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(72) Inventor: **Berndorfer, Axel H.
54453 Nittel (DE)**

(74) Representative: **Jones, Keith William et al
Murgitroyd & Company
Scotland House
165-169 Scotland Street
Glasgow G5 8PL (GB)**

(71) Applicant: **Delphi Technologies, Inc.
Troy, MI 48007 (US)**

(54) **Phaser for controlling the timing between a camshaft and a timing gear**

(57) Phaser (1) for controlling the timing between a camshaft and a timing gear, comprising:

- a rotor (2) having first and second circumferentially spaced apart vanes (4),
- a stator (3), co-axially surrounding the rotor (2), provided with first and second circumferentially spaced apart recesses (5),
- wherein each vane (4) divides each recess into a

- first pocket (6a) and a second pocket (6b),
- wherein the phaser (1) comprises locking means (27) for blocking the movement of the rotor (2) with respect to the stator (3), characterised in that,
- the locking means (27) are adapted to lock the rotor (2) in an angular position with respect to the stator (3) to fix the vanes (4) of the rotor (2) in an intermediate position between the first and second endwall of the recess (5).

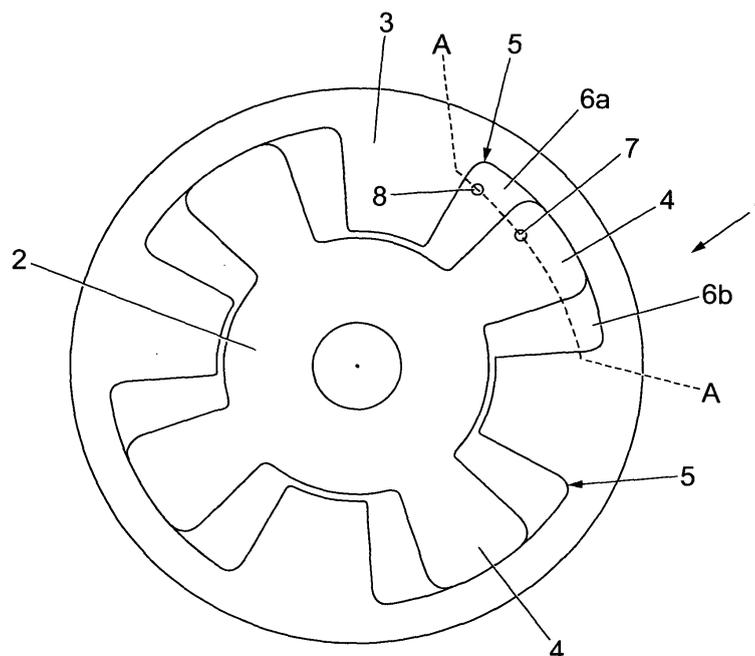


Fig. 1
(PRIOR ART)

Description

[0001] The present invention relates to a phaser for controlling the timing between a camshaft and a timing gear.

[0002] An internal combustion engine has a crankshaft driven by the connecting rods of pistons and one or more camshafts, which actuate the intake and exhaust valves of the cylinders. The camshaft is connected to a timing gear by means of a timing drive, such as a belt, chain or gears. In a variable cam timing system, the timing gear is constructed in order to comprise a variable angle coupling, known as a phaser. The phaser is provided with a rotor connected to the camshaft in a housing or stator connected to the timing gear. This allows the camshaft to rotate independently of the timing gear, within angular limits, to change the relative timing of the camshaft and the crank-shaft. The term "phaser", as used in the present text, includes the stator and the rotor and all of the parts to control the relative angle of position of the stator and the rotor to allow the timing of the camshaft to be offset from the crank-shaft.

[0003] A phaser as described in the introduction is known in the prior art. Most variable camshafts in production today are hydraulically activated devices, using vanes received in recesses, the vanes and the recesses enclosing fluid pockets, wherein the fluid pressure in the fluid pockets will control the angular position of the vane in the recess. The phasers, known in the prior art, are activated by oil pressure derived from an engine oil pump or auxiliary oil pump.

[0004] The known phasers require a reliable locking mechanism for blocking the movement of the rotor with respect to the stator during engine shut down. A reason for blocking the movement of the rotor is to avoid damage to the phaser and potentially to the engine in case the engine oil within the phaser is purged during the engine shut down, or oil pressure is not sufficient to maintain a stable position for the rotor.

