



(11) **EP 1 783 333 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
09.05.2007 Bulletin 2007/19

(51) Int Cl.:
F01L 1/344 (2006.01) F16D 3/10 (2006.01)

(21) Application number: **05256822.7**

(22) Date of filing: **04.11.2005**

(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 NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(72) Inventor: **Baur, Peter**
Trier 54295 (DE)

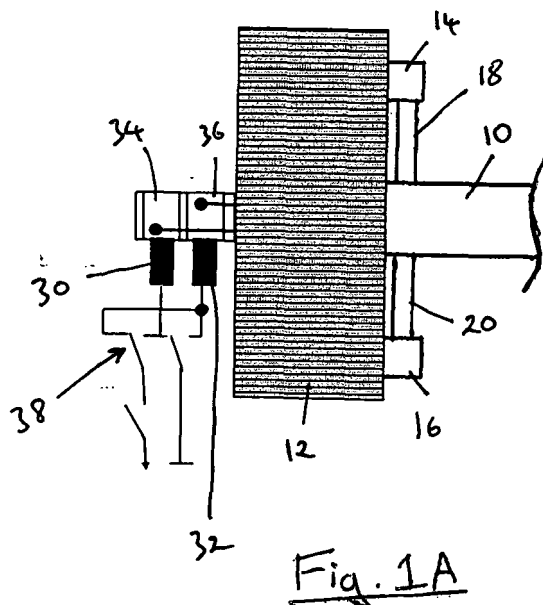
(74) Representative: **Waller, Stephen**
Murgitroyd & Company,
165-169 Scotland Street
Glasgow G5 8PL (GB)

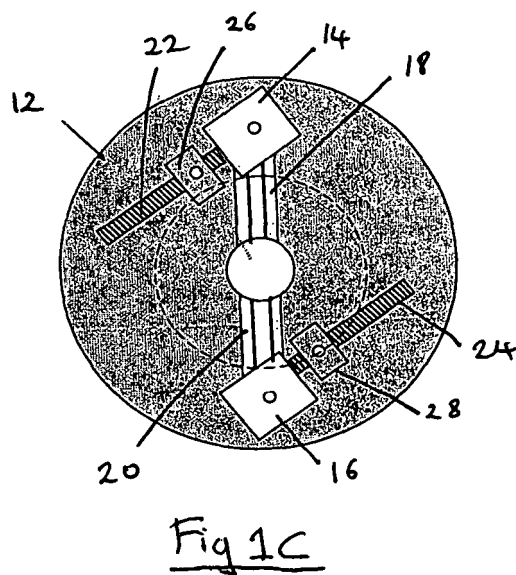
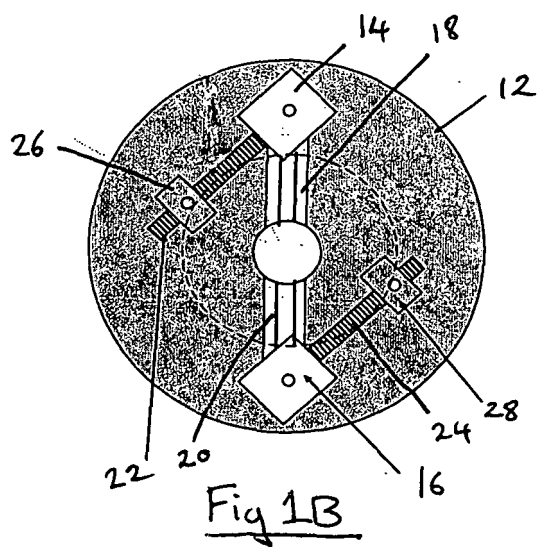
(71) Applicant: **Delphi Technologies, Inc.**
Troy, MI 48007 (US)

(54) **Variable cam phaser apparatus**

(57) A variable cam phaser apparatus comprising coaxial drive and driven members 10,12 drivingly connected by a coupling means, said coupling means enabling said drive and driven members to be relatively angularly adjusted while maintaining driving engagement therebetween, the coupling means comprising at least one ac-

tuator 14,16 mounted on one of said drive and driven members 10,12, the actuator 14,16 including a displacement member 22,24 engaging and co-operable with a follower 26,28 mounted on the other of said drive and driven members 10,12, whereby operation of said actuator 14,16 causes relative angular displacement between the drive and driven members 10,12.





Description

[0001] The present invention relates to a cam phaser apparatus, particularly, but not exclusively a variable cam phaser apparatus used in valve trains of automobile engines.

