

FIG. 2

Description

TECHNICAL FIELD

[0001] The present invention relates generally to oil control valves for variable cam phasers.

BACKGROUND OF THE INVENTION

[0002] A Variable Cam Phaser (VCP) replaces the standard pulley, sprocket or gear in a gasoline engine's valve train. It enables the cam lobe (lift event) timing to crank shaft timing to be changed while the engine is operating, based on the parameters of the engine. Variable cam phasing changes the timing of the valve lift event, and can be used to shift the intake cam, the exhaust cam, or both on dual overhead cam engines. This helps increase engine efficiency, improving idle stability while delivering more torque and horsepower. It also helps boost fuel economy and reduces hydrocarbon emissions.

[0003] The cam lobe angular position of the VCP (i.e., its phase relationship), is controlled by an internal vane mechanism of the VCP that in turn is established by an oil control valve. More specifically, commands from the engine control module (ECM) of the vehicle adjust the position of the oil control valve, which can be mounted in the cylinder head to regulate engine oil flow to either side of the vanes to advance or retard the camshaft position.

[0004] Typically, the oil control valve has a fluid control portion that is driven by an electromagnetic solenoid. The fluid control portion includes a valve body and an internal spool, with two separate openings being formed in the valve body that are in fluid connection with two separate sides of the VCP. The internal spool has an oil inlet and two separate outlets that correspond to and overlap with the two openings in the valve body. With this structure, pressurized engine oil can be made to flow through the valve to the two sides of the variable cam phaser as appropriate for the desired VCP configuration.

[0005] The electromagnetic solenoid of the oil control valve is comprised mainly of a bobbin, which has metal and plastic sections. Currently, the bobbin of the electromagnetic solenoid can become dislodged or loose over time due to the differing thermal expansion of its metal and plastic components caused by the heat of the engine. After becoming dislodged or loose, oil from the fluid control portion of the oil control valve can leak through the bobbin into the electromagnetic solenoid. This effect may cause the oil control valve to malfunction.

[0006] In an attempt to remedy the present situation, manufacturers have attempted various solutions to minimize oil leakage and ensure a permanent fit between the metal and the plastic components of the bobbin. Some of these solutions include press fits, spring washers, and crimping steel to steel surfaces on the bobbin. However, these solutions prove to be expensive. Other

solutions have also been implemented, but only retard the loosening effect and do not ensure a permanent fit. The present invention provides a method for achieving a cost-effective permanent fit between the metal and plastic sections of the bobbin.

SUMMARY OF THE INVENTION

[0007] An oil control valve for a variable cam phaser includes a metal frame that is formed with a radially enlarged part with a first inside diameter and a radially smaller part with a second inside diameter less than the first inside diameter. The two parts are coaxial with each other such that a shoulder is established between them. More specifically, the shoulder defines an annular surface that is perpendicular to the axis of the parts. A bobbin that is partially metal is disposed within the frame with the bobbin abutting the surface of the shoulder. An o-ring is disposed between the bobbin and frame. The combination of the o-ring and bobbin abutting the surface of the shoulder substantially prevents oil from leaking to a connector associated with the valve.

[0008] In non-limiting implementations the connector is substantially coaxial with the axis of the frame and bobbin. The bobbin may include a secondary plate engaged with a plastic body by means of overmolding the plastic body onto the secondary plate, and the secondary plate abuts the surface of the shoulder. In some applications the valve can be engaged with the variable cam phaser.

[0009] In another aspect, an assembly for a vehicle includes a variable cam phaser and an oil control valve engaged with the phaser to selectively port oil to the phaser. The oil control valve has a shoulder defining a metal-to-metal interface between two metal parts of the valve to inhibit oil leakage into an electrical connector of the valve.

[0010] In yet another aspect, an oil control valve includes an electrical connector and a bobbin including a metal secondary plate. A frame surrounds the bobbin. As set forth further below, the frame defines an axis and an annular surface substantially perpendicular to the axis, with the secondary plate abutting the surface.