[0005] In order to provide such a locking mechanism, according to the prior art phasers have a lock pin positioned such that the pin engages at an end position of the phase range. That means that the lock pin will engage in either the fully retarded position or in the fully advanced position of the rotor with respect to the stator. This is necessary since during shut down the oil pressure in the system will drop, making it impossible to control the phaser by means of the engine oil pressure. During the engine shut down, the reversal cam torque will drive the phaser in one of its end positions. In this end position the pin can easily engage, thereby blocking the movement of the rotor with respect to the stator.

[0006] According to the prior art is not possible to let the pin engage in an intermediate position, since at the moment when the engine oil pressure is low enough to allow the pin to engage, nothing would align the pin with its seat. The torque reversals would simply drive the pin over the seat without allowing the pin to engage.

[0007] An important drawback of locking the phaser in one of the end positions is the fact that the end positions do not necessarily correspond with the preferred position for guaranteeing a proper engine start. That means that the engine will be started in a less than ideal position, because of the lack of engine oil pressure. Once the oil pressure is build up, that phaser can be used to optimise the angular position between rotor and stator.

[0008] It is an object of the present invention to improve the phaser according to the prior art, allowing the phaser to have an improved performance during engine start, or during a situation of low oil pressure in the engine.

[0009] This object is achieved in that the invention provides a phaser for controlling the timing between a camshaft and a timing gear, comprising:

- a rotor having first and second circumferentially spaced apart vanes, the rotor being connectable to the camshaft for rotation therewith;
- a stator, co-axially surrounding the rotor, provided with first and second circumferentially spaced apart recesses for receiving the first and second vane of the rotor and allowing rotational movement of the rotor with respect to the stator,
- wherein each vane divides each recess into a first pocket and a second pocket, the pockets being able to receive fluids under pressure, wherein the introduction of a fluid into the pocket causes the rotor to move in a first rotational direction relative to the stator, and wherein the introduction of a fluid in the second pocket causes the rotor to move in the opposite rotational direction relative to the stator,
- each recess having a first endwall defining a first end position for the vane and a second endwall defining a second endposition for the vane,
- wherein the phaser comprises locking means for blocking the movement of the rotor with respect to the stator, wherein,
- the locking means are adapted to lock the rotor in an angular position with respect to the stator to fix the vanes of the rotor in an intermediate position between the first and second endwall of the recess.

[0010] According to the invention it is possible that the locking means are adapted to move from a position for allowing the movement of the rotor with respect to the stator, towards a locking position for locking the rotor in an angular position with respect to the stator, via an intermediate position for limiting the movement of the rotor with respect to the stator.

[0011] Because of these measures it is possible to lock the stator and the rotor in an intermediate position, preferably corresponding with a position for guaranteeing a proper start.

[0012] According to a preferred embodiment of the invention the locking means comprise a pin and a seat, the pin being movable from a first position for allowing the movement of the rotor with respect to the stator to a sec-

ond position for blocking the said movement, the pin at least partially protruding the seat in the second position thereof.

[0013] According to the invention it is possible that the pin is movable in a direction essentially parallel to the rotational axis of the camshaft. Alternatively the pin is movable in a direction essentially perpendicular to the rotational axis of the camshaft.

[0014] Thereby it is possible that the seat is connected to a fluid line, for building up a fluid pressure in the seat in order to thereby move the pin from the second to the first position thereof.

[0015] According to the invention it is possible that the seat has a stepped shape, having an upperpart for, upon entry of the pin in the upperpart, limiting the movement of the rotor with respect to the stator and a bottom part for, upon entry of the pin, preventing the movement of the rotor with respect to the stator.

[0016] With this measure there is a stepped approach for the lock pin engagement. At engine shut down the phaser would be commanded to an end position, e.g. the retarded position. When the oil pressure drops under the limit of hydraulic stability of the phaser, the pin would release until it hits the upper part of the seat. With the following torque reversals it would alternately be driven to the end positions within this upper part of the seat. When the pressure drops further, the lock pin will engage the bottom part of the seat and will thereby be locked completely to block the respective movement between the rotor and the stator.

[0017] According to the invention the upperpart of the seat is connected to the first pocket upon entry of the bolt in the lower part.

[0018] The present invention will now be described with reference to the accompanying drawings wherein:

Figure 1 shows in topview the locking means for locking the rotor and stator of a phaser, according to the prior art;

Figure 2 shows in cross section the locking means for locking the rotor and the stator of a phaser, according to the line A-A in Fig 1;

Figure 3 shows in top view the locking means for locking the rotor and stator of a phaser, according to the present invention;

Figure 4 shows in cross section the locking means according to the present invention, according to the line B-B shown in figure 3.

