



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
24.12.2008 Bulletin 2008/52

(51) Int Cl.:
F01L 1/344 (2006.01)

(21) Application number: **07252293.1**

(22) Date of filing: **07.06.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

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

(74) Representative: **Murgitroyd, Ian George**
Murgitroyd and Company
165-169 Scotland Street
Glasgow G5 8PL (GB)

(71) Applicant: **DELPHI TECHNOLOGIES, INC.**
Troy, MI 48007-5052 (US)

(54) **Locking mechanism for a camshaft phaser**

(57) A locking means for a variable cam phaser including coaxial drive and driven members drivingly connected by phase control means for selectively varying the relative angular orientation of said drive and driven members, said locking means comprising a locking pin provided on one of said drive and driven members for movement between an unlocked position, to allow angular adjustment of said drive and driven members by the phase control means, and a locked position, wherein the locking pin engages a receiving means provided on the other of the drive and driven members to maintain said relative angular orientation between said drive and driven members; biasing means being provided for biasing said locking pin to its locked position; a portion of the locking pin being exposed to a chamber, said chamber being selectively communicable with a source of pressurised fluid whereby pressurisation of said chamber with high pressure fluid urges the locking pin to its unlocked position; actuating means being provided for selectively placing said chamber in fluid communication with said source of pressurised fluid.

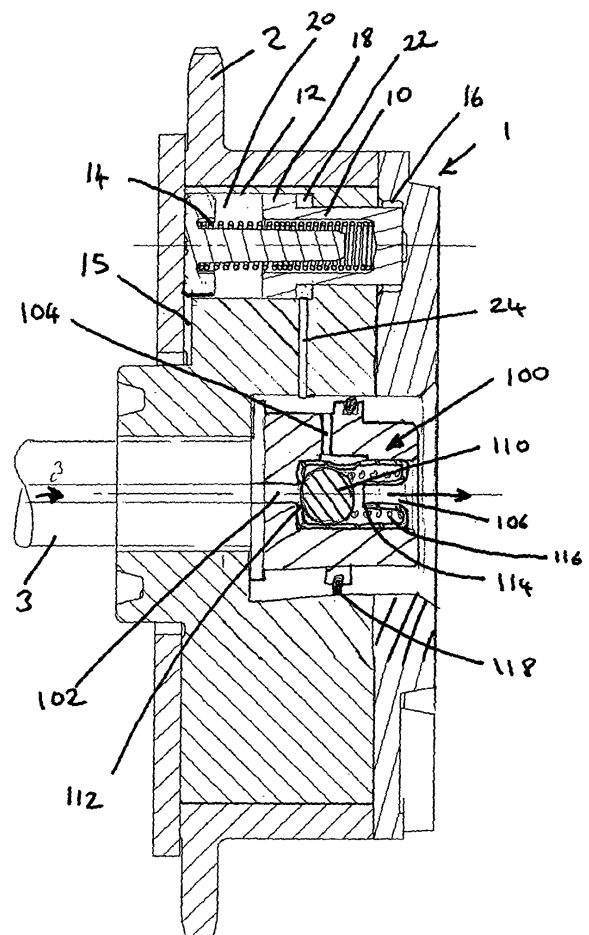


Fig. 1

Description

[0001] The present invention relates to a locking mechanism for a cam phaser and in particular to a locking mechanism for selectively locking drive and driven members of a cam phaser apparatus of an internal combustion engine to selectively maintain the relative angular orientation between said drive and driven members.

[0002] Cam phasers for internal combustion engines are well known. The engine's crankshaft is normally drivingly connected to the camshaft via a chain or belt running on sprockets or pulleys. Typically, a cam phaser is disposed between the camshaft drive sprocket (drive member) and the camshaft (driven member) to permit adjustment of angular orientation of the camshaft with respect to the crankshaft. Typically, pressurized oil from an oil gallery in the engine block is selectively distributed to timing advance and retard chambers within the phaser by means of suitable valve means to controllably vary the phase relationship between the engine's crankshaft and camshaft. In a vane-type cam phaser, the chambers are formed between inwardly-extending lobes of a generally cylindrical stator and outwardly-extending vanes of a rotor concentrically disposed within the stator.

