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(54) Title: SYSTEM AND METHOD FOR MULTI-LIFT VALVE ACTUATION

(57) Abstract: A system and method for actuating one or more engine valves to produce an engine valve event is disclosed. The system may comprise: a housing; an accumulator disposed in the housing having a first open end and a second open end; a master piston slidably disposed in a first bore formed in the housing; a valve train element(s) for imparting motion to the master piston; and a slave piston slidably disposed in a second tore formed in the housing, the slave piston in fluid communication with the master piston through a high pressure hydraulic passage, wherein the first open end and the second open end of the accumulator are in communication with the high pressure hydraulic passage to selectively modify the imparted motion.

SYSTEM AND METHOD FOR MULTI-LIFT VALVE ACTUATION

CROSS-REFERENCE TO RELATED PATENT APPLICATION

[0001] This application claims priority on U.S. Provisional Patent Application No. 60/544,336, for System and Method for Multi-Lift Valve Actuation, filed on February 17, 2004, the entirety of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to a system and method for actuating one or more valves in an engine. In particular, the present invention relates to systems and methods for multi-lift actuation of one or more engine valves to produce an engine valve event. In one embodiment, the present invention may be used to provide multi-lift exhaust gas recirculation valve events. Embodiments of the present invention may provide other multi-lift valve events, such as, for example, main valve events (exhaust and/or intake), compression release braking valve events, bleeder braking valve events, and/or other auxiliary valve events.

BACKGROUND OF THE INVENTION

[0003] Valve actuation in an internal combustion engine is required in order for the engine to produce positive power, engine braking, and exhaust gas recirculation (EGR). During positive power, one or more intake valves may be opened to admit fuel and air into a cylinder for combustion. One or more exhaust valves may be opened to allow combustion gas to escape from the cylinder. Intake, exhaust, and/or auxiliary valves may also be opened during positive power at various times to recirculate gases for improved emissions.

[0004] Engine valve actuation also may be used to produce engine braking and exhaust gas recirculation when the engine is not being used to produce positive power. During engine braking, one or more exhaust valves may be selectively opened to convert, at least temporarily, the engine into an air compressor. In doing so, the engine develops retarding horsepower to help slow the vehicle down. This can provide the operator with increased control over the vehicle and substantially reduce wear on the service brakes of the vehicle.

[0005] Engine valve(s) may be actuated to produce compression-release braking and/or bleeder braking. An example of a prior art compression release engine brake is provided by the disclosure of Cummins, U.S. Pat. No. 3,220,392 (November 1965), which is incorporated herein by reference. An example of a system and method utilizing a bleeder type engine brake is provided by the disclosure of Assignee's U.S. Patent No. 6,594,996 (July 22, 2003), a copy of which is incorporated herein by reference.

[0006] The basic principles of exhaust gas recirculation (EGR) are also well known. After a properly operating engine has performed work on the combination of fuel and inlet air in its combustion chamber, the engine exhausts the remaining gas from the engine cylinder. An EGR system allows a portion of these exhaust gases to flow back into the engine cylinder. This recirculation of gases into the engine cylinder may be used during positive power operation, and/or during engine braking cycles to provide significant benefits. As used herein, EGR may include brake gas recirculation (BGR), which is the recirculation of gases during engine braking cycles.

[0007] During positive power operation, an EGR system is primarily used to improve engine emissions. During engine positive power, one or more intake valves may be opened to admit fuel and air from the atmosphere, which contains the oxygen required to burn the fuel in the cylinder. The air, however, also contains a large quantity of nitrogen. The high temperature found within the engine cylinder causes the nitrogen to react with any unused oxygen and form nitrogen oxides (NOx). Nitrogen oxides are one of the main pollutants emitted by diesel engines. The recirculated gases provided by an EGR system have already been used by the engine and contain only a small amount of oxygen. By mixing these gases with fresh air, the amount of oxygen entering the engine may be reduced and fewer nitrogen oxides may be formed. In addition, the recirculated gases may have the effect of lowering the combustion temperature in the engine cylinder below the point at which nitrogen combines with oxygen to form NOx. As a result, EGR systems may work to reduce the amount of NOx produced and to improve engine emissions. Current environmental standards for diesel engines, as well as proposed regulations, in the United States and other countries indicate that the need for improved emissions will only become more important in the future.