[0019] In figure 1, part of the phaser 1 is shown according to the prior Art. The phaser 1 is provided with a rotor 2 and a stator 3. The phaser is used in an internal combustion engine to allow a camshaft to rotate independently of a timing gear within angular limit to change the relative timing of the camshaft and the crank-shaft.

The rotor 2 is connected to the camshaft (not shown), whereas the stator 3 is connected to the timing gear (not shown). The rotor 2 is provided with vane 4, the vanes are received in recesses 5 in the stator 3. The recesses 5 and the vanes 4 enclose fluid pockets, 6a and 6b on opposite side of the vanes 4.

[0020] The relative movement of the rotor 2 with respect to the stator 3 is accomplished by changing the fluid pressure in the mentioned pockets 6a and 6b received from the engine oil pump.

[0021] The phaser 1 is provided with a locking mechanism, which allows to lock the phaser at a specified position during engine shut down. Reason is for this, that during engine shut down the oil pressure will drop making it impossible to control the relative position of the rotor 2 with respect to the stator 3 by means of engine oil pressure. In order to avoid damage to the phaser 1 and potentially the engine, the locking mechanism is used to lock the relative position of the rotor with respect to the stator 3.

[0022] In figure 1, the locking mechanism is schematically indicated by means of locking pin 7 and the seat. Functioning of the locking mechanism according to the prior Art is shown in more detail in figure 2.

[0023] Figure 2 shows in cross section part of the phaser 1 according to the line A-A, as shown in figure 1.

[0024] The rotor 2 comprises a locking pin 7, which is movably attached to the vane 4. Locking pin is movable against the force of spring 9. The stator 3 is provided with a seat adapted to receive the locking pin 7. The vane 4 is provided with an aperture 12 to allow air and/or oil to escape from the interior of the vane 4.

[0025] The locking pin 7 is movable from a locking position as shown in figure 2 towards a release position. In the locking position, the locking pin 7 retreads from the vane 4 and enters the seat in order to thereby lock the phaser 1, in order to lock the movement of the rotor 2 with respect to the stator 3.

[0026] From the locking position as shown in figure 2, the locking pin is movable upwards against the force of the spring 9 by means of oil pressure. The oil pressure originates from the engine oil pump and is transported towards the locking pin 7 via line 10. In case the oil pressure is high enough the locking pin will enter the vane 4 and thereby allow the movement of the rotor 2 with respect to the stator 3.

[0027] The phaser 1 is provided with a line 13 to transport oil under pressure towards the pocket 6b. In case the vane 4 moves to the right, the space between the vane 4 and the stator 3 will form a further pocket 6a. Oil can be transported to this pocket via the line 10. The relative oil pressure in the mentioned pockets 6a and 6b will determine the relative position of the rotor and the stator.

[0028] It is clear from figure 2 that the lock pin 7 is positioned in order to be able to engage the seat at the end position of the phase range. That means that in case the oil pressure drops to a certain level and it is not longer

possible to control the relative position of the rotor 2 and the stator 3 by means of the oil pressure, the rotor 2 will move with respect to the stator 3 as result or reversal cam torque into one of the end position. In case the vane 4 is pushed against the stator 3 as shown in figure 2, the locking pin 7 and the seat are lined in order for the seat to be able to receive the locking pin 7 to thereby lock the phaser.

[0029] In figure 3, the phaser 20 according to the present invention is shown. The phaser 20 comprises a rotor 22 and a stator 23. The rotor 22 is provided with vane 24 which are received in recesses 25 in the stator 23. On opposite side of the vane 24 pockets 26a and 26b are present for receiving oil, wherein the oil pressure in respective pockets 26a and 26b, determines the angle of position of the rotor 22 with respect to the stator 23. Oil can be fed to pocket 26a and 26b via the lines 30 and 33, respectively.

[0030] The phaser 20 according to the present invention is provided with an alternative locking mechanism, which is shown in more detail in figure 4. Locking mechanism comprises a locking pin 27, attached to the vanes 24 and a seat 28 in the stator 23 for receiving the locking pin 27.