[0003] During initial engine start up and shut down, it is desirable to rotationally lock the drive and driven members of the cam phaser. This is required to guarantee a proper engine start up with a specific cam timing and to avoid damage to the cam phaser and potentially the engine which might occur due to incorrect operation of the cam phaser and thus incorrect cam timing at engine start up due to low oil pressure, particularly if oil within the cam phaser mechanism has drained away while the engine has been inoperative.

[0004] For this purpose, prior art cam phaser assemblies have included a locking pin arranged to lock the drive and driven members of the cam phaser assembly at an end position of the cam phaser range of angular adjustment, either fully retarded or fully advanced.

[0005] The mechanism typically includes a bore disposed in one of the drive or driven members and a spring-biased locking pin disposed therein. The locking pin is spring biased to lock into a corresponding receiving aperture in the other of the drive or driven member whenever the pin and receiving aperture are rotationally aligned at either the fully retarded or fully advanced positions of the cam phaser. An oil well is located on one side of the pin and communicates with a passageway supplied with oil from the oil pump to force the pin from the receiving aperture to enable the cam phaser to operate while the engine is operating and to enable the locking pin to be automatically urged into the receiving aperture to lock the drive and driven members together when the oil pressure falls below that required to overcome the biasing force of the spring bias as the engine is switched off. Although the cam phaser becomes uncontrollable when the oil pressure falls, the cam phaser is moved to an end position of the cam phaser range and

the locking pin is automatically brought into alignment with the receiving aperture by virtue of the torque applied to the camshaft by the valve springs.

[0006] This known mechanism works satisfactorily when the locking pin is required to lock the cam phaser in one of its end positions. However, such arrangement is not satisfactory when the locking pin is required to lock the cam phaser at a position between its end positions, as is increasingly required due to increased range of cam phase variation required during engine operation, because when the engine shuts down, such that the oil pressure falls to a level where the locking pin is urged towards the receiving aperture by the spring, the cam phaser can no longer control the relative angular orientation of the camshaft with respect to the crankshaft and thus cannot align the locking pin with its receiving aperture to allow the locking pin to enter the receiving aperture.

[0007] In such cases it has been known to provide a separate supply of pressurised fluid to the locking pin to permit selective control of the locking pin while the main engine oil pressure remains high enough for control of the cam phaser. However, this has the further disadvantage or requiring additional components and fluid passageways for the additional locking pin control, leading to increased cost, complexity and space requirements.

[0008] According to the present invention there is provided a locking means for a variable cam phaser including coaxial drive and driven members drivingly connected by phase control means for selectively varying the relative angular orientation of said drive and driven members, said locking means comprising a locking pin provided on one of said drive and driven members for movement between an unlocked position, to allow angular adjustment of said drive and driven members by the phase control means, and a locked position, wherein the locking pin engages a receiving means provided on the other of the drive and driven members to maintain said relative angular orientation between said drive and driven members; biasing means being provided for biasing said locking pin to its locked position; a portion of the locking pin being exposed to a chamber, said chamber being selectively communicable with a source of pressurised fluid whereby pressurisation of said chamber with high pressure fluid urges the locking pin to its unlocked position; actuating means being provided for selectively placing said chamber in fluid communication with said source of pressurised fluid.

[0009] This allows the movement of the locking pin to be controlled whereby the cam phaser can be controlled to align the locking pin with the receiving means before the locking pin is released to be moved to its locked position under the action of the biasing means during engine shut down and also enables release of the locking pin to be delayed on engine start up until the oil pressure is high enough to enable the cam phaser to be controlled.

[0010] Preferably the actuating means comprises a valve provided in a fluid passageway between said chamber and said source of pressurised fluid, said valve having

a valve member moveable between a first position, wherein said valve member prevents fluid communication between said source of pressurised fluid and said chamber, and a second position wherein said valve member allows fluid communication between said source of pressurised fluid and said chamber.

[0011] In one embodiment said valve comprises a check valve, said valve member being spring biased towards its first position, said valve member being moved towards its second position when the pressure of fluid in said source of pressurised fluid exceeds a predetermined value.

