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(54) **DEACTIVATING VALVE LIFTER**

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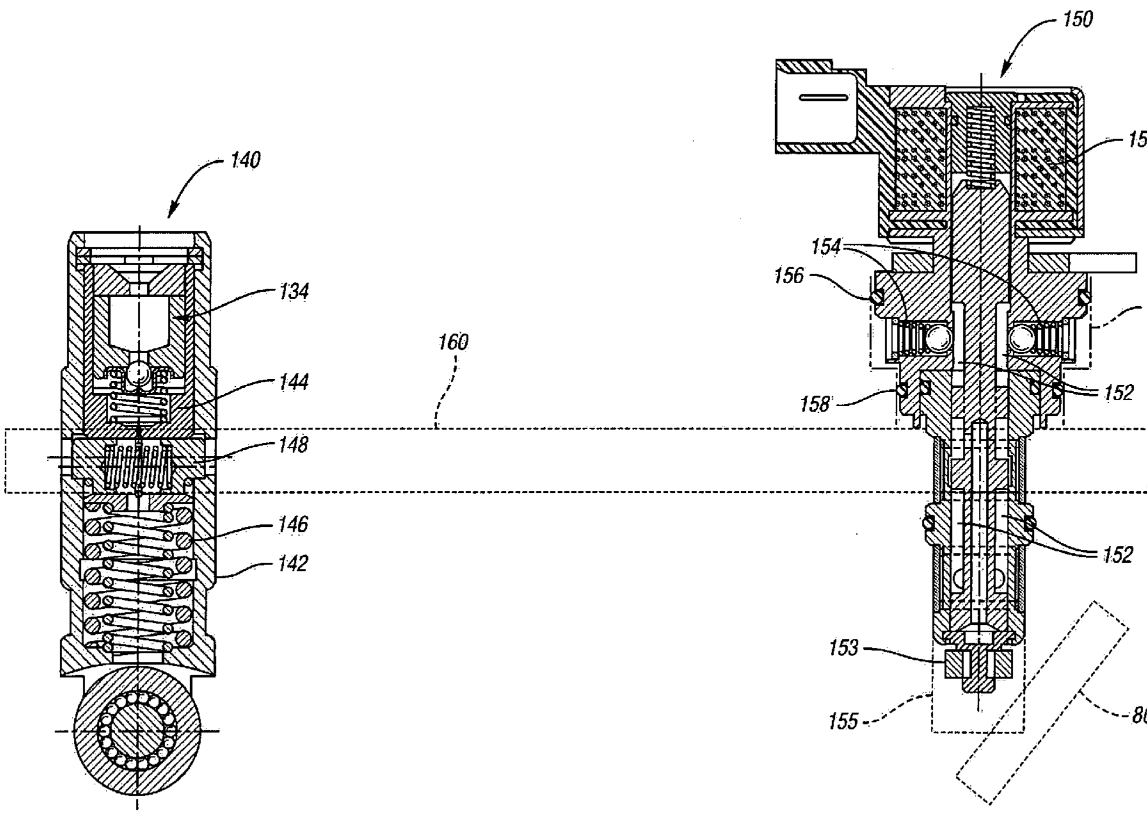
(57) **ABSTRACT**

A valve lifter for an internal combustion engine comprises an outer body, an inner body and at least one pin. The inner body is movable with respect to the outer body, and the at least one pin is movable in response to hydraulic pressure into the groove to lock the outer body against movement relative to the inner body.