[0031] In figure 4, the phaser 20 shown in cross section according to the line B-B as indicated in figure 3. In figure 4 it is shown that the rotor 22 is fixed with respect to the stator 23 in an intermediate position. This means that the vane 24 is not in contact with one of the sidewalls of the recess 25. The locking pin 27 is received in the seat 28. This blocks the movement of the rotor 22 with respect to the stator 23.

[0032] Figure 4 shows that the seat 28 is stepped. The seat 28 comprises a first shallow parts 28a and a second deep part 28b. The functioning of the locking mechanism according to figure 4 is as follows:

[0033] By means of oil pressure, via the line 30, the locking pin 27 is moved upward against the force of the spring 29. The vane 24 is provided with an aperture 32 to allow air to escape from the interior of the vane 24. Movement of the vane 24 is controlled by the respective oil pressure in the pockets 26a and 26b. Upon engine shut down, the engine oil pressure will drop, meaning that the oil pressure on the locking pin 27 will also drop. Because of the pressure drop the locking pin 27 will protrude from the vane 24 and enter the shallow part 28a of the seat 28 in the stator 23. Upon entry in the shallow part 28a the movement of the rotor 22 with respect to the stator 23 is not locked, but limited to a phase range which equals the width of the shallow part 28a of the seat 28. With the oil pressure dropping, the movement of the rotor 22 with respect to the stator 23, may be driven by means of the reversals cam torque. In case the locking pin 27 is moved to the right side of the shallow portion 28a of the seat 28 in the stator 23, the locking pin 27 is in line with the deep part 28b of the seat 28. In case the oil pressure drops below a certain level, the locking pin 27 can enter the deep part 28b to thereby block the move-

ment of the rotor with respect to the stator.

[0034] The locking mechanism as described with respect to figure 3 and 4, enables to fix the position of the rotor in an intermediate position. This intermediate position can be chosen in order to block the phaser in an ideal position to guaranty a proper engine start. This means that the emissions, crank time, start ability, etc... are optimised for optimal start conditions for the engine.

[0035] Please note that in figure 2 a non-stepped pin 7 is shown, while in figure 4 a stepped pin 27 is shown. The blocking means according to the present invention can be provided with either a non-stepped or a stepped pin.

[0036] In figure 4 a seat is shown have two steps. It should be understood that a seat alternatively could be provided with three or more steps.

Claims

1. Phaser for controlling the timing between a camshaft and a timing gear, comprising:

- a rotor having first and second circumferentially spaced apart vanes, the rotor being connectable to the camshaft for rotation therewith;
- a stator, co-axially surrounding the rotor, provided with first and second circumferentially spaced apart recesses for receiving the first and second vane of the rotor and allowing rotational movement of the rotor with respect to the stator,
- wherein each vane divides each recess into a first pocket and a second pocket, the pockets being able to receive fluids under pressure, wherein the introduction of a fluid into the pocket causes the rotor to move in a first rotational direction relative to the stator, and wherein the introduction of a fluid in the second pocket causes the rotor to move in the opposite rotational direction relative to the stator,
- each recess having a first endwall defining a first end position for the vane and a second endwall defining a second endposition for the vane,
- wherein the phaser comprises locking means for blocking the movement of the rotor with respect to the stator, **characterised in that,**
- the locking means are adapted to lock the rotor in an angular position with respect to the stator to fix the vanes of the rotor in an intermediate position between the first and second endwall of the recess.

2. Phaser according to claim 1, wherein the locking means are adapted to move from a position for allowing the movement of the rotor with respect to the stator, towards a locking position for locking the rotor in an angular position with respect to the stator, via an intermediate position for limiting the movement

of the rotor with respect to the stator.

3. Phaser according to claim 1 or 2, wherein the locking means comprise a pin and a seat, the pin being movable from a first position for allowing the movement of the rotor with respect to the stator to a second position for blocking the said movement, the pin at least partially protruding the seat in the second position thereof. 5
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4. Phaser according to claim 3, wherein the pin is movable in a direction essentially perpendicular to the rotational axis of the camshaft.
5. Phaser according to claim 3, wherein the pin is movable in a direction essentially parallel to the rotational axis of the camshaft. 15
6. Phaser according to claim 3 or 4, wherein the seat is connected to a fluid line, for building up a fluid pressure in the seat in order to thereby move the pin from the second to the first position thereof. 20
7. Phaser according to claim 3, 4 or 5, wherein the seat has a stepped shape, having an upperpart for, upon entry of the pin in the upperpart, limiting the movement of the rotor with respect to the stator and a bottom part for, upon entry of the pin, preventing the movement of the rotor with respect to the stator. 25
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8. Phaser according to claim 6, wherein the upperpart of the seat is connected to the first pocket upon entry of the pin in the lower part.
9. Phaser according to claim 6 or 7, wherein the seat has a multiple stepped shape. 35