[0012] Said valve may further include means for venting said chamber to a drain when said valve member moves to its first position. Said venting means may comprise a vent port communicating with a drain or low pressure region. Said valve may include means for closing said vent port when said valve member reaches its first position.

[0013] In a preferred embodiment said valve includes a valve member engageable with a first valve seat when in its first position to close fluid communication between said source of pressurised fluid and said chamber when said valve member engages said first port and engageable with a second valve seat when in its second position to close fluid communication between said chamber and said vent port. Preferably said valve member is biased towards the first valve seat by means of a spring or other resilient biasing means, said valve member being urged towards said second valve seat when the fluid pressure from said source of pressurised fluid exceeds a predetermined level.

[0014] In a second embodiment said valve comprises a solenoid actuated valve.

[0015] According to a further aspect of the present invention there is provided a variable cam phaser including coaxial drive and driven members drivingly connected by phase control means for selectively varying the relative angular orientation of said drive and driven members and a locking means in accordance with the abovementioned first aspect of the invention.

[0016] According to a further aspect of the present invention there is provided an internal combustion engine having a variable cam phaser including coaxial drive and driven members drivingly connected by phase control means for selectively varying the relative angular orientation of said drive and driven members and a locking means in accordance with the abovementioned first aspect of the invention.

[0017] Preferably said fluid comprises lubricating oil for lubricating the moving parts of the engine. Said source of pressurised fluid preferably comprises an oil pump for supplying said lubricating oil to the moving parts of the engine.

[0018] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a sectional view through a variable cam phaser according to an embodiment of the present invention.

[0019] A cam phaser 1 according to an embodiment of the present invention is illustrated in Figure 1. The cam phaser 1 is disposed between the camshaft drive sprocket 2 (drive member) and the camshaft 3 (driven member) to permit adjustment of angular orientation of the camshaft 3 with respect to the crankshaft. Pressurized oil from an oil gallery in the engine block supplied with oil from the oil pump is selectively distributed to timing advance and retard chambers (not shown) within the phaser by means of suitable valve means to controllably vary the phase relationship between the engine's crankshaft and camshaft. The chambers are formed between inwardly-extending lobes of a generally cylindrical stator and outwardly-extending vanes of a rotor concentrically disposed within the stator.

[0020] During initial engine start up and shut down, it is desirable to rotationally lock the drive and driven members of the cam phaser. This is required to guarantee a proper engine start up with a specific cam timing and to avoid damage to the cam phaser and potentially the engine which might occur due to incorrect operation of the cam phaser and thus incorrect cam timing at engine start up due to low oil pressure, particularly if oil within the cam phaser mechanism has drained away while the engine has been inoperative.

[0021] For this purpose, a locking pin 10 is mounted within the cam phaser and arranged to lock the drive and driven members of the cam phaser assembly together at a predetermined position.

[0022] The locking pin 10 is slidably mounted within a bore 12 disposed in one half of the cam phaser. The locking pin 10 is biased by means of a compression spring 14 to engage a corresponding receiving aperture 16 in the other part of the cam phaser whenever the pin 10 and receiving aperture 16 are rotationally aligned. The locking pin 10 includes a portion 18 dividing the bore 12 into a first chamber 20 on one side of said portion 18 and a second chamber 22 on an opposite side of said portion 18 defining an oil chamber communicating with a passageway 24 which can be selectively supplied with oil from the a source of pressurised oil, such as the engine oil pump, to automatically force the pin 10 from the receiving aperture 16 against the biasing force of the spring 14.

[0023] A check valve 100 is provided for selectively placing said chamber 22 in fluid communication with pressurised oil from the oil pump when the oil exceeds a predetermined level, as will be described below. A passageway 15 extends from the first chamber 20 to a low pressure region to vent the first chamber 20 and allow rapid movement of the locking pin 10.

[0024] The check valve 100 is provided in an oil passageway having a first inlet 102 communicating with said source of pressurised oil, a first outlet 104 communicating

with said chamber 22 and a second outlet 106 communicating with a low pressure vent or drain. The check valve 100 includes a valve member 110 engageable with a first valve seat 112 when in a first position to close said first inlet 102 to prevent fluid communication between said source of pressurised oil and said chamber 22 when said valve member 110 engages said first valve seat 112, and engageable with a second valve seat 114 when in a second position to close said second outlet 106.