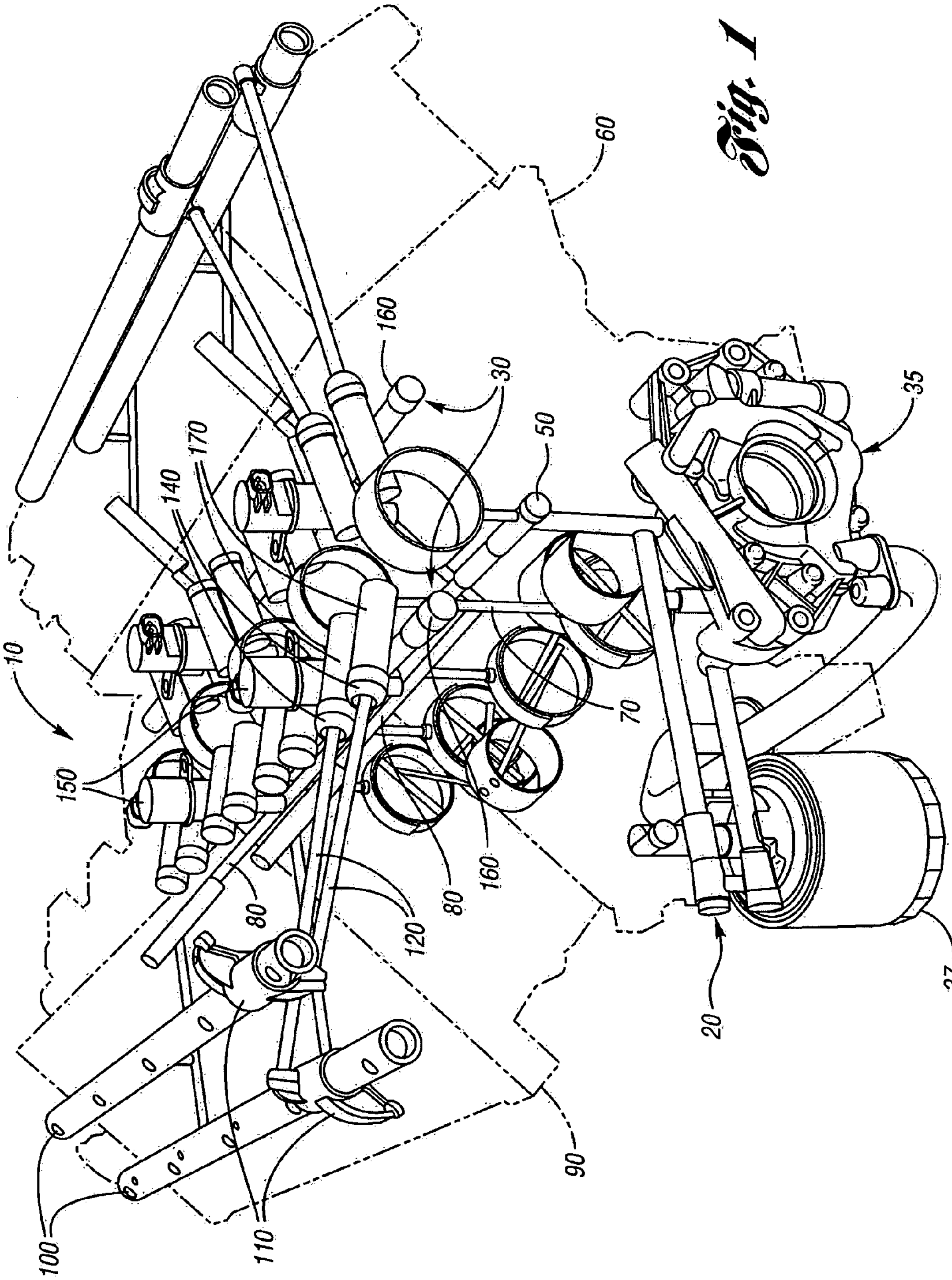


Fig. 1

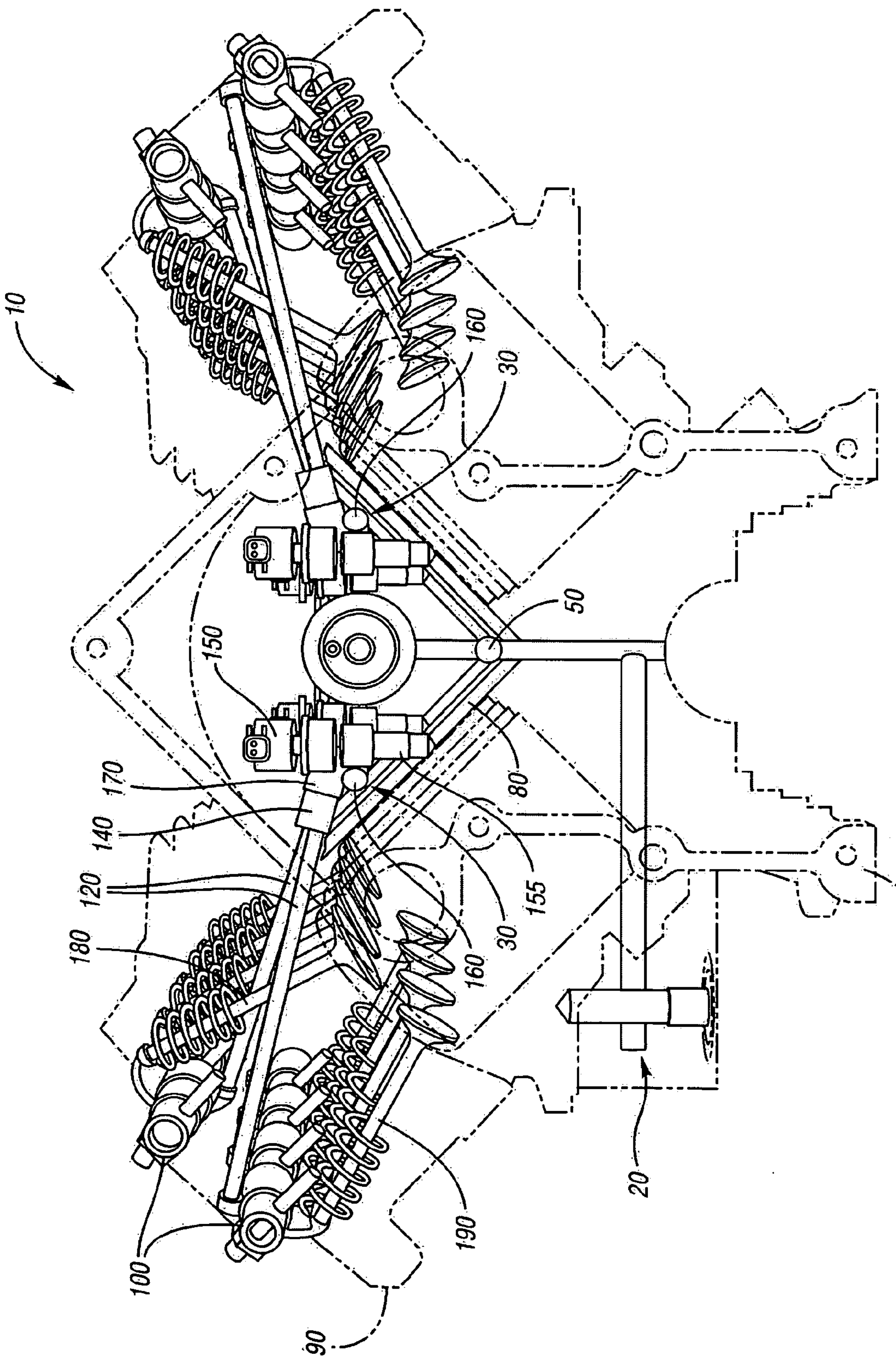