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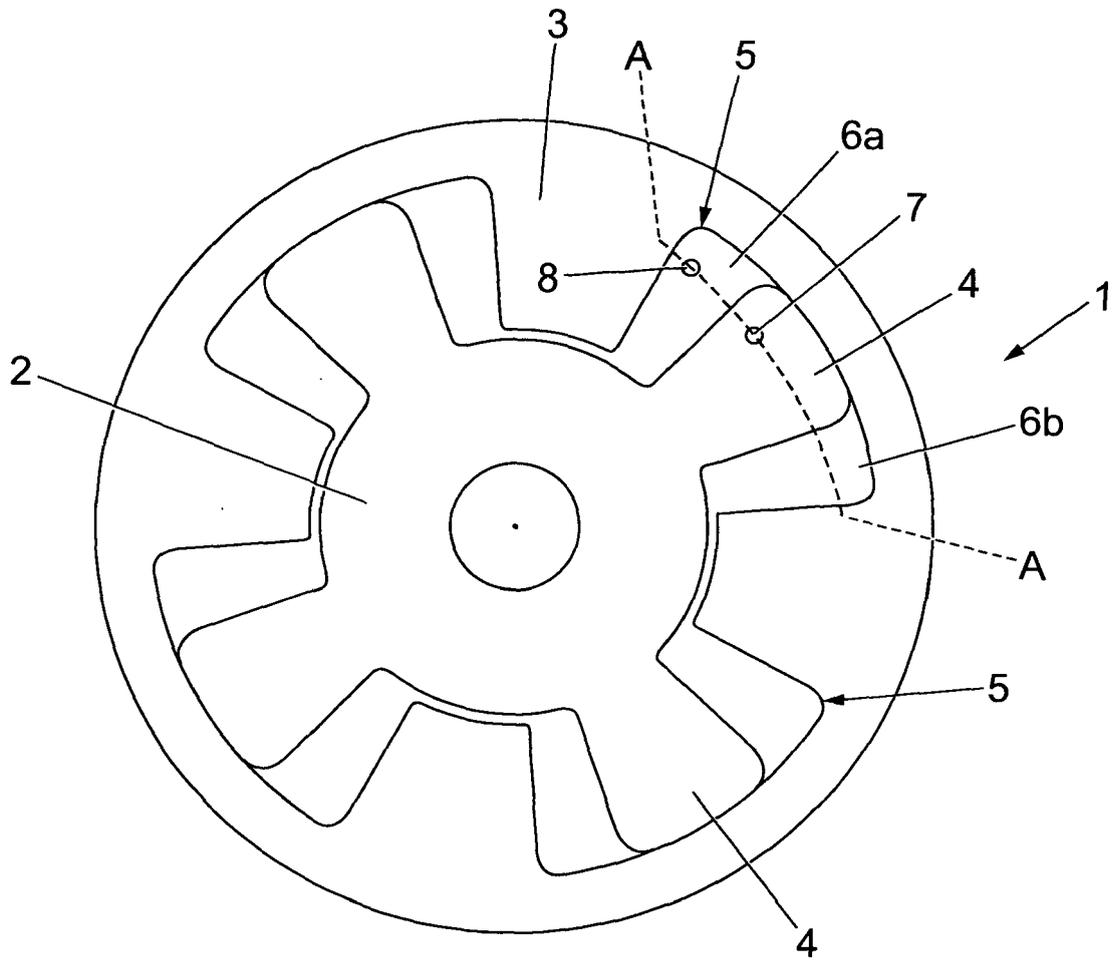


Fig. 1
(PRIOR ART)