[0011] The details of the present invention, both as to its structure and operation, can best be understood in reference to the accompanying drawings, in which like reference numerals refer to like parts, and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Figure 1 is a block diagram of a non-limiting environment of the present oil control valve; and

[0013] Figure 2 is a cut-away side view of an exemplary non-limiting embodiment of the present valve.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0014] Referring initially to Figure 1, an internal combustion engine 5 is shown with a controller 10. The engine 5 is operably coupled to a variable cam phaser 14 that is controlled by an oil control valve 12, the details of which are further described below.

[0015] In general overview, the engine 5 has at least one camshaft 16 with the variable cam phaser 14 attached thereto and a cam position sensor 13. The cam phaser 14 is fluidly connected to the oil control valve 12, which in turn is fluidly connected to a pressurized supply of oil from the engine 5 or other source. In non-limiting exemplary implementations the controller 10 is operably connected to an engine torque management system such as the one described in USPN 6,367,462, incorporated by reference.

[0016] The controller 10 is also operably connected to at least one sensor that is used to monitor engine operation. The engine torque management system may also include a fuel injection system, an ignition system, an electronic throttle control system, an exhaust gas recirculation system, an evaporative control system (not shown), along with the variable cam phaser 14 with the oil control valve 12. Without limitation and in accordance with principles known in the art, the sensor may include an engine speed sensor, a manifold absolute pressure sensor, a throttle position sensor, an oxygen sensor, intake air sensor, mass air flow sensor, EGR position sensor, exhaust pressure sensor, exhaust gas sensor, torque sensor, combustion sensor, or others (not shown), and/or the cam position sensor 13. In any case, the controller 10 collects information from the sensors and control output systems, including the engine torque management system, using control algorithms and calibrations internal to the controller 10.

[0017] With particular regard to elements of the oil control valve 12 that are the subject of further disclosure below, the valve 12 includes an electromagnetic solenoid 30 and a valve 32. The valve advantageously may be a spool valve 32 with a single inlet 34 of oil and two outlets of oil 36, 38. A spool 31 is attached to an armature (not shown) of the electromagnetic solenoid 30, and the spool 31 is contained within a valve body 33 coaxial to the longitudinal axis of the body 33.

[0018] Each of the two outlets 36, 38 of oil is attached to one of the inlets of the cam phaser 14, as described above. In some embodiments, the electromechanical solenoid 30 is driven by a pulsewidth-modulated (PWM) signal 40 sent from the controller 10. In operation, a PWM signal 40 is sent to the electromagnetic solenoid 30 to cause the armature (not shown in Figure 1) and attached spool 31 to move linearly along the longitudinal axis within the valve body 33.

[0019] The position of the spool 31 in conjunction with the designs of the spool 31 and the valve body 33 determines the oil flow through the valve 32 from the fluid inlet

34 to each of the two fluid outlets 36, 38. The oil control valve 12 provides sufficient oil flow rate through the valve 32 so that the response time of the cam phaser 14 and corresponding combustion efficiency of the engine 5 can be optimized at typical oil pressures, temperatures and voltage levels.

[0020] Moving to Figure 2, relevant details of the electromagnetic end of the valve 12 are shown. The electromagnetic solenoid 30 shown in Figure 1 is wound around a bobbin 42 that extends past the solenoid and that defines an axis 44. The electromagnetic solenoid in Figure 1 is electrically connected to a connector 46, which is disposed in a connector cavity 48 formed in the bobbin 42. As shown in Figure 2, the connector cavity 48 is coaxial with the axis 44 of the bobbin 42 and the connector pin 46 is parallel to and if desired coaxial with the axis 44.

[0021] The bobbin 42, which may be hollow such that it forms a bobbin chamber 50 as shown, is surrounded by a metal frame 52. In accordance with present principles, the frame 52 is formed with a radially enlarged part 54 with a first inside diameter D1 and a radially smaller part 56 with a second inside diameter D2 which is less than the first inside diameter D1. The radially enlarged part 54 and the radially smaller part 56 are coaxial with each other and with the connector 46.

[0022] As shown in Figure 2, a shoulder 58 is established between the radially enlarged part 54 and the radially smaller part 56. The shoulder 58 defines an annular surface 60 that is perpendicular to the axis 44 of the bobbin 42. Further, the bobbin 42 abuts the surface of the shoulder 58 and is at least partially disposed within the frame 52.