Fig. 2

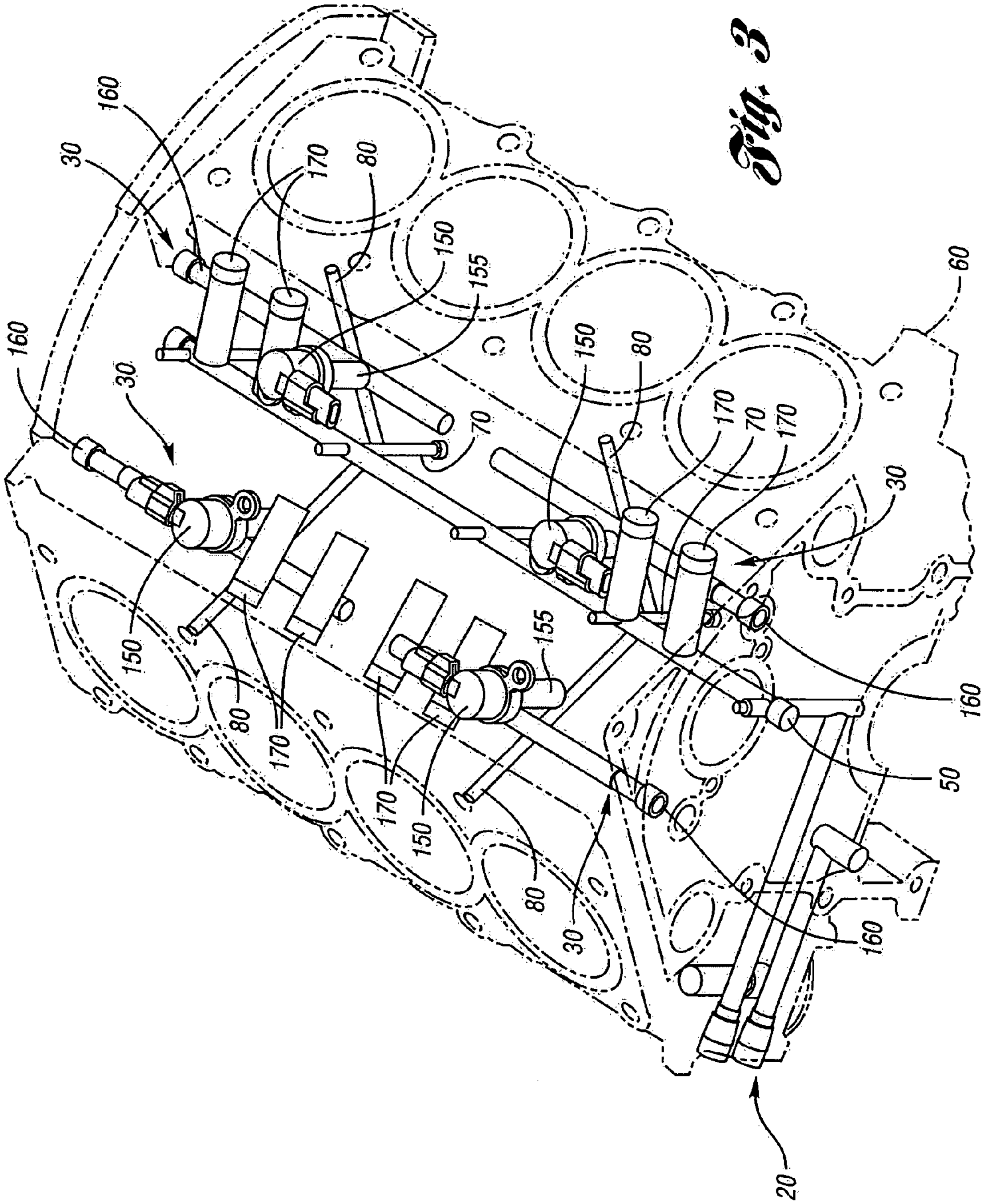

160
30
170
80
150
155
60
160
30
70
80
170
70
170
30
150
155
160
50
150
80
170
170
150
80
30
160
20