[0002] It is desirable to be able to be able to adjust the cam phase (i.e. the timing of the opening and closing of the valves) of engines during engine operation in order to improve engine performance and / or emissions. Various types of arrangements capable of achieving this adjustment exist. Such systems are required to efficiently convert rotational movement from the drive shaft into rotational movement of the cam shaft whilst allowing dislocation between these rotational movements in order to allow variation of the cam phase. Current systems typically utilise hydraulic actuators using high pressure oil to enable relative angular displacement between drive and driven members (e.g. cam sprocket and cam shaft) of the valve train.

[0003] Such systems have difficulty operating at extremes of temperature, in particular during engine start up when the oil is cold, due to temperature related viscosity changes of the oil.

[0004] Whilst attempts have been made to design electrically actuated variable cam phase arrangement, such usually require a complex arrangement of planetary gears or clutch arrangements which have the disadvantage of producing large frictional losses in the conversion process. The complex arrangement of such systems can also introduce controllability and reliability problems.

[0005] According to the present invention there is provided a variable cam phaser comprising coaxial drive and driven members drivingly connected by a coupling means, said coupling means enabling said drive and driven members to be relatively angularly adjusted while maintaining driving engagement therebetween, the coupling means comprising at least one actuator mounted on one of said drive and driven members, the actuator including a displacement member engaging and co-operable with a follower mounted on the other of said drive and driven members, whereby operation of said actuator causes relative angular displacement between the drive and driven members.

[0006] Preferably the displacement member comprises a rotatable elongate member extending from and being rotatable by said actuator, said elongate member being arranged substantially tangentially to a circle coaxial with the drive and driven members, the elongate member being provided with a threaded portion engaging said follower, said follower having formations cooperating with said threaded portion whereby rotation of the elongate member causes axial displacement of the follower with respect to the elongate member. The or each actuator and the or each follower may be respectively mounted for pivotal movement about an axis substantially parallel to the rotational axis of the drive or driven member.

[0007] Preferably said actuator comprises an electric

motor. Electrical power may be supplied to the motor via slip rings mounted on a shaft connected to and coaxial with one of said drive and driven members.

[0008] An embodiment of the apparatus according to the present invention will now be described, with reference to the accompanying drawings, in which:-

Fig. 1A is a side view of a cam phaser apparatus according to the present invention;

Fig. 1B is an end view of the apparatus of Fig. 1A; Fig. 1C is an end view of the apparatus of Fig. 1A showing the cam phase adjusted from that position shown in Fig. 1B; and

Fig 2 is an end view of a cam phaser apparatus according to a second embodiment of the present invention.

[0009] As shown in the drawings, a camshaft 10 is typically driven by a cam sprocket 12 which is in turn rotatably driven by the crankshaft of the engine via a toothed drive belt or chain (not shown).

[0010] A coupling means provides a connection between the cam shaft 10 and sprocket 12 and enables the camshaft 10 and sprocket 12 to be relatively angularly adjusted while maintaining driving engagement therebetween, as will be described below.

[0011] The coupling means comprises two direct current electric motors 14,16 mounted on radially extending support members 18,20 connected to the camshaft 12.

[0012] The output shaft from each motor 14,16 comprises a threaded lead screw 22,24.

[0013] Each electric motor 14,16 is pivotally mounted on the respective support member 18,20 to permit each motor 14,16 to pivot about an axis parallel to the rotational axis of the camshaft 10 and sprocket 12.

[0014] Each lead screw 22,24 engages a cooperating nut 26,28 respectively mounted on the cam sprocket 12 whereby rotation of each lead screw 22,24 by the respective electric motor 14,16 causes translational movement of the associated nut 26,28 along the lead screw 22,24. Each nut 26,28 is pivotally mounted on the sprocket 12 to permit each nut 26,28 to pivot about an axis parallel to the rotational axis of the camshaft 10 and sprocket 12.

[0015] As shown in Fig. 1A, electrical power is supplied to the motors 14,16 via brushes 30,32 engaging slip rings 34,36 provided on a shaft coaxial with and extending from the cam shaft. It is also envisaged that electric power might be supplied to the motors 14,16 via inductive coupling.

[0016] In use, the electric motors 14,16 are operated to rotate the lead screws 22,24 whereby each nut 26,28 translates along its associated lead screw 22,24 to adjust the angular position of the sprocket 12 with respect to the camshaft 10. Rotation of the lead screws 22,24 in a first direction will cause the nuts 26,28 to move away from the associated motor 14,16, advancing the timing of the opening and closing of the associated valves while rotation of the lead screws 22,24 in a second opposite

direction will cause the nuts 26,28 to move towards the associated motor 14,16, retarding the timing of the opening and closing of the associated valves.

