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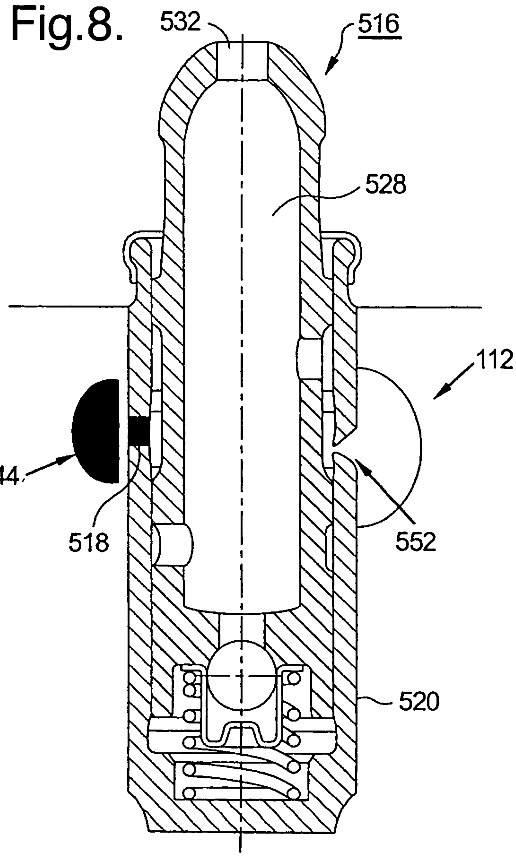
(54) **Method and apparatus for controlling a switchable cam follower**

(57) An internal combustion engine is equipped to supply the camshaft bearings (114) with pressurized oil via a first dedicated oil gallery (112) independently of the hydraulic lash adjusters (HLAs) (316) and any valve deactivation devices which are supplied from a second dedicated oil gallery (244). The galleries may be connected at their downstream ends and a flow restriction (352) is placed in a connecting passage or within each HLA. An improved HLA is similar to a prior art HLA except that the prior art annular oil distribution groove in the outer surface of the HLA body is eliminated to prevent communication of the primary engine oil gallery with the HLA. The secondary gallery is formed remotely from the first oil gallery in the HLA residence bore in the engine, and the HLA is prevented from rotating within the residence bore.

Fig.8.



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Description

TECHNICAL FIELD

[0001] The present invention relates to variable valve activation mechanisms for combustion valves of internal combustion engines; more particularly, to methods and apparatus for controllably supplying activating engine oil to such variable valve activation mechanisms including switchable cam followers; and most particularly, to an improved hydraulic lash adjuster and control scheme for such controllable valve actuation.

BACKGROUND OF THE INVENTION

[0002] Mechanisms for varying the valve timing and/or lift of combustion valves in internal combustion engines are well known. A typical prior art selective valve deactivation mechanism includes a switchable cam follower such as an articulated two-step deactivation roller finger follower (DRFF) disposed between an engine camshaft lobe and a valve stem. The DRFF includes a hydraulically-actuated lock pin to engage or disengage the articulated members. In one example of a DRFF, the lock pin is engaged between the articulated members by a return spring, such that the valve train is in high-lift mode by default at shutdown or other times as desired. The lock pins are disengaged by application of high pressure hydraulic fluid, typically engine oil provided by the engine's oil distribution system to overcome the return spring. The DRFF is pivoted on a hydraulic lash adjuster (HLA) at an end opposite to the valve-engaging end. The HLA is mounted rotatably about its axis in a residence bore in the engine, typically in the engine head. The HLA is supplied with engine oil from a molded or bored engine gallery to feed the lash adjuster mechanism therein, and oil also flows from the HLA to the DRFF through a central opening in the ball head of the HLA and a mating passage in the DRFF. When oil is supplied through the engine gallery at low pressure, the lock pin spring overcomes the oil pressure and the DRFF is in high-lift mode. To overcome the lock pin spring, the oil pressure is increased via a regulating oil control valve (ROCV) to a higher pressure sufficient to cause the lock pin to be retracted, placing the DRFF in low-lift or no-lift mode. The engine oil gallery thus doubles as a switching gallery and an oil supply gallery for top engine functions such as camshaft bearings.

[0003] A problem arises in using a single oil gallery in such a dual mode in that the pressure logic of a deactivation application mandates that oil pressure in the gallery be low (lock pin engaged, valves actuated) at the highest engine speeds and load conditions. Under these conditions, the camshaft bearings, which are oiled from the same gallery, are subjected to highest load and lowest oil flow which can result in premature bearing wear or outright failure.

[0004] One known approach to preventing this problem is to provide a second gallery adjacent the first gallery specifically for supplying the DRFF and to relegate the primary gallery to satisfying the lash adjustment and camshaft bearing lubrication requirements. This approach avoids the necessity for an ROCV, which is both bulky and expensive, but it requires significant changes in the prior art HLA design to provide independent oil feeds for the lash adjustment and switching functions. See, for example, US Patent No. 7,047,925, depicting a dual feed HLA. Such designs significantly reduce the volume of the HLA low-pressure chamber, raising concerns for potential noise upon cold start of the engine. Further, it can be difficult and expensive to provide two adjacent galleries so close together within the engine block; and further, significant leakage can occur between the two galleries along the wall of the HLA residence bore.

[0005] Instead of using a ROCV, the function may be provided by a combination of a three-way on/off valve in the switching gallery coupled to a pressure relief valve and an in-line flow restrictor to maintain low switching pressure at between about 0.3 bar and about 0.8 bar. However, this approach can be difficult to package on existing engine block or head arrangements because of the common oil gallery shared by the HLAs and the cam bearings.

[0006] What is needed in the art is an HLA arrangement that may be packaged in an existing head wherein the camshaft bearings are lubricated via an existing first oil gallery and the HLA switching and lash adjusting functions are satisfied, at least in part, from a second, independently controlled oil gallery remote from the first oil gallery, and wherein the first and second galleries are readily purged of air.

[0007] It is a principal object of the present invention to separate the camshaft oil supply requirements from the HLA oil supply requirements while using a common engine oil pressurizing pump.

[0008] It is a further object of the present invention to readily and automatically purge all oil galleries of air.

[0009] It is a still further object of the present invention to require the minimum changes in prior art engine casting molds by utilizing the existing HLA oil supply gallery and providing a second oil supply gallery.