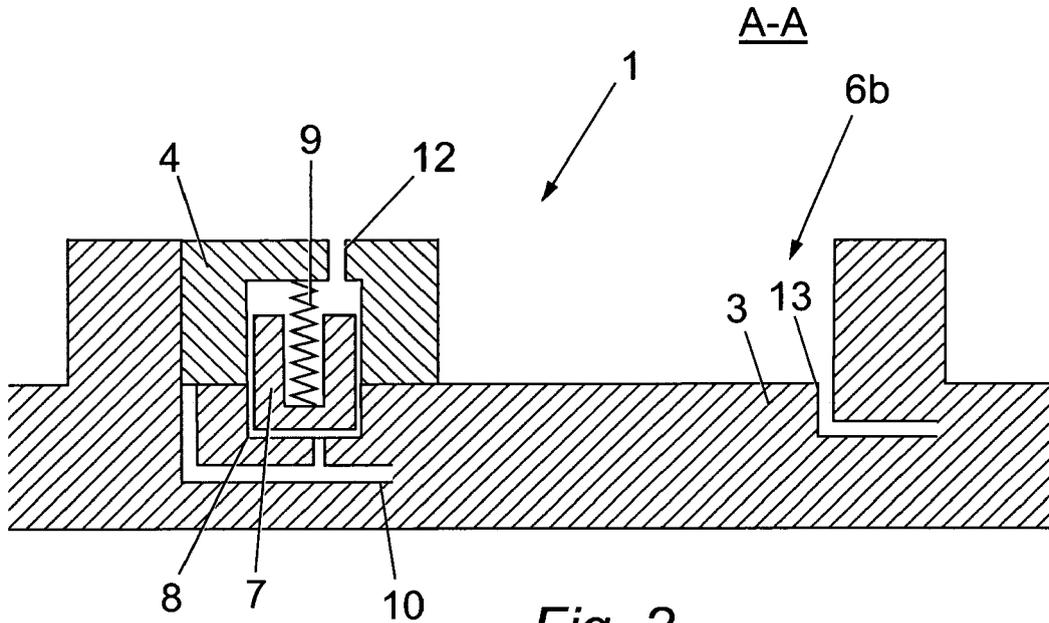


Fig. 2
(PRIOR ART)