[0017] In an alternative embodiment, shown in Fig. 2, only a single electric motor 14' may be required with a single lead screw 22' and associated nut 26' mounted on the sprocket 12. In such embodiment, in order to avoid rotational imbalance, it is necessary to mount a balance weight 40 on the sprocket 12 at a position radially opposite said motor 14'.

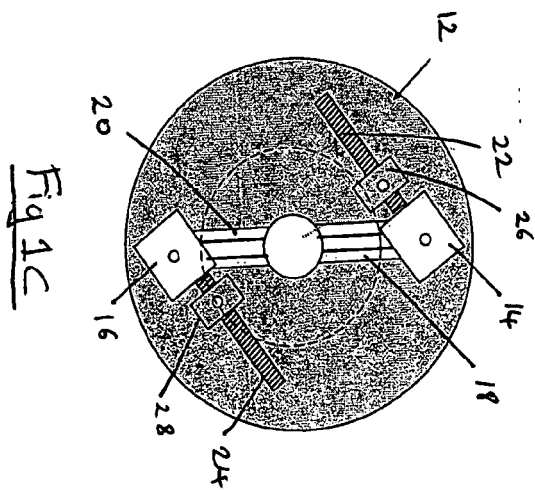
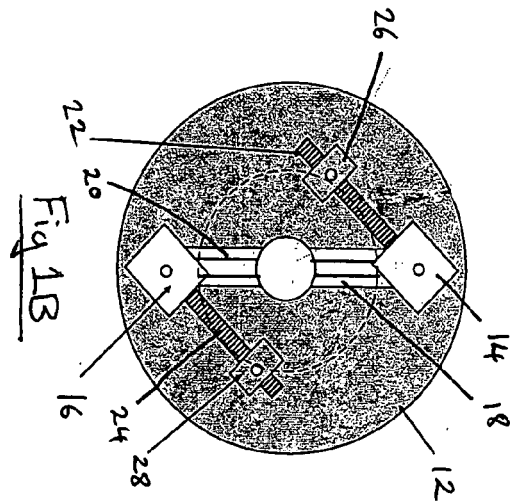
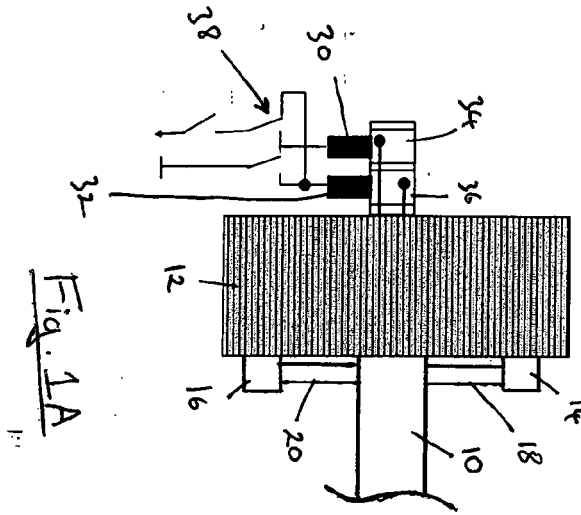
[0018] The system described allows the phase of the cam shaft to be reliably altered whilst the engine is running. In this regard, it should be noted that the cam phase may be advanced or retarded depending upon the direction in which the lead screws 22,24 are rotated. Such adjustment may be controlled by the engine management system of typical automobiles. The system therefore effectively allows the rotational position of the cam shaft 10 to be varied relative to the rotational position of the sprocket 12. Importantly, once the cam phase has been adjusted into the advanced / retarded position it will remain in that position until it is positively re-adjusted by the engine management system.

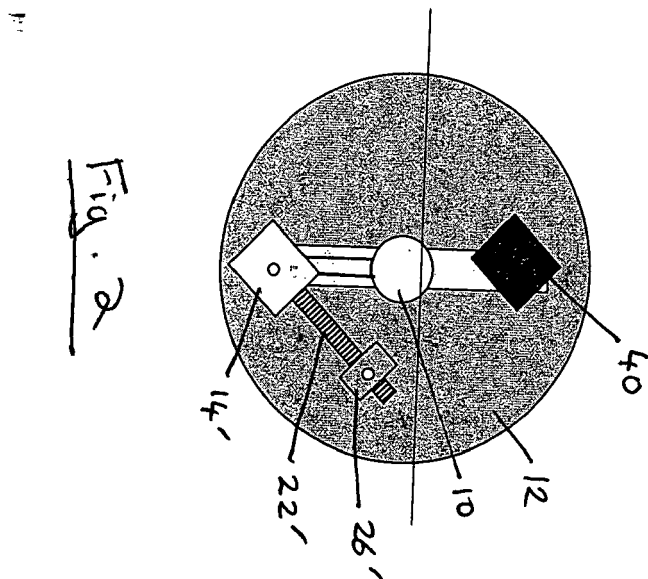
[0019] Modifications and improvement may be made to the foregoing, without departing from the scope of the present invention, for example:-

[0020] Although the present invention has been described in relation to automobile engines, it could be used in similar engines used in other applications.