SUMMARY OF THE INVENTION

[0010] Briefly described, an internal combustion engine is equipped to supply the camshaft bearings with pressurized oil via a first dedicated oil gallery independently of the hydraulic lash adjusters and any valve deactivation devices which are supplied from a second dedicated oil gallery. To improve air purging of both galleries, the galleries are connected and a small-orifice flow restriction is placed either in a connecting passage between the first and second galleries or within the HLAs themselves. In an aspect of the present invention, the primary engine oil gallery is as in the prior art, to minimize required retooling of engine molds. An improved hydraulic lash adjuster, formed in accordance with the invention, is identical with a prior art HLA except that the prior art annular oil distribution groove in the outer surface of the body is eliminated to prevent communication of the primary engine oil gallery with the HLA. The secondary gallery is formed remotely from the first oil gallery in the HLA residence bore in the engine, and the HLA is prevented from rotating within the residence bore. Thus, the HLA can communicate for actuation with only the new, second oil gallery. Forming the improved HLA requires only the omission of the prior art annular oil groove in the HLA body and provision for non-rotation of the improved HLA.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1a is a schematic drawing of a first prior art oil supply system, showing a single-feed HLA supplied by a single oil gallery via a regulating oil control valve;
FIG. 1b is an elevational cross-sectional drawing of a prior art single-feed HLA useful in the system shown in FIG. 1a;
FIG. 2a is a schematic drawing of a second prior art oil supply system, showing a dual-feed HLA supplied by a conventional oil gallery and a switching oil gallery via a three-way on/off valve;
FIG. 2b is an elevational cross-sectional view of a portion of a prior art valve train as shown schematically in FIG. 2a;
FIG. 3 is a schematic drawing of a third prior art oil supply system, showing a single-feed HLA fed by a switching oil gallery, in low-pressure (high valve lift) mode, and the cam bearings fed by a conventional oil gallery;
FIG. 4 is a schematic drawing of the third prior art oil supply system shown in FIG. 3, in high-pressure (low valve lift) mode;
FIG. 5 is an elevational cross-sectional view of a first embodiment of an improved HLA in accordance with the invention, which improved HLA is suitable for use in the first improved oil supply system shown in FIGS. 6 and 7;
FIG. 6 is a schematic drawing of a first improved oil supply system in accordance with the invention, showing an improved single-feed HLA fed by a switching oil gallery, in low-pressure (high valve lift) mode, and the cam bearings fed by a conventional oil gallery, the two galleries being hydraulically connected but functionally isolated via a flow restriction;
FIG. 7 is a schematic drawing of the first improved oil supply system in accordance with the invention shown in FIG. 6, in high-pressure (low valve lift) mode;
FIG. 8 is an elevational cross-sectional view of a second embodiment of an HLA in accordance with the invention;
FIG. 9 is a schematic drawing of a second improved oil supply system in accordance with the invention, showing an improved dual-feed HLA fed by a switching oil gallery, in low-pressure (high valve lift) mode, and the cam bearings fed by a conventional oil gallery, the two galleries being hydraulically connected but functionally isolated via a flow restriction in each HLA in the engine; and
FIG. 10 is a schematic drawing of the second improved oil supply system in accordance with the invention shown in FIG. 9, in high-pressure (low valve lift) mode.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] The advantages and benefits of an oil supply system in accordance with the invention may be better appreciated by first considering three prior art systems.

[0013] Referring to FIGS. 1a and 1b, a first prior art oil supply system 100 includes a pressurizing pump 102 which draws intake hydraulic fluid 104 from a sump 106. Fluid 104 is typically engine oil and sump 106 is typically an engine crankcase. Pressurized output oil 108 from pump 102 is directed through a regulating oil control valve (ROCV) 110 which regulates pressure in a conventional oil gallery 112 to about 0.5 bar. Pressurized oil is supplied from gallery 112 to cam bearings 114 and to a conventional hydraulic lash adjuster 116 disposed rotatably about its axis in a residence bore 115 in an engine head 117. Oil enters HLA 116 through a first port 118 in HLA body 120, thence into an inner annular groove 122 formed in plunger 124, thence through a second port 126 in plunger 124 which opens into a low-pressure reservoir 128. From reservoir 128, oil flows both into lash adjusting mechanism 130 and also out of HLA 116 through a third port 132 which mates with a rocker arm or finger follower mechanism (not shown, but see FIG. 2b). An outer annular groove 119 in HLA body 120 coincides with first port 118, and HLA 116 thus is free to rotate about its longitudinal axis while oil is supplied to port 118 from groove 119 at any angular orientation of the HLA. ROCV 110 is controlled by an engine control module (not shown). The "normal" ("low") operating pressure 134 as noted above is about 0.5 bar. When deactivation of an associated switchable cam follower such a DRFF is desired, ROCV 110 opens to permit higher oil pressure 136 (which may be the same as pressure 108 or not) to flow to HLA 116 and thence into the DRFF. Of course, the higher oil pressure is also felt by cam bearings 114. As noted above, at high engine speed or high engine load a low oil pressure 134 required for full valve activation can rob the cam bearings 114 of adequate oil flow.

[0014] Referring now to FIGS. 2a and 2b, a second prior art oil supply system 200 includes pressurizing oil pump 102 which draws intake oil 104 from sump 106, as in prior art system 100 (FIG. 1a). Pressurized output oil 108 from pump 102 is fed through a first flow restriction

240 into a conventional oil gallery 112 at an unregulated intermediate pressure 242 sufficient to lubricate cam bearings 114 and fill the low-pressure reservoir 228 and lash adjusting mechanism 230 of a second prior art HLA 216 disposed in a residence bore 215 in an engine head 217. A second (switching) gallery 244 is provided in engine head 217 in parallel with conventional gallery 112 and communicates with a switchable cam follower such as DRFF 246 via a passage 248 independent of low-pressure reservoir 228. In some engine systems, first flow restriction 240 is simply a small-diameter port where the oil feed passes through the engine head gasket.

[0015] There is no ROCV in this second prior art system. Rather, a three-way on/off valve 250 controlled by an engine control module (not shown) governs flow of oil into switching gallery 244. Oil flow into switching gallery 244 is either at high pressure 108 or a very low pressure 254. Although the three-way valve 250 is only either open or closed, a bypass "bleed" 252 preferably is provided to maintain a slight charge pressure 254 in switching gallery 244, as is desirable for some valve deactivation systems.

[0016] Prior art system 200 desirably divorces the lash adjusting and cam bearing lubrication functions from the valve deactivation functions. However, the presence of conventional oil gallery 112 where formed in existing engine heads leaves little room for the addition of a switching gallery 244 adjacent thereto. Further, a longer HLA is required, having in some designs a two-piece plunger, and the volume of the low-pressure reservoir is quite small, making an engine equipped with this system vulnerable to cold-starting clatter.