Fig. 3

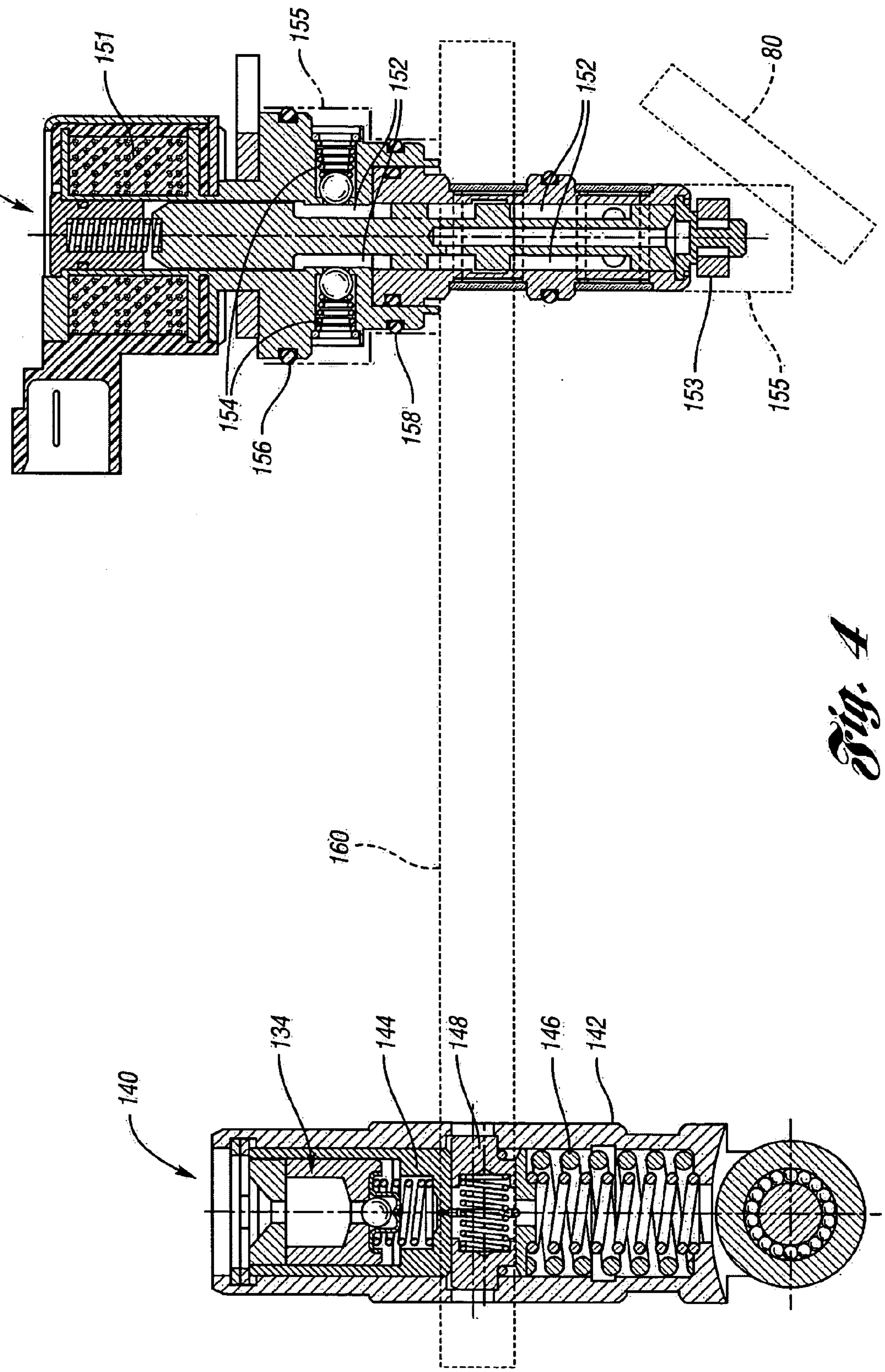

150
151
155
152
152
80
154
156
158
153
155
160
140
134
144
148
146
142

Fig. 4

DEACTIVATING VALVE LIFTER

CROSS REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims benefit of U.S. Provisional Application No. 60/475,276 filed on Jun. 3, 2003.

FIELD OF THE INVENTION

[0002] The present invention relates generally to an engine for a motor vehicle, and, more particularly, to a variable displacement engine for a motor vehicle powertrain.

BACKGROUND OF THE INVENTION

[0003] In vehicle design, fuel economy is becoming increasingly important. To that end, fuel conservation and engine system design play a significant role. In addition, with the popularity of sport utility vehicles and performance luxury cars, and with increasing competition in the automotive market, superior engine refinement coupled with strong engine performance are necessary deliverables for an engine to satisfy many of today's automotive consumer requirements.