[0025] The valve member 110 is biased towards the first valve seat 112 by means of a return spring 116 to close fluid communication between the chamber 22 and the source of pressurised oil when the oil pressure is too low for correct operation of the cam phaser, thus maintaining the locking pin 10 in its receiving aperture 16.

[0026] When the oil pressure exceeds a predetermined level, the oil pressure acting against the valve member 110 exceeds the spring force of the return spring 116 and urges the valve member 110 towards said second valve seat 114 to close the second outlet 106 and allows high pressure oil to flow into the chamber 22 and to move the locking pin 10 out of the receiving aperture 16 to allow operation of the cam phaser.

[0027] As the oil pressure falls during engine shut off, at a predetermined oil pressure, the return spring 116 overcomes the oil pressure to move the valve member 110 away from the second valve seat 114 and into contact with the first valve seat 112, cutting off the supply of pressurised oil from the chamber 22 and oil within the chamber 22 to flow into through the second outlet 106 and into the drain, thereby allowing the movement of the locking pin 10 into engagement with the receiving aperture 16 while the oil pressure remains high enough to control the relative positions of the drive and driven members of the cam phaser.

[0028] The check valve 100 may be mounted within a locking bolt for securing the cam phaser to the cam shaft, an O-ring 118 being provided around the periphery of the locking bolt to seal against an inner face of the cam phaser to define part of said oil passageway.

[0029] Various modifications and variations to the described embodiment of the invention will be apparent to those skilled in the art without departing from the scope of the invention as defined in the appended claims. Although the invention has been described in connection with a specific preferred embodiment, it should be understood that the invention as claimed should not be unduly limited to such specific embodiment.

Claims

1. A locking means for a variable cam phaser including coaxial drive and driven members drivingly connected by phase control means for selectively varying the relative angular orientation of said drive and driven members, said locking means comprising a locking pin provided on one of said drive and driven mem-

bers for movement between an unlocked position, to allow angular adjustment of said drive and driven members by the phase control means, and a locked position, wherein the locking pin engages a receiving means provided on the other of the drive and driven members to maintain said relative angular orientation between said drive and driven members; biasing means being provided for biasing said locking pin to its locked position; a portion of the locking pin being exposed to a chamber, said chamber being selectively communicable with a source of pressurised fluid whereby pressurisation of said chamber with high pressure fluid urges the locking pin to its unlocked position; actuating means being provided for selectively placing said chamber in fluid communication with said source of pressurised fluid.

2. A locking means as claimed in claim 1, wherein the actuating means comprises a valve provided in a fluid passageway between said chamber and said source of pressurised fluid, said valve having a valve member moveable between a first position, wherein said valve member prevents fluid communication between said source of pressurised fluid and said chamber, and a second position wherein said valve member allows fluid communication between said source of pressurised fluid and said chamber.

3. A locking means as claimed in claim 2, wherein said valve comprises a check valve, said valve member being spring biased towards its first position, said valve member being moved towards its second position when the pressure of fluid in said source of pressurised fluid exceeds a predetermined value.

4. A locking means as claimed in claim 3, wherein said valve further includes means for venting said chamber to a drain when said valve member moves to its first position.

5. A locking means as claimed in claim 4, wherein said venting means comprises a vent port communicating with a drain or low pressure region.

6. A locking means as claimed in claim 5, wherein said valve may include means for closing said vent port when said valve member reaches its second position.

7. A locking means as claimed in claim 6, wherein said valve includes a valve member engageable with a first valve seat when in its first position to close fluid communication between said source of pressurised fluid and said chamber when said valve member engages said first port and engageable with a second valve seat when in its second position to close fluid communication between said chamber and said vent port.