[0017] Referring to FIGS. 3 and 4, a third prior art oil supply system 300 includes pressurizing oil pump 102 which draws intake oil 104 from sump 106, as in prior art systems 100 and 200 (FIGS. 1a and 2a). As in system 200, pressurized output oil 108 from pump 102 is fed through a first flow restriction 240 into a conventional oil gallery 112 at an unregulated intermediate pressure 242 sufficient to lubricate cam bearings 114. However, the HLA is entirely divorced from gallery 112. A second gallery 244 is provided in engine head 217 adjacent conventional gallery 112 and supplies an HLA 316 similar to HLA 116, filling the low-pressure reservoir and lash adjusting mechanism via a single feed.

[0018] Again, there is no ROCV in this third prior art system. Rather, a three-way on/off valve 350 governs flow of oil into switching gallery 244. Oil flow into switching gallery 244 is either at low pressure 334 (FIG. 3, DRFF engaged for high valve lift)) or high pressure 108 (FIG. 4, DRFF disengaged for no or low valve lift). Although three-way valve 350 is only either open or closed, a second flow restriction 352 around valve 350 and a pressure relief valve 356 maintains low pressure 334 in switching gallery 244, preferably about 0.5 bar similar to pressure 134 as in first system 100 for lash adjusting functions of HLA 316. When high pressure to HLA 316 is desired, valve 350 opens to oil pressure 108 and closes to relief valve 356.

[0019] Third prior art system 300 achieves the objective of divorcing cam bearing lubrication from HLA activities while utilizing a substantially unmodified production HLA such as HLA 116 (FIGS. 1a and 1b). However, the presence of the conventional oil gallery 112 where formed in existing engine heads leaves little room for the addition of a switching gallery 244 adjacent thereto. Further, the first and second galleries and the HLA are not readily purged of air and may have dead legs at various points therein.

[0020] Referring now to FIGS. 5, 6, and 7, a first improved oil supply system 400 in accordance with the invention is similar to but improves upon prior art system 300. Improved system 400 includes pressurizing oil pump 102 which draws intake oil 104 from sump 106 as in prior art system 300 (FIGS. 3 and 4). As in system 300, pressurized output oil 108 from pump 102 is fed through a first flow restriction 240 into a conventional oil gallery 112 at an unregulated intermediate pressure 242 sufficient to lubricate cam bearings 114. HLA 416 is entirely divorced from gallery 112. A second gallery 244 is provided in engine head 217 in addition to the conventional gallery 112 and supplies an improved HLA 416 similar to conventional HLA 116, filling the low-pressure reservoir and lash adjusting mechanism via a single feed. As shown in FIG. 5, however, HLA 416 differs from HLA 116 in having no annular oil supply groove 119 formed in the unfeatured cylindrical exterior of HLA body 420; and further, HLA 416 is prevented from free rotation in the HLA residence bore 215 (FIG. 2b) in engine head 217 by inclusion of an anti-rotation flat or other obvious mechanical preventer as known in the art. Thus, the HLA fill port 418 in body 420 is inaccessible to the conventional oil gallery 112 disposed in an existing head in which HLA 416 might be retro-fitted and is positioned to communicate with only second gallery 244 for all HLA oil supply functions.

[0021] As in prior art embodiment 300, there is no ROCV in first improved oil supply system 400. Rather, a three-way on/off valve 350 governs flow of oil into switching gallery 244. Oil flow into switching gallery 244 is either at low pressure 434 (FIG. 6, DRFF engaged for high valve lift)) or high pressure 108 (FIG. 7, DRFF disengaged for no or low valve lift). Although the three-way valve 350 is only either open or closed, a second flow restriction 452 in a connecting passage 453 between the distal ends 455,457 respectively of conventional oil gallery 112 and switching oil gallery 244, which distal ends are not connected in the prior art embodiments, combined with a pressure relief valve 356 in gallery 244 maintains low pressure 434 in switching gallery 244, preferably about 0.5 bar similar to pressure 134 as in first system 100 for lash adjusting functions of HLA 316, when three-way valve 350 is closed to high pressure oil flow 108 in a first position. Switching gallery 244 is open to pressure relief valve 356. Referring to FIG. 7, when high pressure oil to HLA 416 is desired, valve 350 opens switching gallery 244 to a second position to oil pressure 108 and closes switching gallery 244 to relief valve 356.

[0022] First improved oil supply system 400 achieves the objective of divorcing cam bearing lubrication from HLA activities while utilizing a minimally modified production HLA such as HLA 116 (FIGS. 1a and 1b), and while accommodating a conventional oil gallery passage in a current head.

[0023] System 400 also provides several other important advantages not available in the prior art. First, any air bubbles in either of the oil galleries are automatically purged through pressure relief valve 356 when the system is in low pressure mode as shown in FIG. 6. Second, because galleries 112 and 244 are connected at their distal ends by connector 453, there are no dead legs in the flow path and thus all air is purged, unlike the prior art systems wherein each of the oil galleries has a dead terminal leg. Third, the conventional oil gallery 112 and the switching oil gallery 244 are formed in engine head 217 on opposite sides of HLA 416. This arrangement makes it relatively easy to form the two galleries in an existing engine head mold with minimal required retooling of the mold. The arrangement also provides maximal flow separation of the two galleries within the residence bore of the HLA and thus minimizes hydraulic cross-talk between the two galleries, whereas in the prior art (FIG. 2b) the two galleries, being adjacent and on the same side of the residence bore, are separated by only a few millimeters of bore wall.

[0024] Referring now to FIGS. 8, 9, and 10, a second improved oil supply system 500 in accordance with the invention is similar to first improved system 400, differing only in the implementation of a pressure reducing flow restriction between the two galleries.

[0025] As just described, in system 400 the ends of the conventional and switching galleries 112,244 are joined via a connector 453 containing flow restrictor 452. In the low pressure mode (FIG. 6), oil flows from the conventional gallery through restrictor 452 and into the switching gallery. Pressure relief valve 356 and flow restrictor 452 are sized to regulate the pressure in the switching gallery to the desired 0.5 bar pressure. In addition, air from gallery 112 is swept by pressurized oil through connector 453 where it joins with air in gallery 244 and both are purged through relief valve 356.

[0026] In system 500, the ends of galleries 112,244 are not joined except through the final HLA in an engine bank; thus there are still no dead flow legs. However, in this embodiment, the pressure reducing flow restrictions are located in the body of the HLA rather than in connector 453 as in system 400.