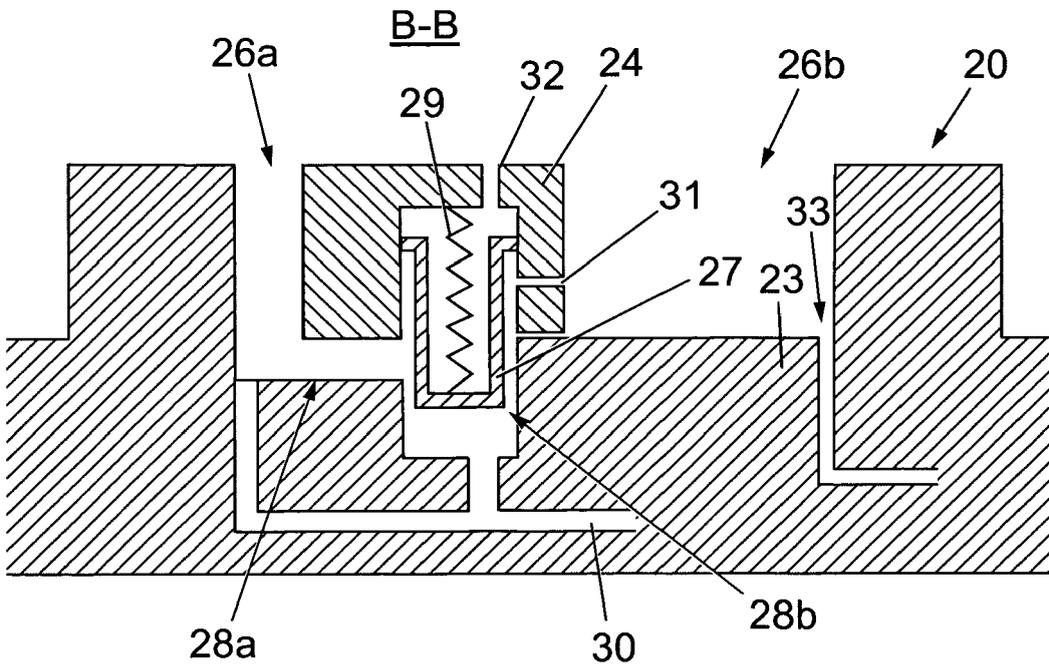


Fig. 4

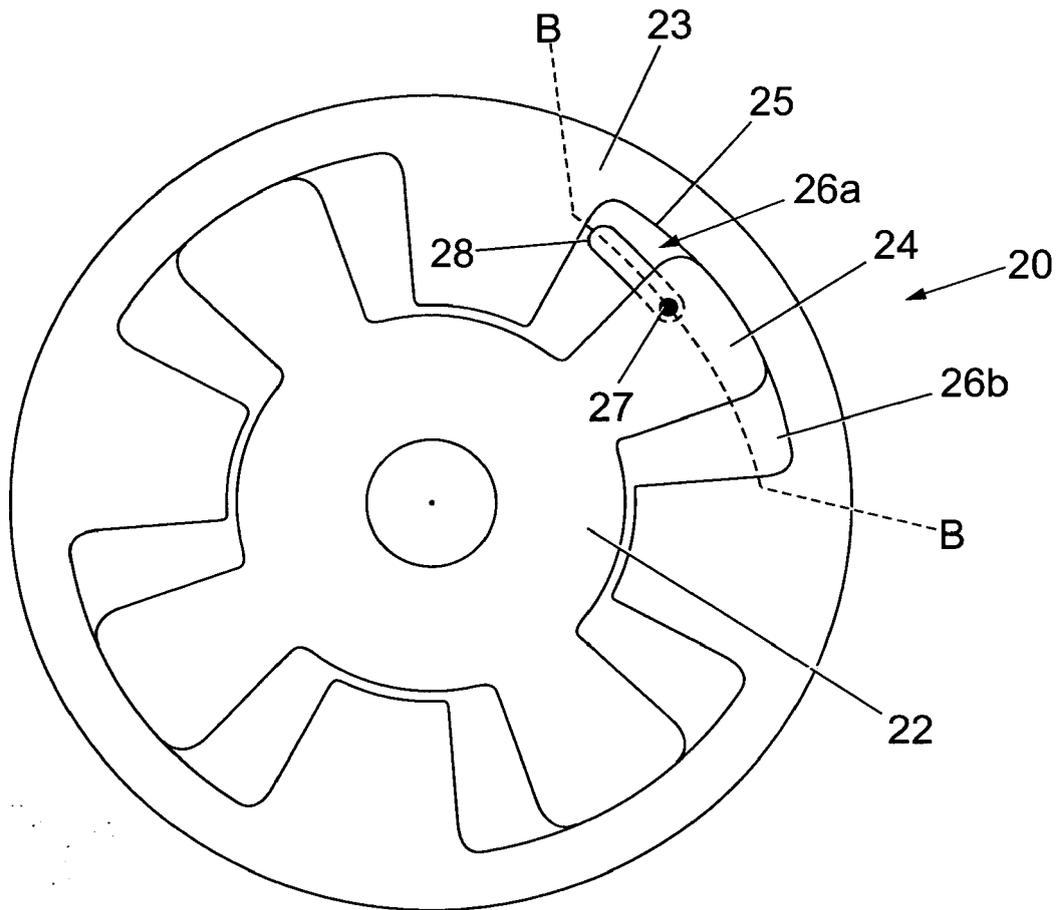


Fig. 3



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 6 334 414 B1 (OKADA ET AL) 1 January 2002 (2002-01-01) * column 3, line 19 - column 6, line 22 * * column 16, lines 1,2 * * figures 1-5,7a-10 * -----	1-7	F01L1/344
X	DE 102 46 838 A (DAIMLERCHRYSLER) 29 April 2004 (2004-04-29) * paragraph [0006] - paragraph [0007] * -----	1-3,5-9	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F01L
X	DE 102 23 409 A (DAIMLERCHRYSLER) 4 December 2003 (2003-12-04) * paragraph [0006] * * claims * * figures *	1,3,5,6	
A	-----	4	
X	US 2004/112314 A1 (KANADA ET AL.) 17 June 2004 (2004-06-17) * paragraph [0036] - paragraph [0040]; figures *	1,3,4,6	
A	-----	8	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 30 June 2005	Examiner Paquay, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 25 0233

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

30-06-2005

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6334414	B1	01-01-2002	JP 2001050017 A	23-02-2001
			JP 2001050018 A	23-02-2001
			DE 10038082 A1	29-03-2001

DE 10246838	A	29-04-2004	DE 10246838 A1	29-04-2004
			WO 2004033860 A1	22-04-2004

DE 10223409	A	04-12-2003	DE 10223409 A1	04-12-2003
			WO 03100222 A1	04-12-2003
			EP 1507961 A1	23-02-2005
			US 2005092275 A1	05-05-2005

US 2004112314	A1	17-06-2004	JP 2004116411 A	15-04-2004
			DE 10344816 A1	06-05-2004

EPO FORM P0469

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