[0023] More specifically, the bobbin 42 includes a hollow metal secondary plate 62 that is engaged with the plastic body of the bobbin 42 by means of, e.g., overmolding the plastic body onto the secondary plate 62, and a portion of the secondary plate 62 abuts the surface of the shoulder 58, creating a metal-to-metal interface. By way of the metal-to-metal interface, oil is in part prevented from leaking through the bobbin 42 into the connector 46 because the thermal expansion of both metal components will remain equal and the seal between the metal interfaces will remain secure, thereby inhibiting oil from leaking up through the bobbin.

[0024] A further seal between the bobbin and the frame is created through the existence of an O-ring 64. The O-ring 64 is disposed between the bobbin 42 and frame 52 in a circular groove 66 that is formed in the bobbin 42 as shown. Any oil leaking past the metal-to-metal interface described above will be further impeded by the O-ring 64, which acts as a secondary barrier to ensure that oil does not leak into the connector 46.

[0025] While the particular OIL CONTROL VALVE FOR VARIABLE CAM PHASER is herein shown and described in detail, it is to be understood that the subject matter which is encompassed by the present invention is limited only by the claims.

Claims

1. An oil control valve for a variable cam phaser (14), comprising:

a metal frame (52) formed with a radially enlarged part (54) with a first inside diameter and a radially smaller part (56) with a second inside diameter less than the first inside diameter, the two parts (54, 56) being coaxial with each other and a shoulder (58) being established therebetween, the shoulder (58) defining an annular surface perpendicular to the axis of the parts (54, 56);

a bobbin (42) at least partially metal and disposed within the frame (52), the bobbin (42) abutting the surface of the shoulder (58); and at least one o-ring (64) disposed between the bobbin (42) and frame (52), whereby the combination of the o-ring (64) and bobbin (42) abutting the surface of the shoulder (58) substantially prevents oil from leaking to a connector (46) associated with the valve.

2. The valve of Claim 1, wherein the connector (46) is substantially coaxial with the axis of the frame (52) and bobbin (42).

3. The valve of Claim 1, wherein the bobbin (42) includes a secondary plate (62) engaged with a plastic body by means of overmolding the plastic body onto the secondary plate (62), the secondary plate (62) abutting the surface of the shoulder (58).

4. The valve of Claim 1, wherein the valve is engaged with the variable cam phaser (14).

5. An assembly for a vehicle comprising:

a variable cam phaser (14); and an oil control valve engaged with the phaser (14) to selectively port oil thereto, the oil control valve having a shoulder (58) defining a metal-to-metal interface between two metal parts (52, 62) of the valve to inhibit oil leakage into an electrical connector (46) of the valve.

6. The assembly of Claim 5, wherein the two parts (52, 62) include an outer frame (52) and an inner bobbin (42) at least partially disposed in the frame (52), the bobbin defining an end abutting the shoulder (58).

7. The assembly of Claim 6, wherein the frame (52) defines the shoulder (58).

8. The assembly of Claim 7, comprising at least one o-ring (64) disposed between the bobbin (42) and frame (52), whereby the combination of the o-ring

(64) and bobbin (42) abutting the shoulder (58) substantially prevents oil from leaking to the electrical connector (46).

9. The valve of Claim 6, wherein the electrical connector (46) is substantially coaxial with the axis of the frame (52) and bobbin (42).

10. The valve of Claim 6, wherein the bobbin (42) includes a secondary plate (62) engaged with a plastic body by means of overmolding the plastic body onto the secondary plate (62), the secondary plate (62) abutting the shoulder (58).

11. An oil control valve, comprising:

an electrical connector (46);

a bobbin (42) including a metal secondary plate (62); and

a frame (52) surrounding the bobbin (42), the frame (52) defining an axis and an annular surface substantially perpendicular to the axis, the secondary plate (62) abutting the surface.

12. The valve of Claim 11, comprising at least one o-ring (64) disposed between the bobbin (42) and frame (52), whereby the combination of the o-ring (64) and bobbin (42) abutting the surface substantially prevents oil from leaking to a connector (46) associated with the valve.