[0027] Each HLA 516 (FIG. 8) is identical to HLA 416 except that an orifice or flow restriction 552 is provided through HLA body 520 in communication with conventional oil gallery 112. Thus, referring to FIG. 9, oil flows from the conventional gallery through the flow restriction into the HLA low pressure chamber and switching gallery and eventually out the pressure relief valve. The pressure relief valve and flow restrictors are sized to regulate the pressure in the switching gallery to the desired 0.5 bar pressure. This eliminates having to manufacture connector 453 containing restriction 452 of system 400. Air in gallery 112 is purged into low-pressure reservoir 528 and thence out of the HLA via tip opening 532. Continued purging from gallery 112 through HLA 516 drives air in port 518 and switching gallery 244 out through three-way valve 350 and relief valve 356 (FIGS. 8 and 9).

[0028] An added advantage of systems 400 and 500 is that in high-pressure mode (FIGS. 7 and 10) the flow restrictions (452, 552) are slightly back flushed, which can help to keep the orifice from becoming plugged with engine debris in long-term use. As in system 400, HLA 516 must be prevented from rotation to keep the supply ports in the HLA registered with the proper oil gallery.

[0029] The benefits of improved oil distribution systems in accordance with the invention may be summarized as follows:

a) they utilize a smaller, faster, and less expensive on/off OCV than the ROCV of the prior art;

b) they utilize two separate oil galleries to avoid cam bearing lubrication concerns, especially in valve-deactivation applications;

c) the conventional and switching oil galleries are in communication for excellent purging of air and have no dead legs;

d) the conventional and switching oil galleries are on opposite sides of the residence bore for the HLA;

e) the low pressure limit for default operation of an associated DRFF can be set lower than for a prior art ROCV system, which aids switching performance;

f) The conventional oil gallery remains positioned as in prior art engines,requiring minimal retooling of engine molds; and

g) although a modified HLA is required, the necessary changes involve less risk than for the prior art dual feed system 200; further, only the HLA body requires modification, so the advantages of the prior art single-piece plunger can be retained.

[0030] While the invention has been described by reference to various specific embodiments, it should be understood that numerous changes may be made within the spirit and scope of the inventive concepts described. Accordingly, it is intended that the invention not be limited to the described embodiments, but will have full scope defined by the language of the following claims.

Claims

1. In an internal combustion engine having at least one camshaft bearing, at least one hydraulic lash adjuster disposed in a residence bore formed in said engine, and at least one switchable cam follower actuated by hydraulic fluid fed from the hydraulic lash

adjuster, a system for controllably supplying hydraulic fluid to the camshaft bearing and to the hydraulic lash adjuster, comprising:

a) a first hydraulic gallery in said engine for supplying said hydraulic fluid at a first pressure from a pressurized source to said camshaft bearing;
b) a second hydraulic gallery in said engine for supplying said hydraulic fluid at a second pressure from said pressurized source to said hydraulic lash adjuster.
c) a valve for variably connecting said second hydraulic gallery to said pressurized source; and
d) a fluid connector in fluid communication with said first and second hydraulic galleries, said connector including a flow-restricting orifice,

wherein said first and second hydraulic galleries are independently disposed on sides of said residence bore, and
wherein said hydraulic lash adjuster includes a hydraulic lash adjuster mechanism, said lash adjuster further comprising a low pressure chamber in fluid communication with the hydraulic lash adjuster mechanism and the switchable cam follower.

2. A system in accordance with Claim 1 wherein said valve is a three-way on/off valve.

3. A system in accordance with Claim 2 further comprising a pressure relief valve in fluid communication with said three-way on/off valve for selective connection to said second hydraulic gallery.

4. A system in accordance with Claim 3 wherein a first position of said three-way on/off valve prohibits flow of said hydraulic fluid from said pressurized source through said valve to said second hydraulic gallery, and wherein a second position of said three-way on/off valve permits flow of said hydraulic fluid from said pressurized source through said valve to said second hydraulic gallery.

5. A system in accordance with Claim 1 wherein said hydraulic fluid is engine oil supplied from an engine sump.

6. A system in accordance with Claim 1 wherein said fluid connecting passage is connected between the distal ends of said first and second hydraulic galleries.

7. A system in accordance with Claim 1 wherein said flow-restricting orifice is formed in a body of said hydraulic lash adjuster.

8. A system in accordance with Claim 7 wherein the first gallery intersects the resident bore and is in flow communication with said low pressure chamber through said orifice.

9. A system in accordance with Claim 1 wherein said flow-restricting orifice is disposed in a connecting passage, said connecting passage connecting said first and second hydraulic galleries.

10. A system in accordance with Claim 1 wherein said hydraulic lash adjuster includes a body having a cylindrical outer surface unfeatured by an annular groove.

11. A system in accordance with Claim 8 wherein one of said hydraulic lash adjuster or said resident bore includes an anti-rotation feature whereby axial rotation of said body relative to said resident bore is limited.

12. A multiple-cylinder internal combustion engine comprising:

a) at least one camshaft bearing;
b) at least one hydraulic lash adjuster disposed in a residence bore formed in said engine;
c) at least one switchable cam follower actuated by hydraulic fluid fed from said hydraulic lash adjuster; and
d) a system for controllably supplying hydraulic fluid to said camshaft bearing and to said hydraulic lash adjuster, including

a first hydraulic gallery in said engine for supplying said hydraulic fluid from a pressurized source to said camshaft bearing;
a second hydraulic gallery in said engine for supplying said hydraulic fluid from said pressurized source to said hydraulic lash adjuster.
a valve for variably connecting said second hydraulic gallery to said pressurized source; and
a fluid connector in fluid communication with said first and second hydraulic galleries, said connector including a flow-restricting orifice,

wherein said first and second hydraulic galleries are independently disposed on sides of said residence bore, and
wherein said hydraulic lash adjuster includes a hydraulic lash adjuster mechanism, said lash adjuster further comprising a low pressure chamber in fluid communication with the hydraulic lash adjuster mechanism and the switchable cam follower.

Fig.1a.

(PRIOR ART)