8. A locking means as claimed in claim 7, wherein said valve member is biased towards the first valve seat by means of a spring or other resilient biasing means, said valve member being urged towards said second valve seat when the fluid pressure from said source of pressurised fluid exceeds a predetermined level. 5
9. A locking means as claimed in claim 2, wherein said valve comprises a solenoid actuated valve. 10
10. A variable cam phaser including coaxial drive and driven members drivingly connected by phase control means for selectively varying the relative angular orientation of said drive and driven members and a locking means as claimed in any preceding claim. 15
11. An internal combustion engine having a variable cam phaser including coaxial drive and driven members drivingly connected by phase control means for selectively varying the relative angular orientation of said drive and driven members and a locking means as claimed in any of claims 1 to 9. 20
12. An internal combustion engine as claimed in claim 11, wherein said fluid comprises lubricating oil for lubricating the moving parts of the engine. 25
13. An internal combustion engine as claimed in claim 12, wherein said source of pressurised fluid comprises an oil pump for supplying said lubricating oil to the moving parts of the engine. 30

35

40

45

50

55

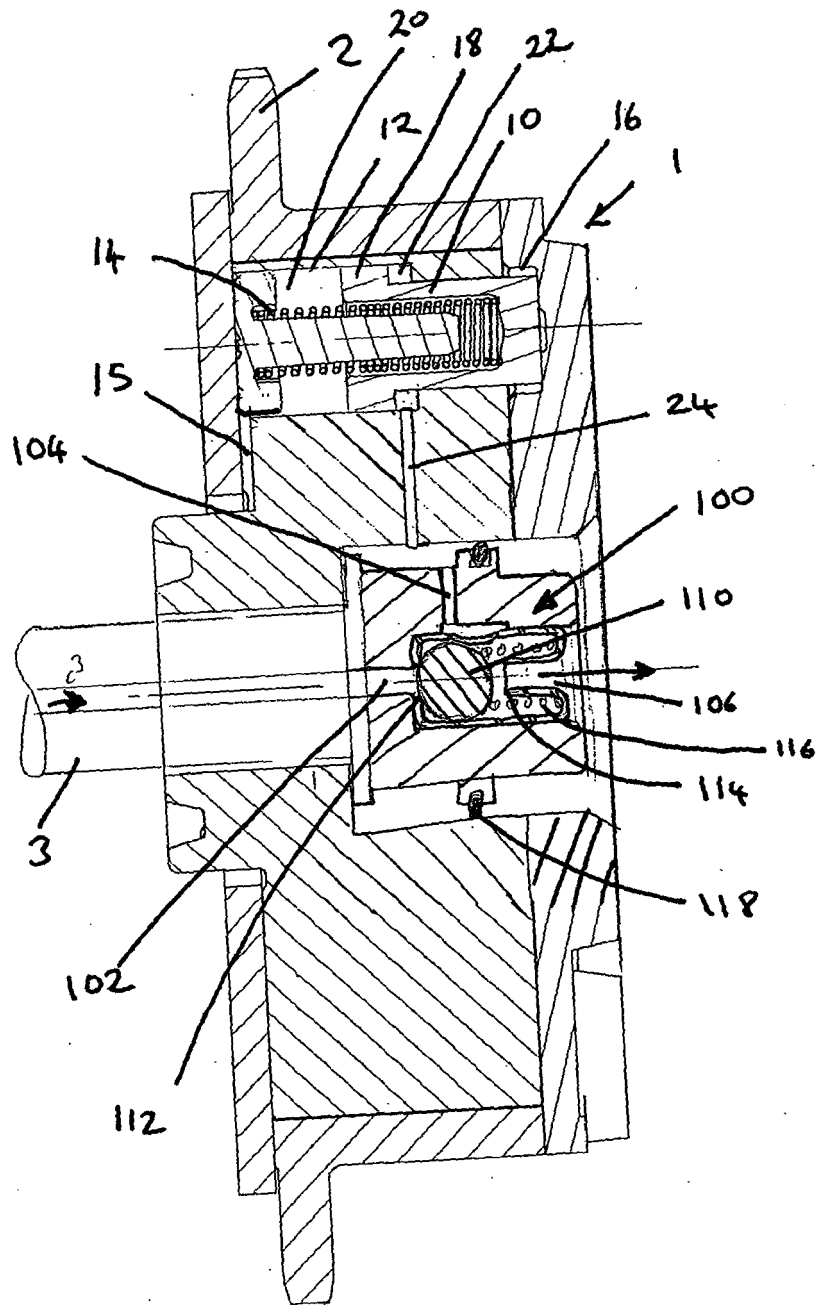


Fig. 1