[0004] To satisfy the performance aspect, larger displacement engines, such as a V-6 or V-8 engine, are typically developed for these vehicles. As is known, these larger displacement engines generally do not realize the same fuel economy as a smaller displacement engine. To that end, variable displacement engines can provide for fuel economy benefits by operating on the principle of cylinder deactivation. During operating conditions that require high output torque, such as acceleration, every cylinder of a variable displacement engine is arranged to be activated. In contrast, for low load conditions, such as steady cruising, cylinders may be deactivated to improve fuel economy for the variable displacement engine vehicle.

[0005] While such variable displacement engines provide advantages of improved fuel economy, conventional cylinder deactivation systems of these arrangements rely on add-on engine componentry, such as externally coupled hydraulic fluid passages that increase engine cost and complexity as well as create additional sources for potential hydraulic fluid leakage from the engine.

SUMMARY OF THE INVENTION

[0006] Accordingly, a valve lifter is provided for an internal combustion engine. In one aspect of the invention, the valve lifter comprises an outer body, an inner body and at least one pin. The inner body is movable with respect to the outer body, and the at least one pin is movable in response to hydraulic pressure into the groove to lock the outer body against movement relative to the inner body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Other aspects, features, and advantages of the present invention will become more fully apparent from the following detailed description of the preferred embodiment, the appended claims, and in the accompanying drawings in which:

[0008] **FIG. 1** illustrates an isometric view of an exemplary embodiment of a V-8 engine having a main oiling circuit and a lifter oil gallery control circuit in accordance with the present invention;

[0009] **FIG. 2** illustrates a front view of the engine shown in **FIG. 1** and including valve train componentry in accordance with the present invention;

[0010] **FIG. 3** illustrates an isometric view of the engine shown in **FIG. 1** highlighting a cylinder block and aspects of the main oiling circuit and the lifter oil gallery control circuit for cylinders arranged to be selectively deactivated in accordance with the present invention; and

[0011] **FIG. 4** illustrates aspects of the lifter oil gallery control circuit including a control valve and a deactivating lifter in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMIENT

[0012] In the following description, several well-known features of an internal combustion engine are not shown or described so as not to obscure the present invention. Referring now to the drawings, **FIGS. 1, 2** and **3** illustrate an exemplary embodiment of an engine **10** with a main oiling circuit **20** and a lifter oil gallery control circuit **30** arranged to deactivate selective cylinders to improve fuel economy. Main oiling circuit **20** provides a path for oil flow from an oil pump **35** through an oil filter **37** and into a main oil gallery **50** of cylinder block **60**. Feed passages **70** provide a flow path between the main oil gallery **50** and a crankshaft oiling circuit **40**. Main oil gallery **50** is then generally used to further feed a plurality of other passages and components. Most relevant to this invention are feed passages **80** that continue from feed passages **70** and serve as the feed passages to cylinder heads **90**.

[0013] Cylinder heads **90** in the exemplary embodiment utilize a top down oiling arrangement where the oil feed passages **80** continue through the cylinder head **90** via interface with rocker shafts **100**. From the rocker shafts, oil travels through the respective rocker arms **110** and then through hollow push rods **120**. From the push rods, the oil then travels into a deactivating lifter **140** to provide hydraulic pressure to a lash adjuster **134** (**FIG. 4**) housed within the deactivating lifter **140**. Oil then flows through conventional oil drain (not shown) back into an oil pan (not shown).

[0014] Feed passages **80**, in addition to feeding the cylinder head, provide an oil supply to the lifter oil gallery control circuit **30**. As oil flows through feed passages **80** towards cylinder heads **90**, solenoid control valve **150** positioned in a bore **155** formed in cylinder block **60** is arranged to selectively provide high pressure oil flow to lifter oil gallery **160**. Lifter oil gallery **160** is connected to and interacts with a lifter bore **170** that houses the deactivating lifter **140**. Also, the lifter oil gallery control circuit **30** is laid out in a manner that naturally purges air from the lifter oil gallery control circuit passages. This is accomplished by utilizing a bottom up oil passage architecture incorporated into cylinder block **60** and the oil feeding passages of cylinder heads **90**. For example, the bottom up oiling architecture allows any air that travels into feed passages **80** to travel up to the rocker shafts **100**, a high point in the system and beyond the oil gallery lifter control circuit **30**. In addition, any air that migrates from feed passage **80** into the lifter oil gallery **160** is allowed to purge from the system through natural oil leakage between the lifter bore **170** and the deactivating lifter **140**.