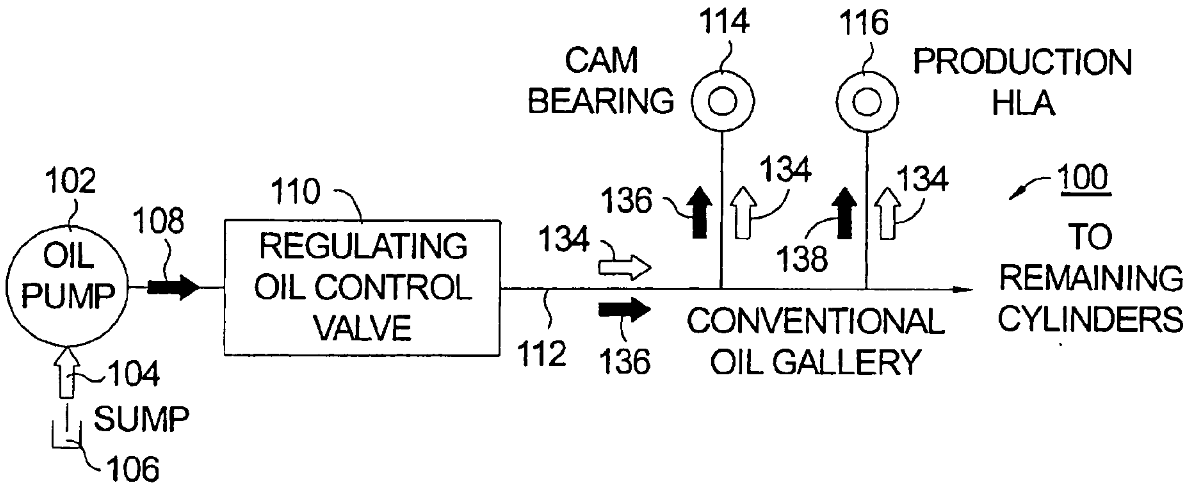
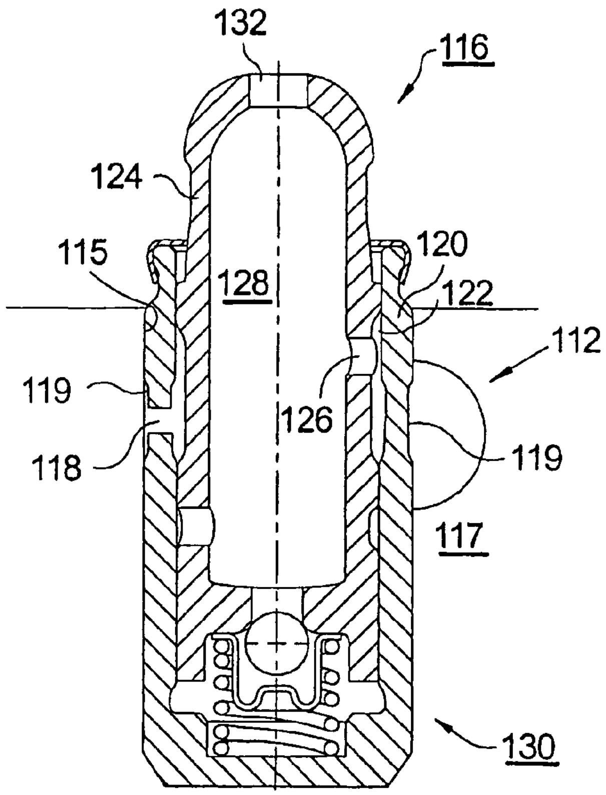


Fig.1b.

(PRIOR ART)



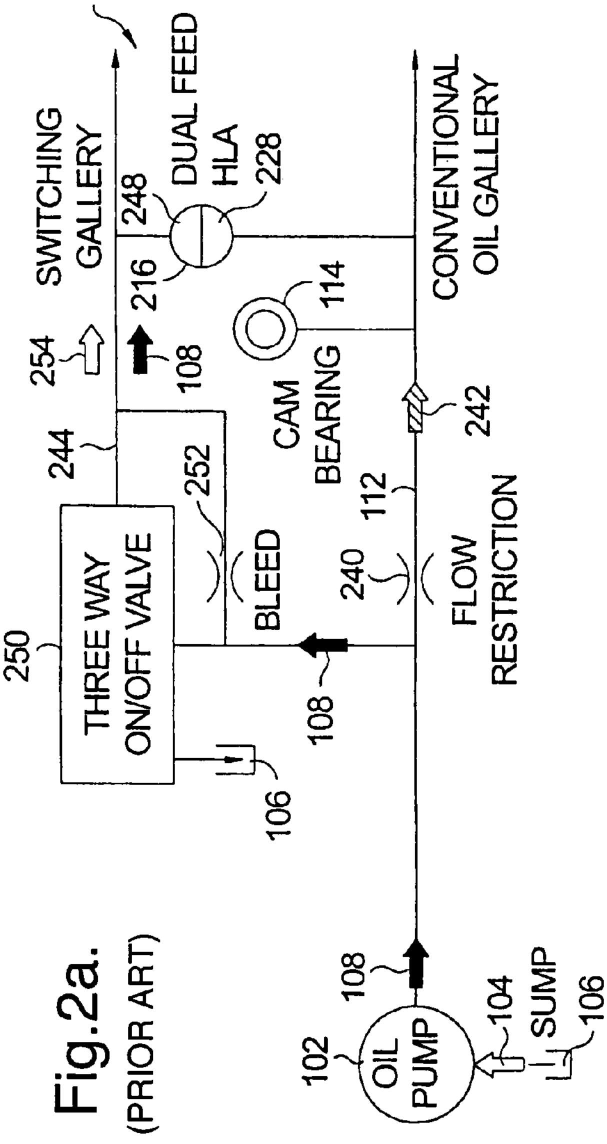


Fig.2a.
(PRIOR ART)

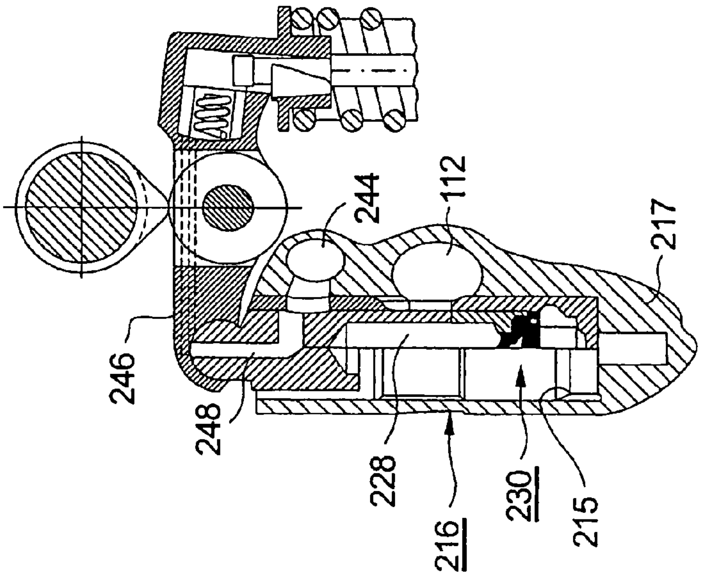


Fig.2b.
(PRIOR ART)

Fig.3.