13. The valve of Claim 12, wherein the connector (46) is substantially coaxial with the axis of the frame (52).

14. The valve of Claim 11, wherein the secondary plate (62) is engaged with a plastic body of the bobbin (42) by means of overmolding the plastic body onto the secondary plate (62), the secondary plate (62) abutting the surface.

15. The valve of Claim 11, comprising a variable cam phaser (14) receiving oil from the valve.

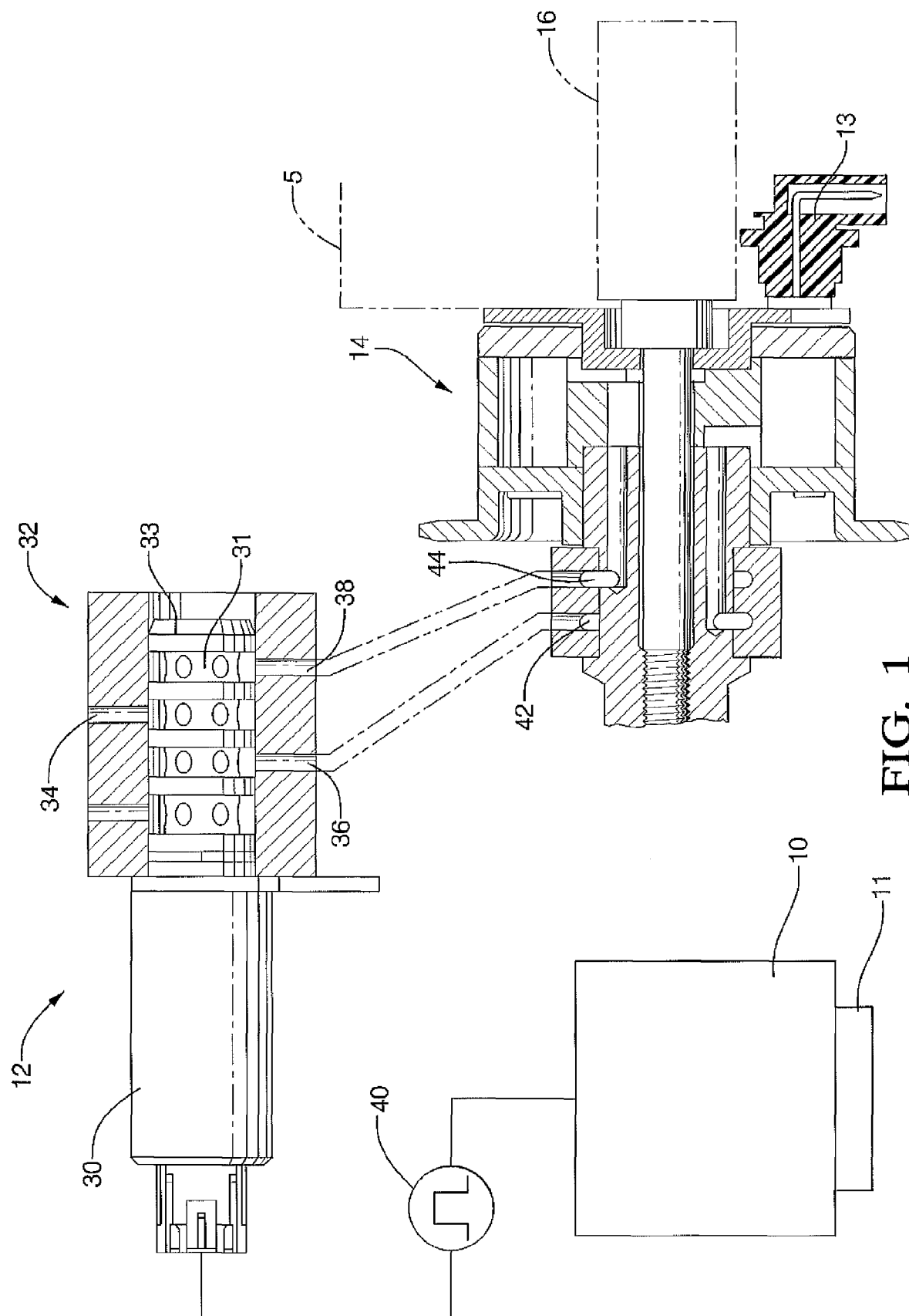


FIG. 1

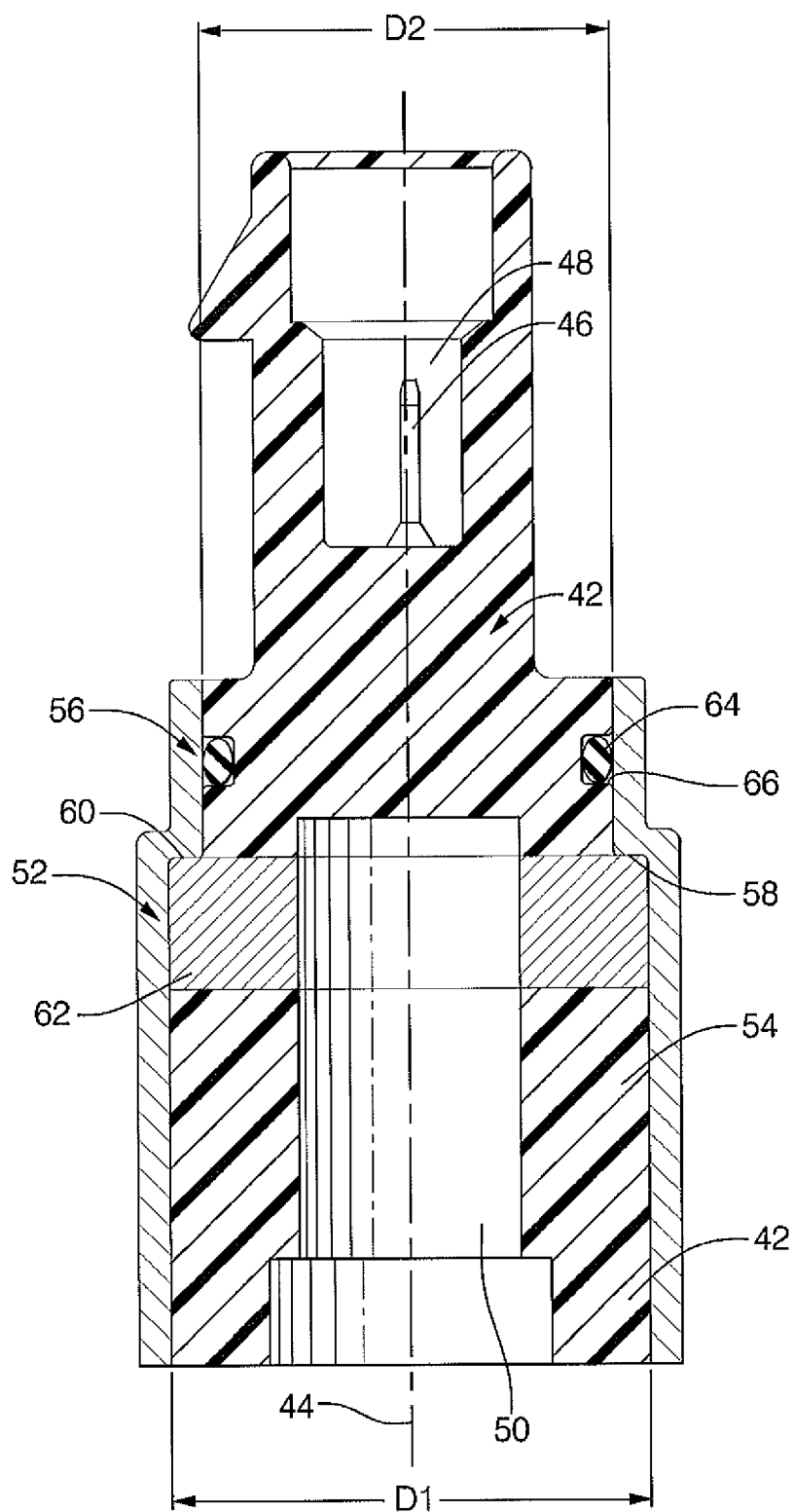


FIG. 2