Claims

1. A variable cam phaser apparatus comprising coaxial drive and driven members drivingly connected by a coupling means, said coupling means enabling said drive and driven members to be relatively angularly adjusted while maintaining driving engagement therebetween, the coupling means comprising at least one actuator mounted on one of said drive and driven members, the actuator including a displacement member engaging and co-operable with a follower mounted on the other of said drive and driven members, whereby operation of said actuator causes relative angular displacement between the drive and driven members.
2. An apparatus as claimed in claim 1, wherein the displacement member comprises a rotatable elongate member extending from and being rotatable by said actuator, said elongate member being arranged substantially tangentially to a circle coaxial with the drive and driven members, the elongate member being provided with a threaded portion engaging said follower, said follower having formations cooperating with said threaded portion whereby rotation of the elongate member causes axial displacement of the follower with respect to the elongate member.
3. An apparatus as claimed in any preceding claim wherein the or each actuator and the or each follower are respectively mounted for pivotal movement about an axis substantially parallel to the rotational axis of the drive or driven member.
4. An apparatus as claimed in any preceding claim, wherein said actuator comprises an electric motor.
5. An apparatus as claimed in claim 4, wherein electrical power is supplied to the motor via slip rings mounted on a shaft connected to and coaxial with one of said drive and driven members.
6. An apparatus as claimed in claim 4, wherein electrical power is supplied to the motor via an inductive coupling.
7. An apparatus as claimed in any preceding claims, wherein said coupling means comprises first and second actuators respectively mounted on radially opposite sides of one of said drive or driven members to provide rotational balance of the coupling means.
8. An apparatus as claimed in any of claims 1 to 6, wherein said actuator is mounted to one side of the rotational axis of said drive or driven member and a balance weight is mounted on a radially opposite side, said balance weight having a mass substantially equal to that of the actuator and the associated displacement member and follower whereby the coupling means is rotationally balanced.
9. An apparatus as claimed in any preceding claim wherein the or each actuator is mounted on a radially extending support member provided on the driven member, the or each follower being mounted on the drive member.
10. An apparatus as claimed in any preceding claim wherein said drive member comprises a cam sprocket and said driven member comprises a cam shaft.







European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 25 6822

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 40 40 486 A1 (DR. SCHRICK GMBH, 5630 REMSCHEID, DE) 2 January 1992 (1992-01-02)	1-5,9,10	INV. F01L1/344 F16D3/10
Y	* the whole document *	6	
Y	EP 1 030 090 A (CONTINENTAL ISAD ELECTRONIC SYSTEMS GMBH & CO. KG) 23 August 2000 (2000-08-23) * paragraphs [0009], [0010] *	6	
X	US 5 156 119 A (SUGA ET AL) 20 October 1992 (1992-10-20) * figures 1,2 *	1,7,10	
X	US 2001/006050 A1 (HEER SIEGFRIED) 5 July 2001 (2001-07-05) * figure 6 *	1,4,5,10	
A	US 1 691 408 A (PALMER WALTER TUTTLE) 13 November 1928 (1928-11-13) * claim 1; figure 2 *	1	
A	US 3 812 734 A (HAMBURGER E,US) 28 May 1974 (1974-05-28) * claim 1; figures 1-3 *	1	TECHNICAL FIELDS SEARCHED (IPC) F01L F16D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 May 2006	Examiner Clot, P
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			

2
EPO FORM 1503 03.82 (P04C01)

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

EP 05 25 6822

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.

15-05-2006

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 4040486	A1	02-01-1992	NONE	
EP 1030090	A	23-08-2000	DE 19906657 A1	24-08-2000
US 5156119	A	20-10-1992	DE 4125232 A1	06-02-1992
			FR 2665483 A1	07-02-1992
			JP 4086310 A	18-03-1992
US 2001006050	A1	05-07-2001	AU 2173301 A	16-07-2001
			WO 0150057 A1	12-07-2001
			EP 1114917 A2	11-07-2001
US 1691408	A	13-11-1928	NONE	
US 3812734	A	28-05-1974	NONE	