(PRIOR ART)

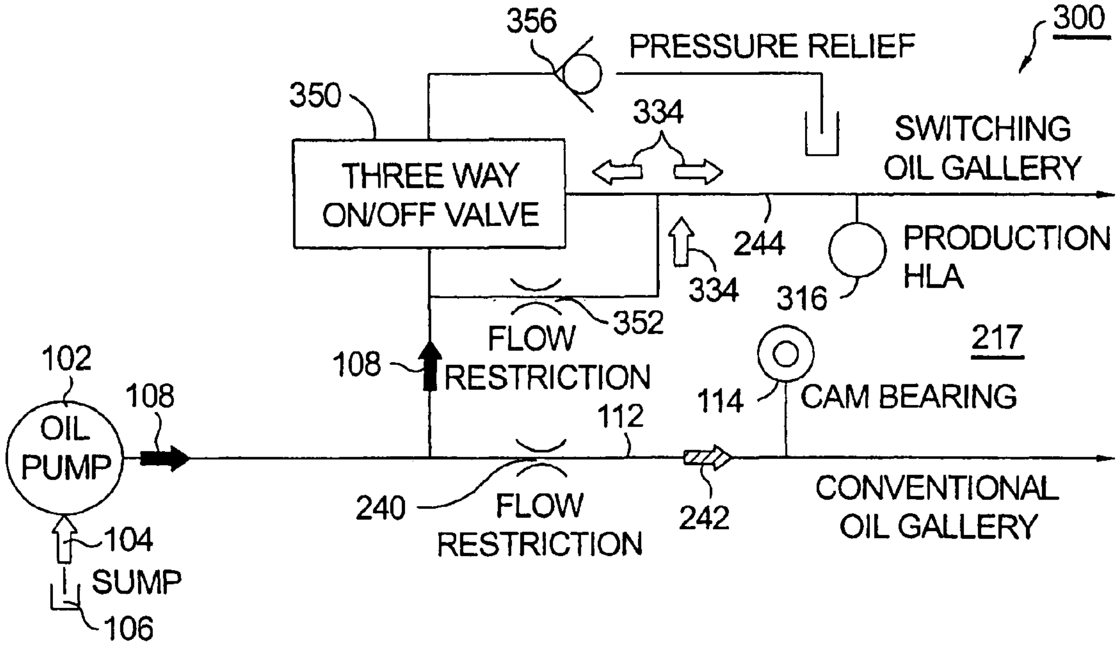


Fig.4.

(PRIOR ART)

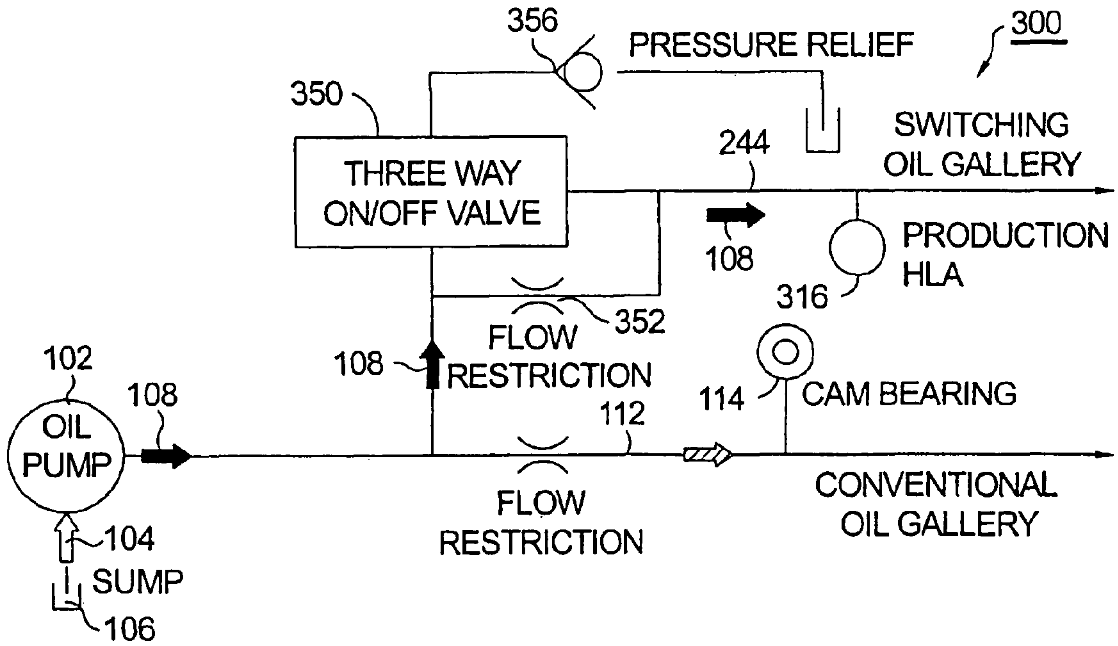


Fig.8.

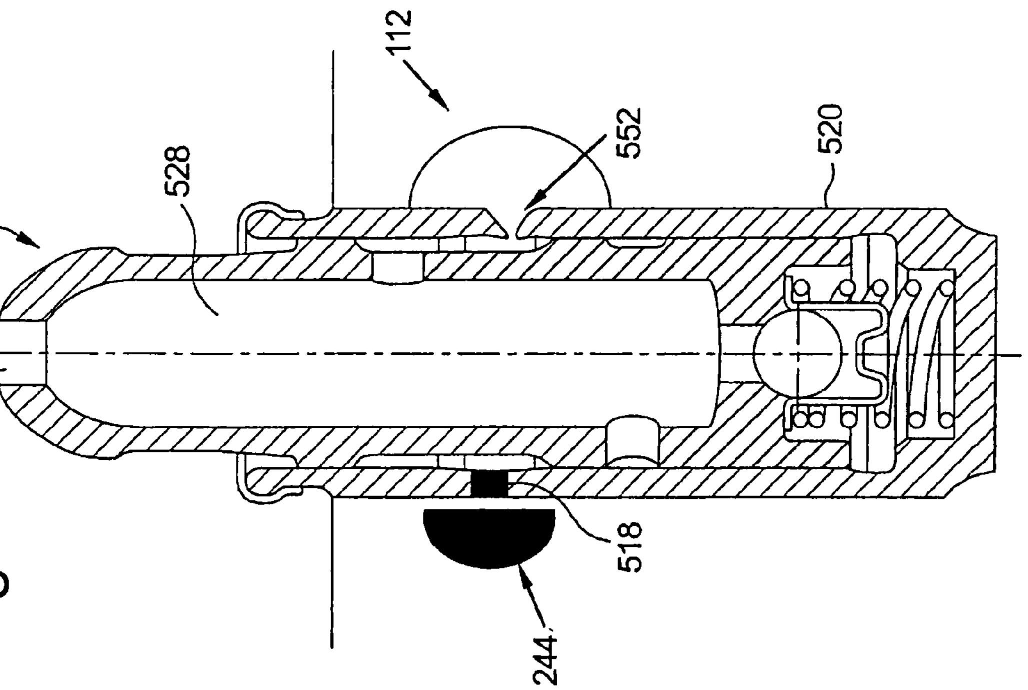


Fig.5.