[0015] In operation and referring to **FIGS. 2, 3** and **4**, to deactivate a cylinder both the intake valve **180** and the exhaust valve **190** are turned off by decoupling these valves from the valve train. This is accomplished through a series of sequential events. At a proper time in the engine cycle, the engine solenoid control valve **150** is energized and this opens a flow path for oil from feed passage **80** through the control valve **150** and into lifter oil gallery **160**. This raises the oil pressure in lifter oil gallery **160** to that of the main oiling circuit **10** (high pressure oil) and this in turn deactivates a locking mechanism in deactivating lifter **140** allowing the lifter to absorb camshaft input without activating the intake and exhaust valves as further described below.

[0016] Deactivating lifter **140**, like a conventional lifter, houses the hydraulic lash adjuster **134** and also includes an outer body **142** with an inner body **144** and a lost motion spring **146** between the two bodies. The inner body has a pair of pins **148** that extend or retract in response to oil pressure below or above predetermined high or low thresholds, respectively. When extended, the pins **148** sit on a groove formed on the inside of the outer body **142**, locking the inner and outer bodies together. In response to high oil pressure, the pins **148** are arranged to retract and enable relative motion between the outer and inner bodies of the lifter and decouple the camshaft input from a specific intake or exhaust valve of the respective cylinder to be deactivated. For a given cylinder that is arranged to be selectively deactivated, one solenoid control valve **150** is used to control two deactivating lifters **140**, one lifter for the intake valve **180** and one lifter for exhaust valve **190**. When deactivated, the lost motion spring **146** supplies a force necessary to ensure contact is maintained between valvetrain components. Applicants hereby incorporate by reference commonly owned copending patent application Ser. No. ______ filed on ______ and entitled Multiple Displacement System for an Engine (Docket No. 706670US2).

[0017] To reactivate deactivated cylinders, removing the energizing voltage source from a solenoid **151** of the control valve **150** substantially closes the flow path through the valve into the lifter oil gallery **160** and simultaneously opens a pressure relief valve **154** within control valve **150** resulting in the oil pressure falling to a nominal pressure, such as 3 psi. This resultant loss in pressure removes the hydraulic pressure necessary to force retraction of the lifter pins **148** and thus the pins **148** of the inner lifter housing **144** reengage the outer lifter housing **142** which eliminates relative motion of the lifter and re-couples the lifter to valve train cam input.

[0018] In addition to controlling hydraulic pressure necessary to activate and deactivate cylinders of the engine, the control valve **150** also maintains a nominal oil pressure in the deactivating lifter oil gallery circuit control **30** through a combination of an internal passage **152** in the control valve and the pressure relief valve **154**. The internal passage allows a restricted flow of oil into the lifter gallery **160** and the pressure relief valve maintains pressure in the lifter oil gallery at a nominal 3 psi when the control valve is in the closed position. Control valve **150** seals at o-ring **156** and o-ring **158** in the bore **155** formed in cylinder block **60**. O-ring **156** prevents oil from leaking external to the engine and o-ring **158** prevents oil flowing past the pressure relief valve from interacting with lifter oil gallery **160**. Thus, any oil that flows past relief valve **154** collects in the lifter bore **170** between the O-rings and then drains though a conventionally designed oil drainback passage (not shown). Maintaining this nominal oil pressure is desirable to enable an optimum response time for deactivation and reactivation events such that these respective events are not discernable to a vehicle operator. A magnet **153** located on the nose of the unit collects ferrous debris to minimize the contamination of the valve and lifters.

