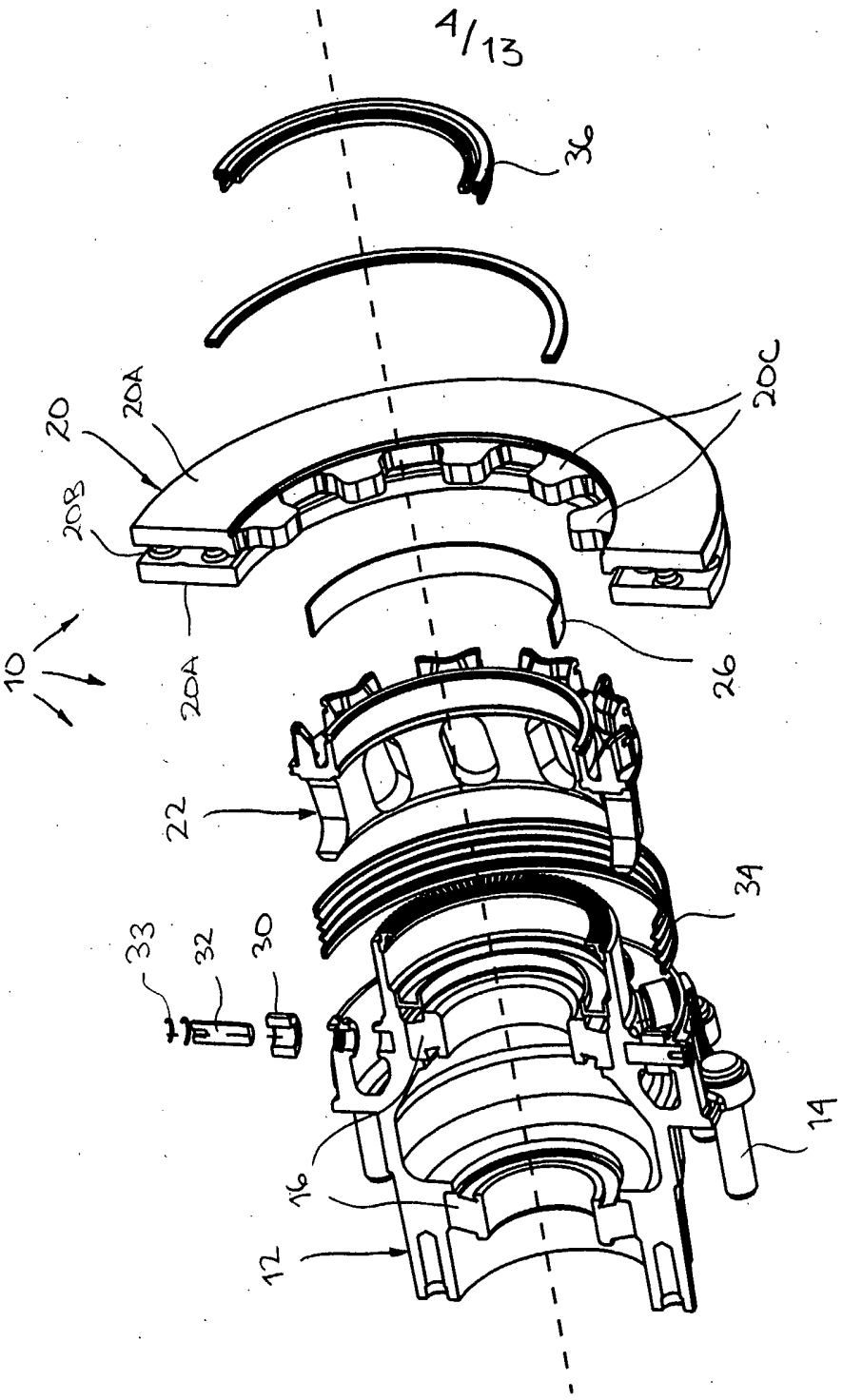

FIG.4

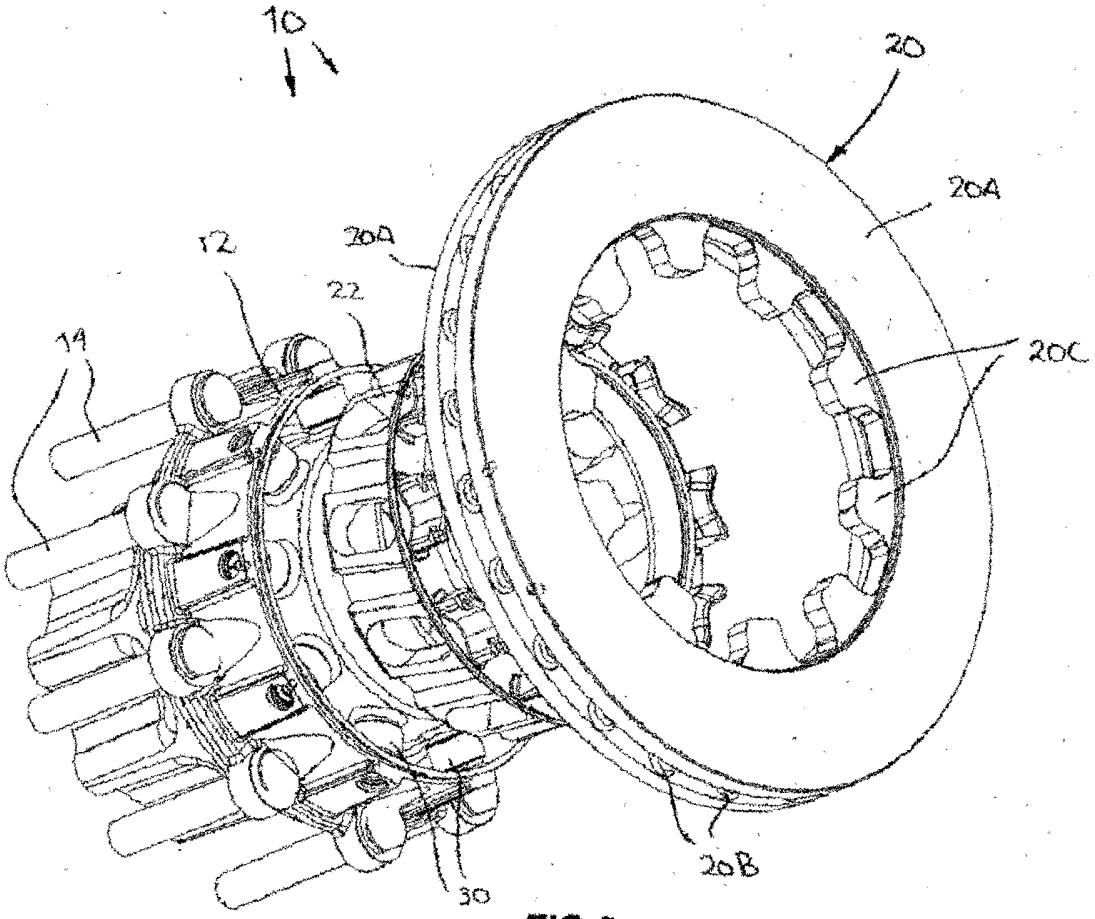

FIG.5

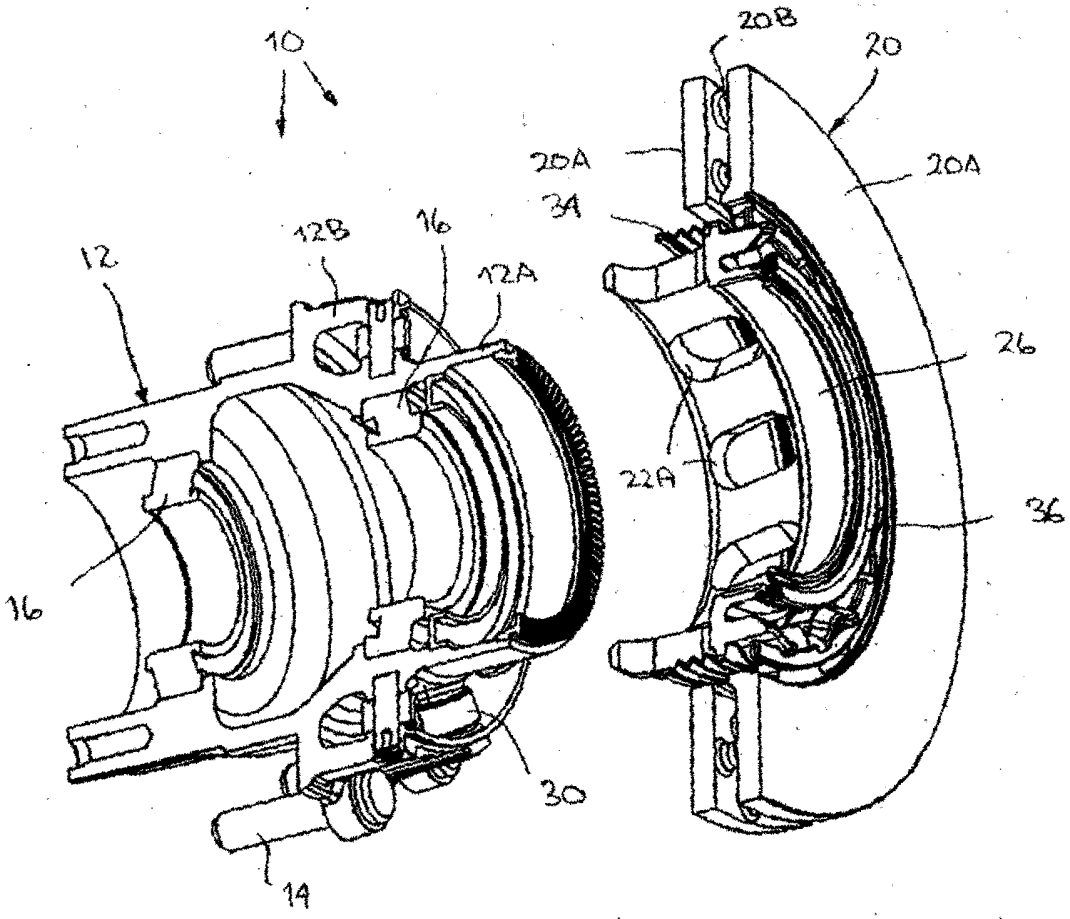

FIG.6

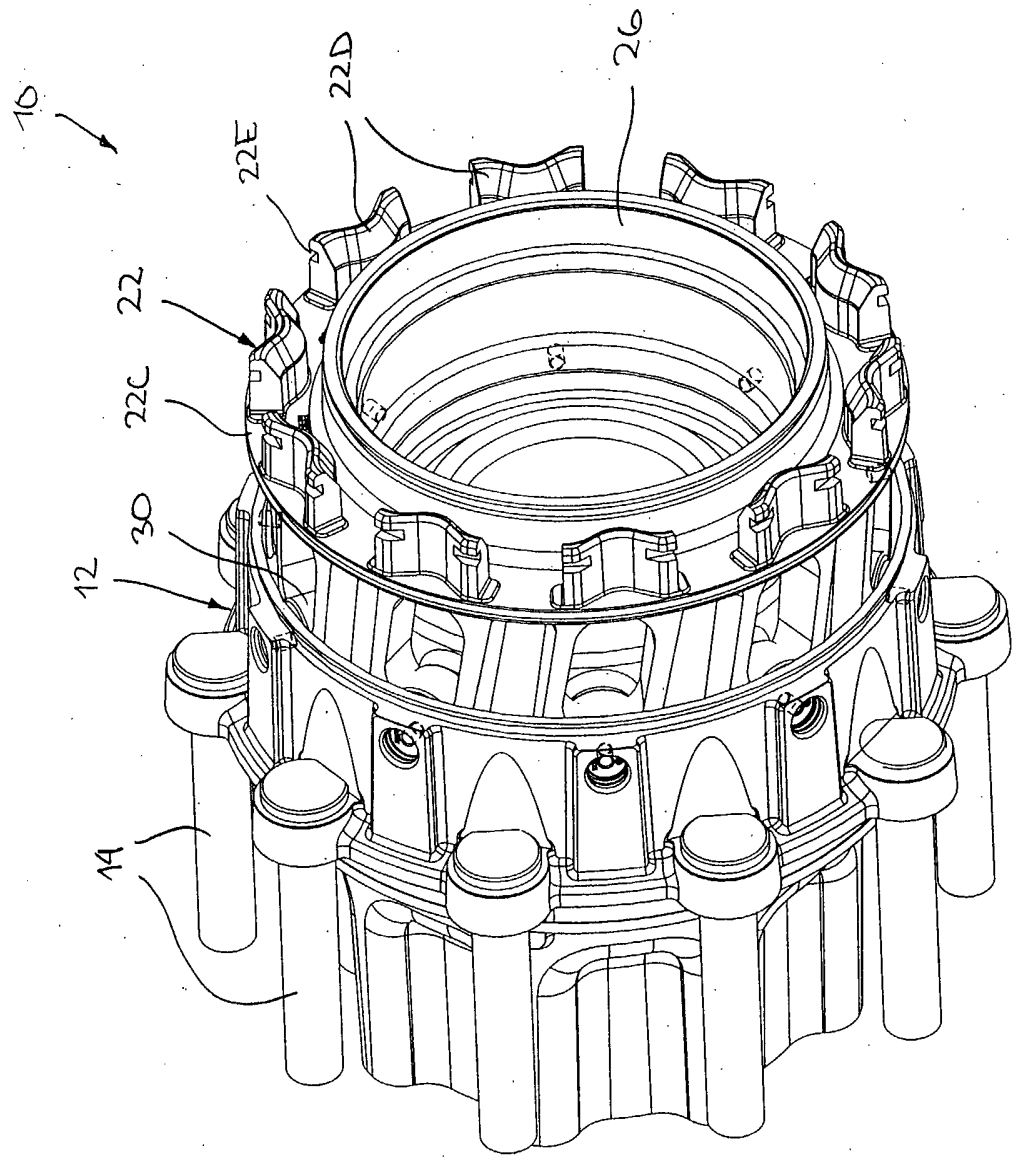

FIG.7

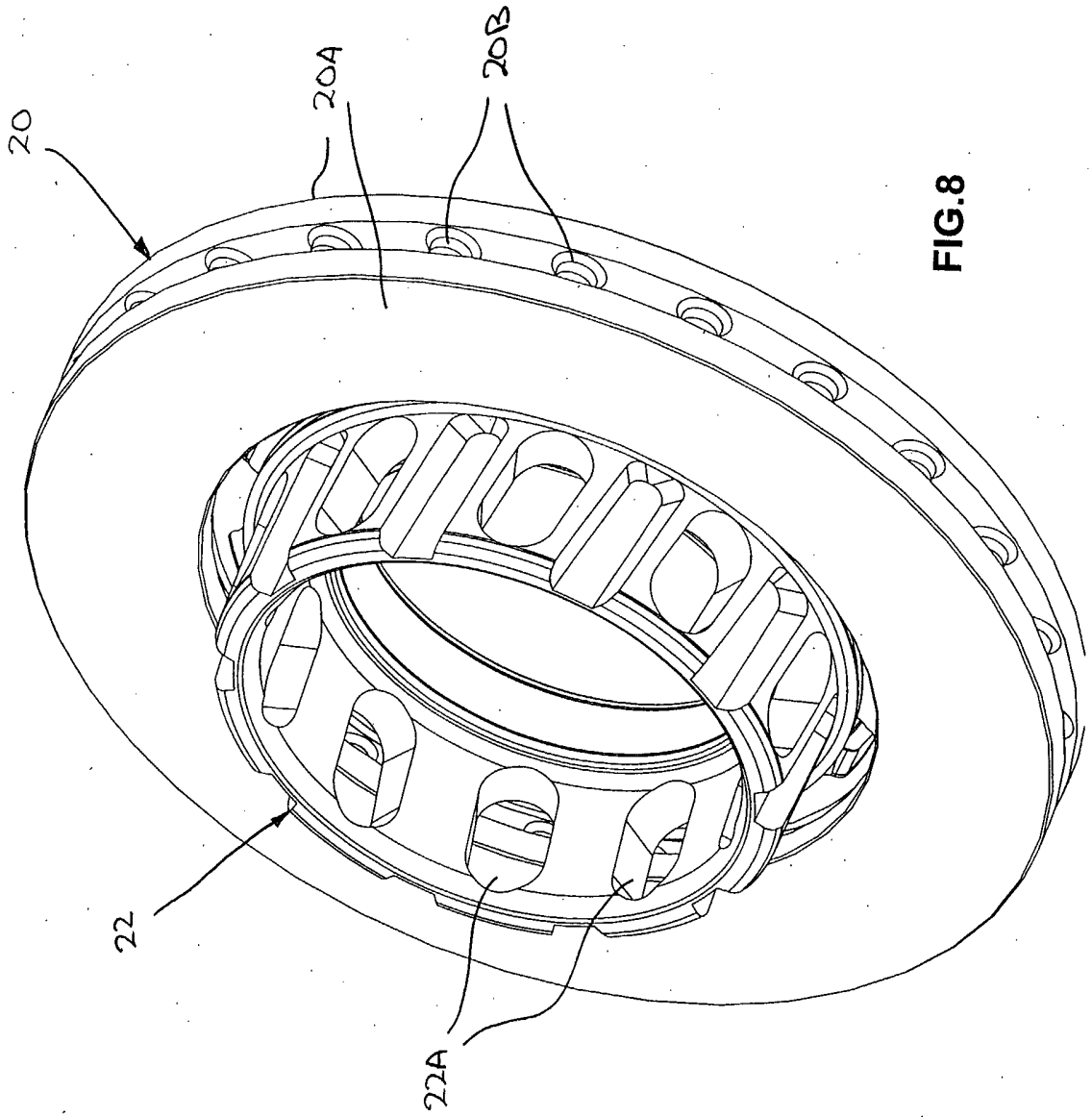