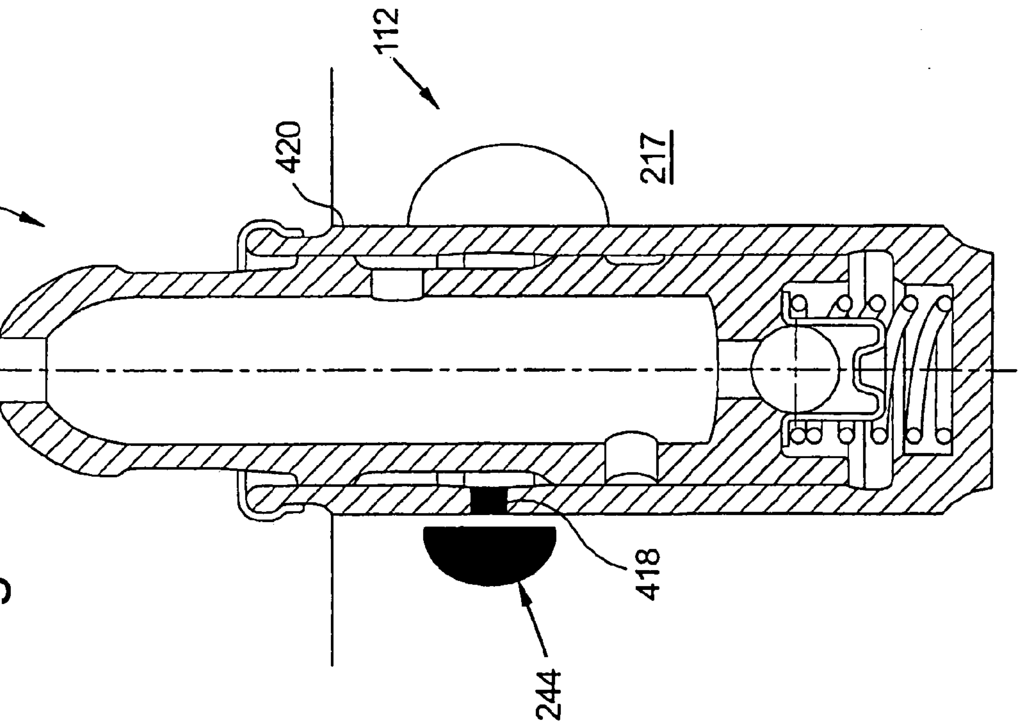


Fig.6.

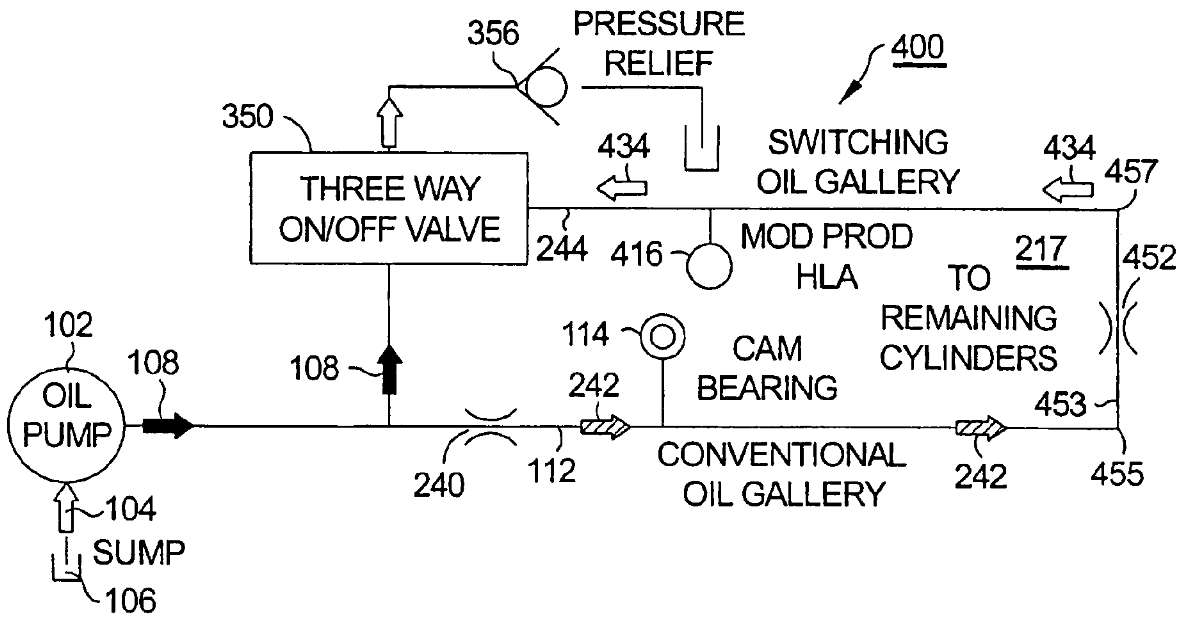

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Fig.7.