[0019] In today's competitive automotive environment, it is increasingly important for automotive OEM's to provide a product that satisfies customer expectations in a cost effective manner. For engines, especially a larger displacement V-8 engine, this generally breaks down to providing a low warranty risk, low leak potential engine with significant horsepower while meeting government fuel economy requirements and all in a cost effective manner.

[0020] The MDS engine architecture for this exemplary embodiment represents a system fully integrated into the engine block hardware providing for a lower cost, lower complexity system while also minimizing potential oil leak paths. Integrating all of the oil control and flow passages directly into the block as well as having the control valve mount directly to the engine block via a bore formed in the block greatly reduces the amount of oil leak paths, especially when compared to an add-on or bolt-on oil hardware system. In addition, using formed passages and bores in the engine block reduces manufacturing and component complexity through both a minimization of engine assembly operations and a reduction in the number of system components, both of which also reduce cost. For example, in the exemplary embodiment there is a separate lifter oil gallery control circuit for each cylinder arranged to be selectively deactivated and each lifter oil gallery can be formed (i.e., drilled) from the front or rear face of the engine block for ease of manufacturing. Finally, the architecture of the main and lifter oil gallery circuits result in a design that naturally purges air from the system and thus eliminates the need for an additional and/or external purge air device.

[0021] The foregoing description constitutes the embodiments devised by the inventors for practicing the invention. It is apparent, however, that the invention is susceptible to modification, variation, and change that will become obvious to those skilled in the art. Inasmuch as the foregoing description is intended to enable one skilled in the pertinent art to practice the invention, it should not be construed to be limited thereby but should be construed to include such aforementioned obvious variations and be limited only by the proper scope or fair meaning of the accompanying claims.

1. A valve lifter comprising:

an outer body having a groove;

an inner body movable with respect to the outer body;

at least one pin movable in response to hydraulic pressure, the at least one pin being movable into the groove to lock the outer body against movement relative to the inner body.

2. The valve lifter of claim 1 further comprising a lost motion spring disposed between the outer body and the inner body.

3. The valve lifter of claim 1 wherein the at least one pin is retractable out of the groove and within the inner body.

4. The valve lifter of claim 1 wherein the at least one pin is retractable out of the groove and within the inner body in response to relatively high hydraulic pressure.

5. The valve lifter of claim 1 wherein the at least one pin is retractable out of the groove against a spring force.

6. The valve lifter of claim 1 wherein the at least one pin comprises a pair of pins.

7. The valve lifter of claim 1 wherein the hydraulic pressure is developed by engine oil.

8. The valve lifter of claim 1 further comprising a hydraulic lash adjuster disposed within the inner body.

9. A valve lifter comprising:

an outer body having a pair of grooves;

an inner body movable with respect to the outer body;

a pair of pins movable in response to hydraulic pressure, each pin being movable into a respective groove to lock the outer body against movement relative to the inner body.

10. The valve lifter of claim 9 further comprising a lost motion spring disposed between the outer body and the inner body.

11. The valve lifter of claim 9 wherein the at least one pin is retractable out of the groove and within the inner body.

12. The valve lifter of claim 9 wherein the at least one pin is retractable out of the groove and within the inner body in response to relatively high hydraulic pressure.

13. The valve lifter of claim 9 wherein the at least one pin is retractable out of the groove against a spring force.

14. The valve lifter of claim 9 wherein the hydraulic pressure is developed by engine oil.

15. The valve lifter of claim 9 further comprising a hydraulic lash adjuster disposed within the inner body.

16. A valve lifter for an internal combustion engine, the valve lifter comprising:

an outer body having a groove;

an inner body movable with respect to the outer body;

at least one pin movable into the groove to lock the outer body against movement relative to the inner body, the at least one pin being retractable out of the groove and within the inner body in response to relatively high oil pressure developed by the engine.

17. The valve lifter of claim 1 further comprising a lost motion spring disposed between the outer body and the inner body.

18. The valve lifter of claim 1 wherein the at least one pin is retractable out of the groove against a spring force.

19. The valve lifter of claim 1 wherein the at least one pin comprises a pair of pins.

20. The valve lifter of claim 1 further comprising a hydraulic lash adjuster disposed within the inner body.

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