FIG.8

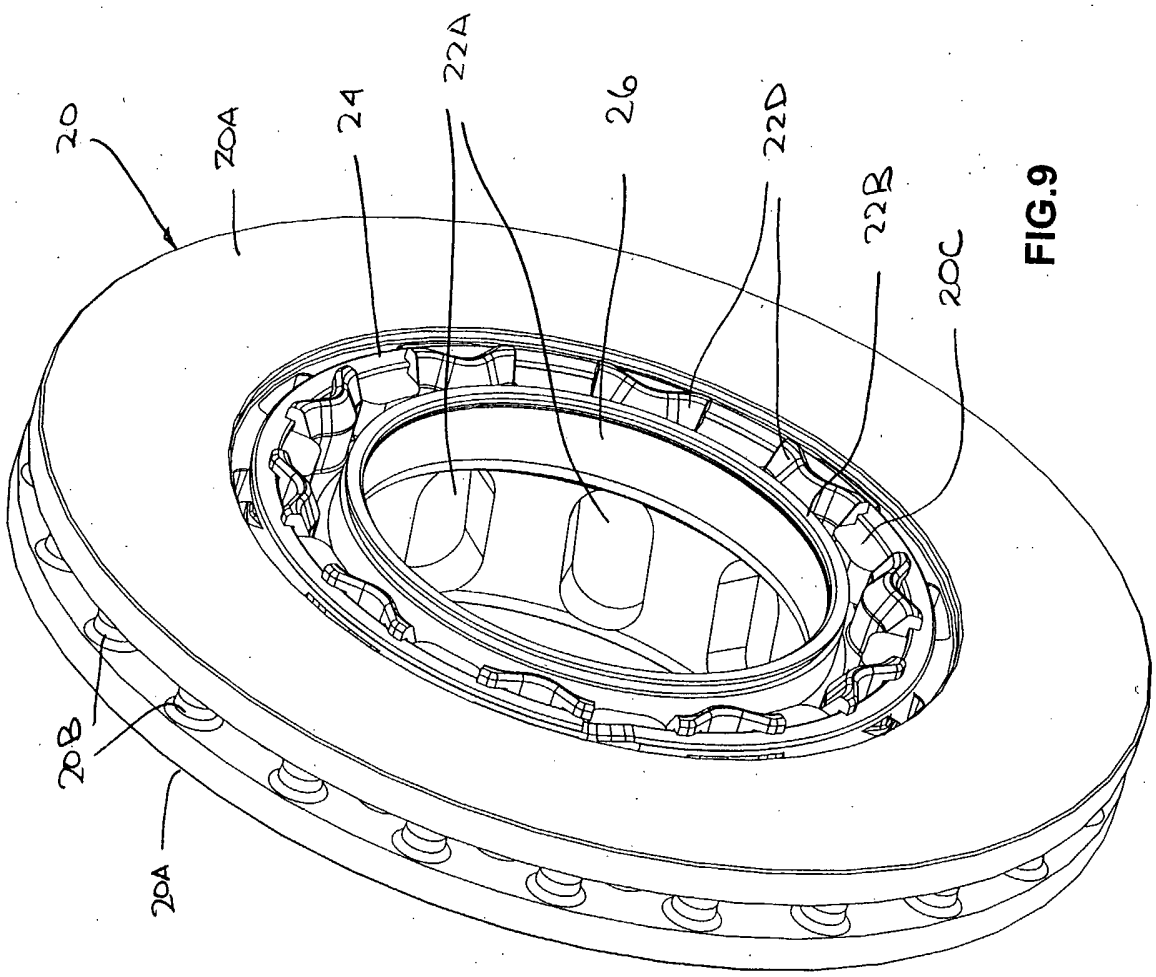

FIG.9

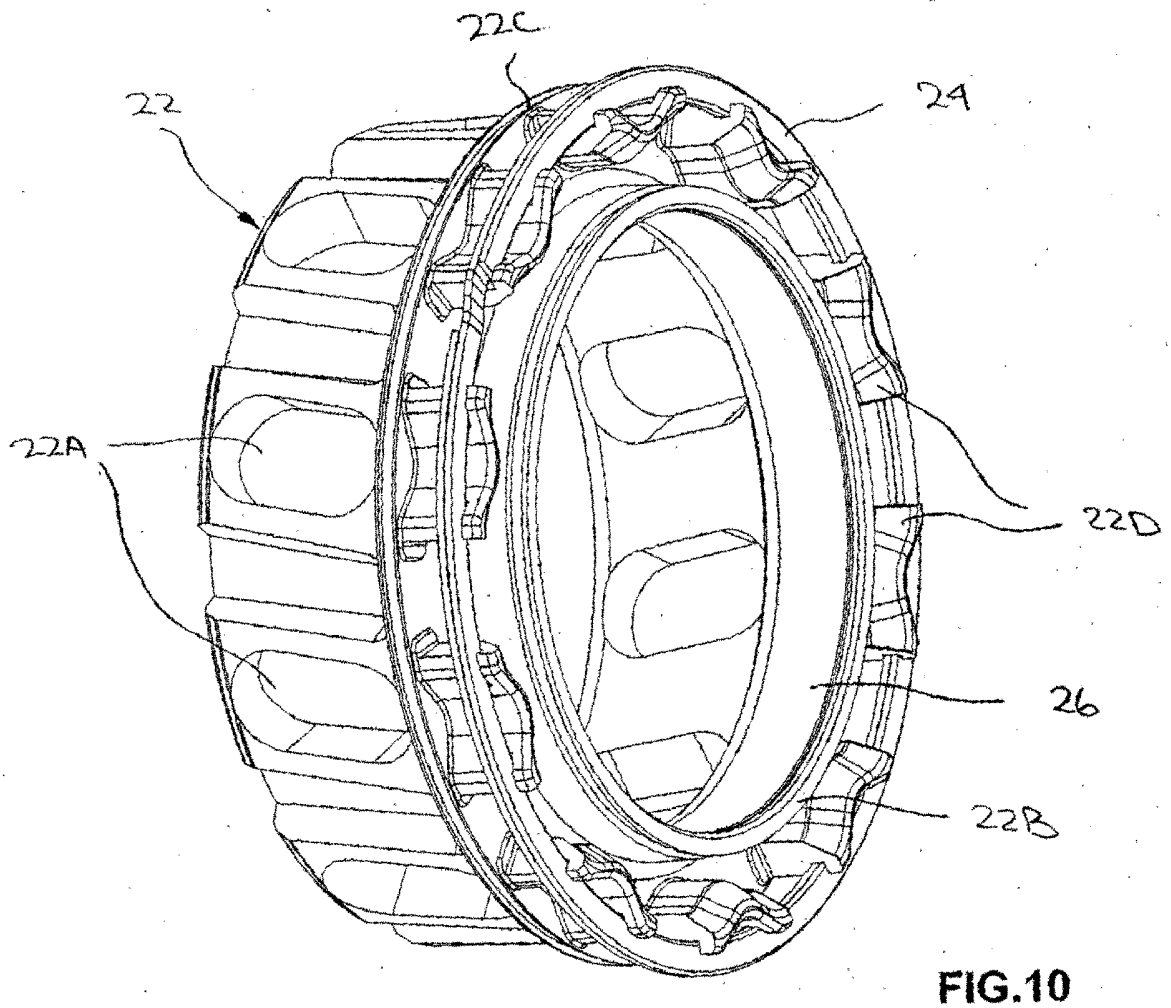

FIG.10

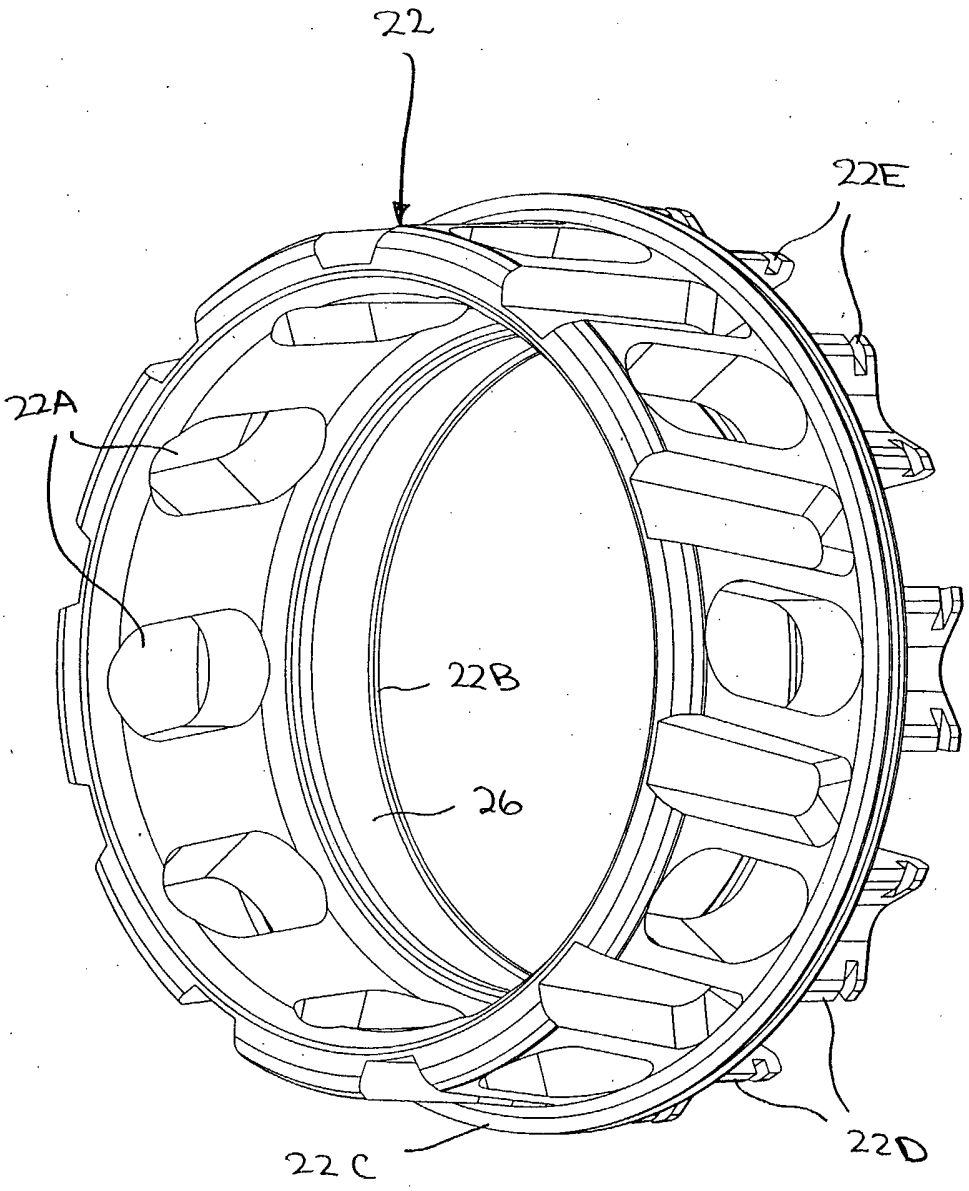

FIG.11

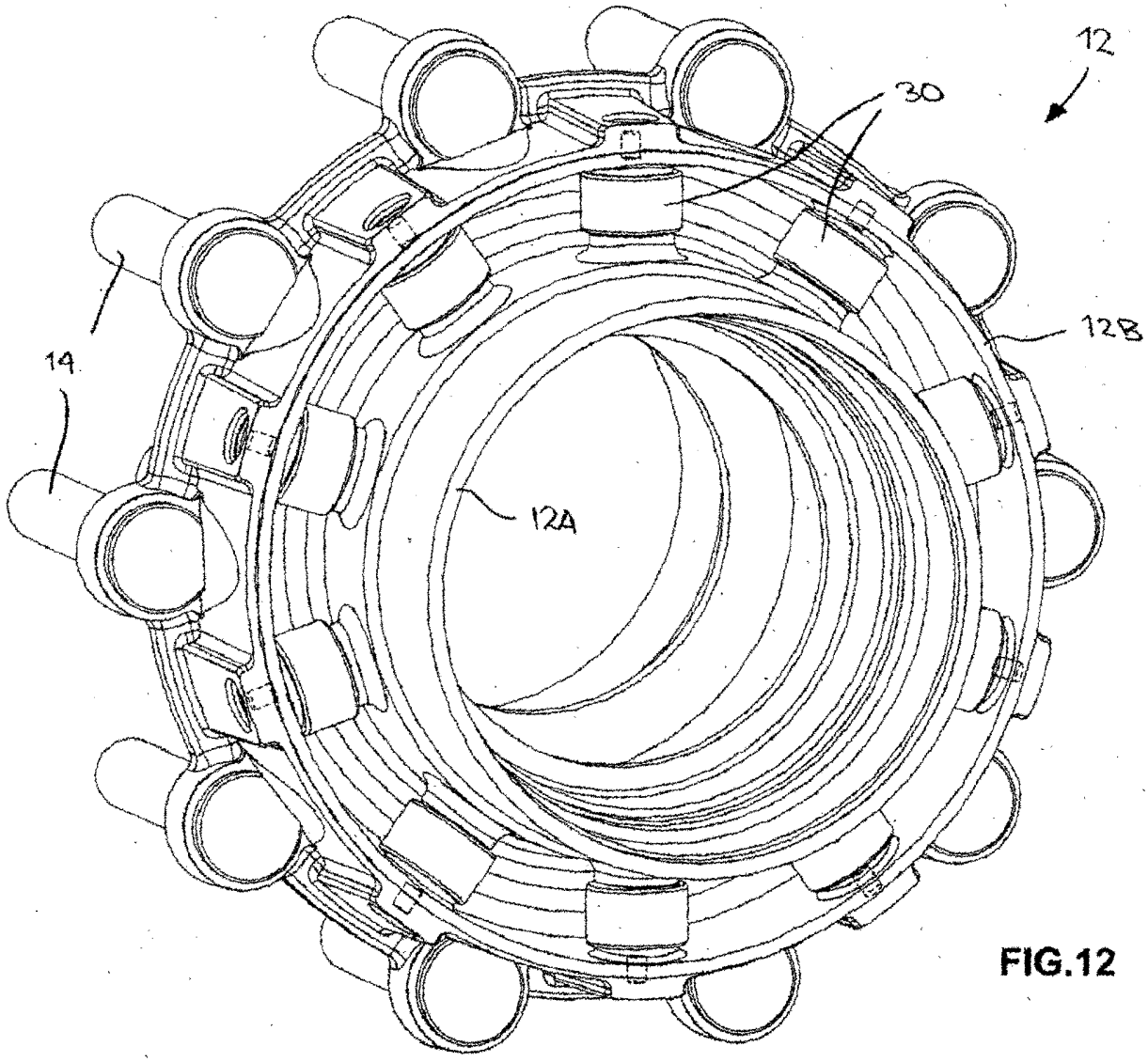

FIG.12

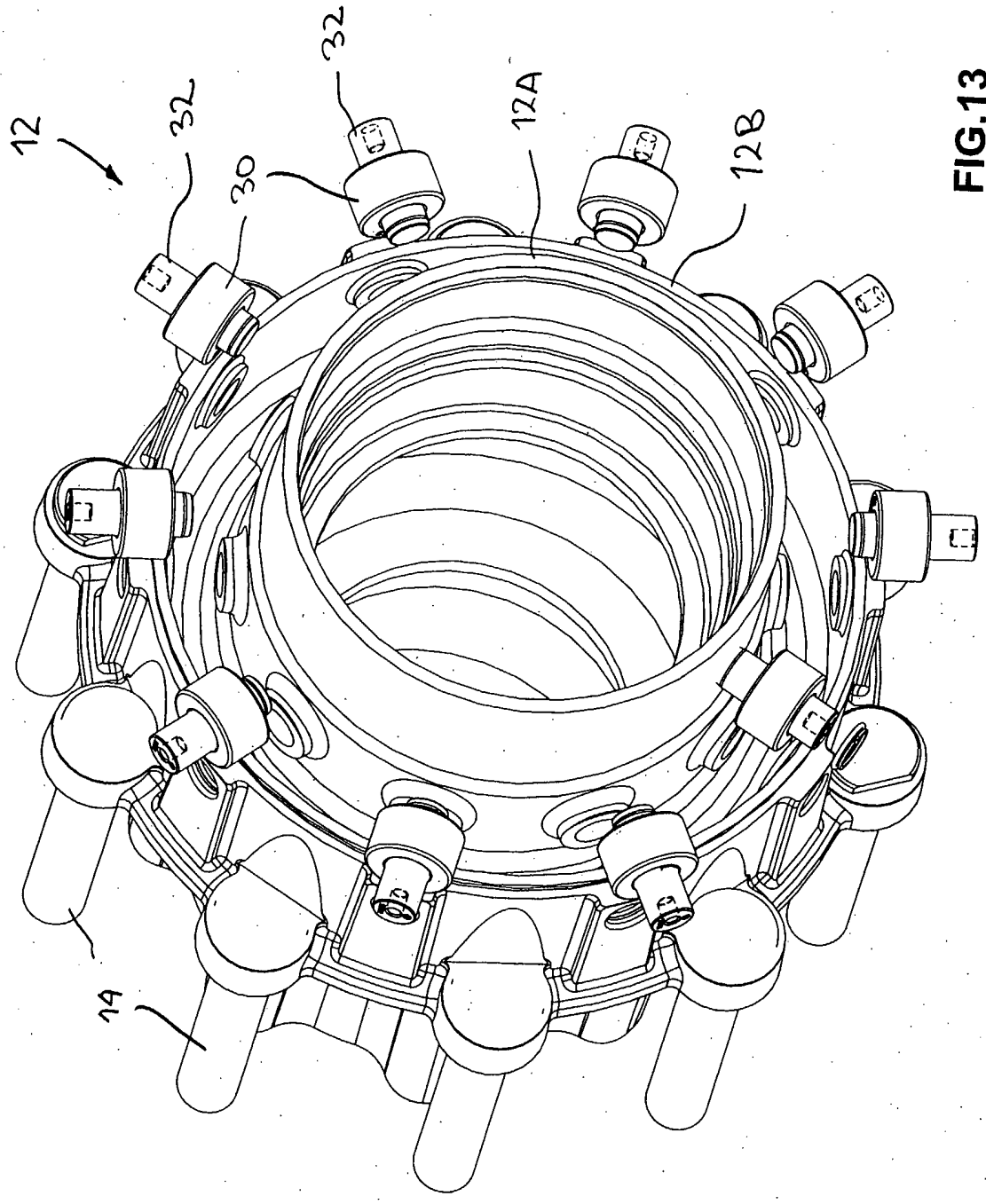

FIG.13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/001702

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***F16D 65/02*** (2006.01), ***F16D 65/12*** (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)
IPC 7: F16D CPC:188 USPC:188

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Delphion, Derwent, Esp@cenet, CPD

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 03/062662 A1 (GOTTI et al.) 31 July 2003 (31.07.2003) *Whole Document*	1 and 12
X	WO 03/029684 A1 (PERICO) 10 April 2003 (10-04-2003) *Whole Document*	1, 12, 13 and 14
X	CA 2,289,833 A (RANCOURT et al.) 15 May 2001 (15-05-2001) *Whole Document*	1, 7, and 12
A	CA 2,046,370 B (PAQUET et al.) 21 December 1992 (21-12-1992) Patent Family Member Cited By Applicant *Whole Document*	1 and 12
A	CA 2,110,996 (RANCOURT et al.) 07 January 1993 (07-01-1993) Patent Family Member Cited By Applicant *Whole Document*	1 and 12

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

[X] See patent family annex.

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"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
09 December 2005 (09-12-2005)	03 February 2006 (03-02-2006)

Name and mailing address of the ISA/CA	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001(819)953-2476	Shawn De Salvo (819) 934-4270

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/CA2005/001702

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