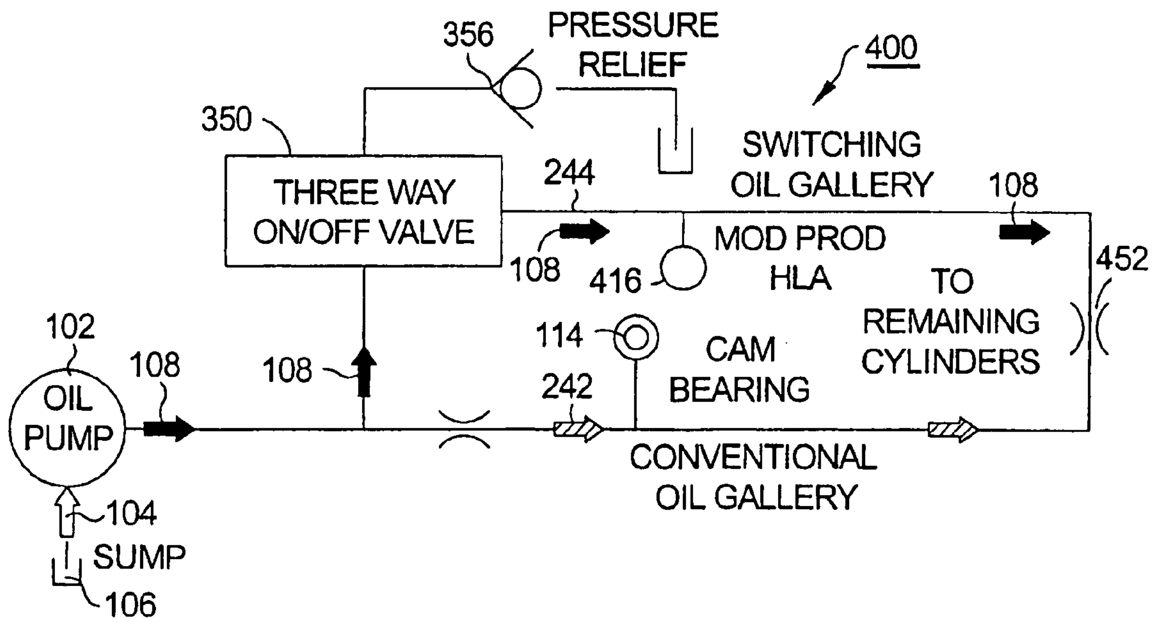
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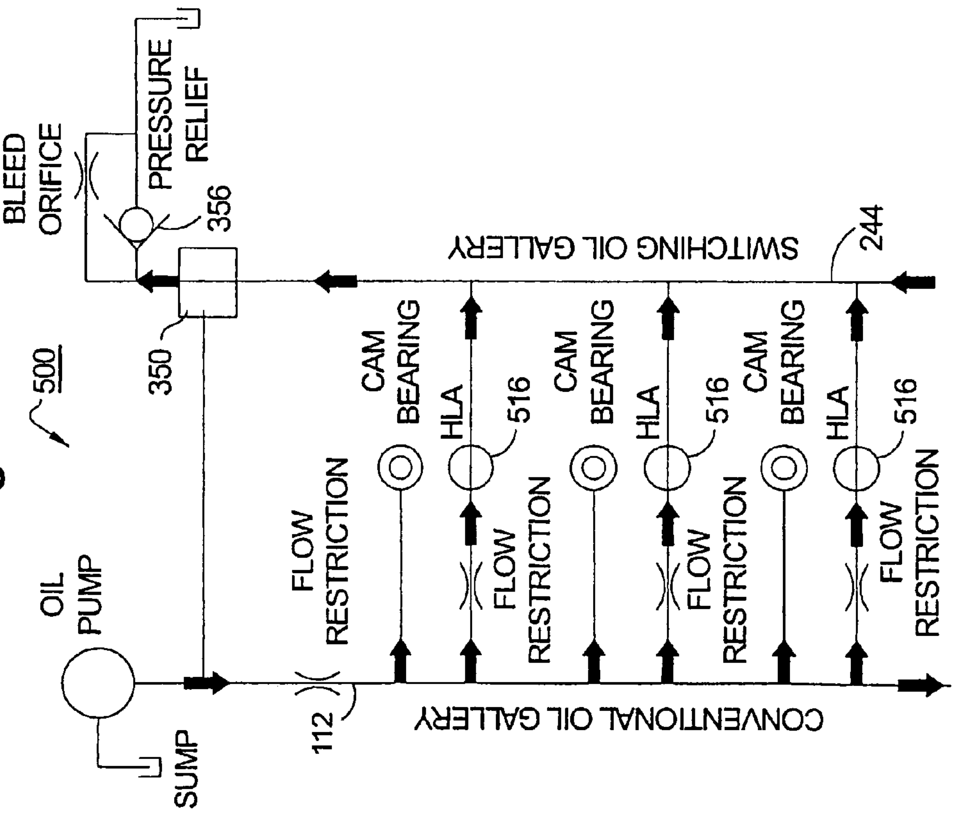
Fig.9.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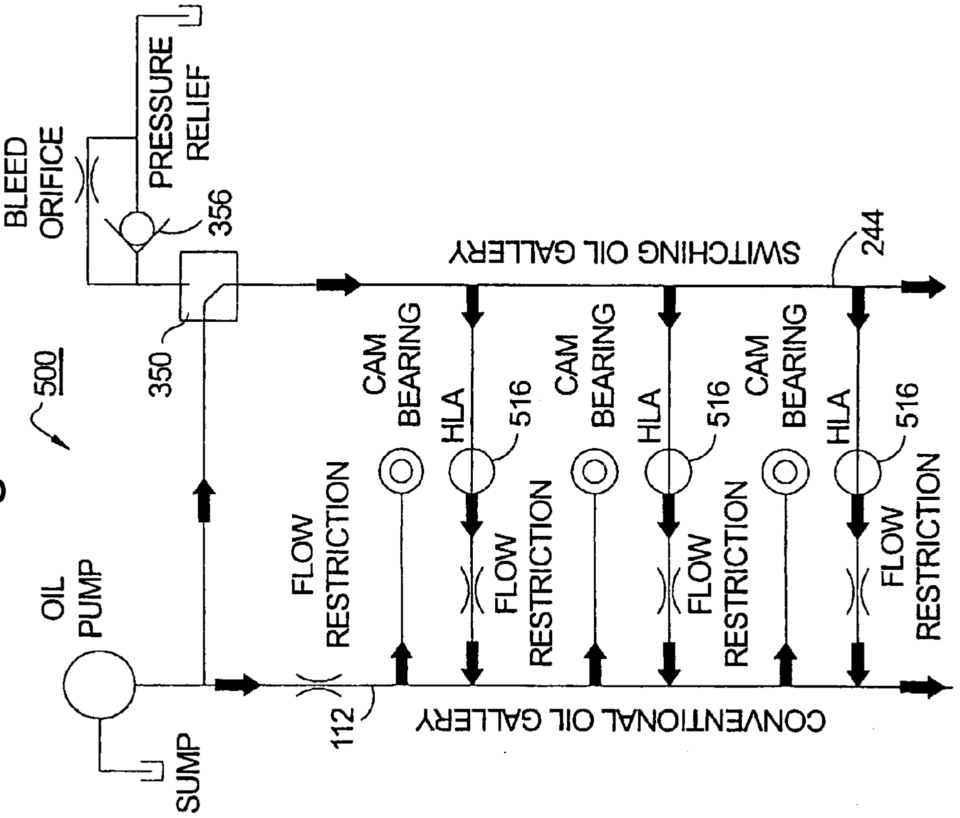
CONVENTIONAL OIL GALLERY

Fig.10.


500
OIL PUMP
SUMP
350
356
BLEED ORIFICE
PRESSURE RELIEF
FLOW RESTRICTION
112
CAM BEARING
HLA
516
FLOW RESTRICTION
CAM BEARING
HLA
516
FLOW RESTRICTION
CAM BEARING
HLA
516
FLOW RESTRICTION
SWITCHING OIL GALLERY
244
CONVENTIONAL OIL GALLERY

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 07 5619

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Munich	30 November 2007	Paulson, Bo

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