[0008] An EGR system may also be used to optimize retarding power during engine braking operation. As discussed above, during engine braking, one or more exhaust valves may be selectively opened to convert, at least temporarily, the engine into an air compressor. By controlling the pressure and temperature in the engine using EGR, the level of braking may be optimized at various operating conditions.

[0009] In many systems, it may be desirable to provide multiple valve lifts for an engine valve event. For example, the amount of exhaust gas recirculation desired may increase with engine speed. Thus, ,when providing an EGR valve event, it may be desirable for the valve lift to be higher and/or longer at higher engine speeds, and lower and/or shorter at slower engine speeds.

[0010] In many internal combustion engines, the engine intake and exhaust valves may be opened and closed by fixed profile cams, and more specifically by one or more fixed lobes which may be an integral part of each of the cams. Benefits such as increased performance, improved fuel economy, lower emissions, and better vehicle drivability may be obtained if the intake and exhaust valve timing and lift can be varied. The use of fixed profile cams, however, can make it difficult to adjust the timings and/or amounts of engine valve lift to optimize them for various engine operating conditions.

[0011] One method of adjusting valve timing and lift, given a fixed cam profile, has been to provide valve actuation that incorporates a "lost motion" system in the valve train linkage between the valve and the cam. Lost motion is the term applied to a class of technical solutions for modifying the valve motion prescribed by a cam profile with a variable length mechanical, hydraulic, and/or other linkage assembly. In a lost motion system, a cam lobe may provide the "maximum" (longest dwell and greatest lift) motion needed over a full range of engine operating conditions. A variable length system may then be included in the valve train linkage, intermediate of the valve to be opened and the cam providing the maximum motion, to subtract or lose part or all of the motion imparted by the cam to the valve. It is advantageous to provide a system for modifying the motion of a fixed cam profile that may be turned on or off, and selectively controlled based on various conditions.

[0012] The systems and methods of the present invention may be particularly useful in engines requiring valve actuation for positive power, engine braking valve events and/or EGR/BGR valve events. The systems and methods of various embodiments of the present invention may provide a lower cost, simpler variable valve actuation system. In addition, the systems and methods of the present invention may provide multiple valve lift profiles to improve engine performance during positive power, engine braking, EGR and/or BGR operation under a variety of engine conditions. Additional advantages of embodiments of the invention are set forth, in part, in the description which follows and, in part, will be apparent to one of ordinary skill in the art from the description and/or from the practice of the invention.

SUMMARY OF THE INVENTION

[0013] Responsive to the foregoing challenges, Applicant has developed innovative systems and methods for actuating one or more engine valves. In one embodiment, the system may comprise: a housing; an accumulator disposed in the housing having a first open end and a second open end; a master piston slidably disposed in a first bore formed in the housing; a valve train element(s) for imparting motion to the master piston; and a slave piston slidably disposed in a second bore formed in the housing, the slave piston in fluid communication with the master piston through a high pressure hydraulic passage, wherein the first open end and the second open end of the accumulator are in communication with the high pressure hydraulic passage to selectively modify the imparted motion.

[0014] Applicant has further developed a system of actuating one or more engine valves in an internal combustion engine to produce an exhaust gas recirculation engine valve event, the system comprising: a housing; an accumulator disposed in the housing having a first open end and a second open end; a high pressure fluid passage; a master piston slidably disposed in a first bore formed in the housing; means for imparting motion to the master piston; a slave piston slidably disposed in a second bore formed in the housing, the slave piston in fluid communication with the master piston through the high pressure hydraulic passage; a shuttle valve; and a first solenoid valve for controlling the shuttle valve to selectively communicate the first open end and the second open end of the accumulator with the high pressure hydraulic passage, wherein the first open end and the second open end of the accumulator are in selective communication with the high pressure hydraulic passage to selectively modify the imparted motion.

[0015] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only, and are not restrictive of the invention as claimed. The accompanying drawings, which are incorporated herein by reference, and which constitute a part of this specification, illustrate certain embodiments of the invention and, together with the detailed description, serve to explain the principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] In order to assist the understanding of this invention, reference will now be made to the appended drawings, in which like reference numerals refer to like elements. The drawings are exemplary only, and should not be construed as limiting the invention.

[0017] Fig. 1 is a block diagram of a first embodiment of the valve actuation system of the present invention.

[0018] Fig. 2 is a schematic diagram of a cam that may be used in an embodiment of the present invention.

[0019] Fig. 3 is a schematic diagram of a second embodiment of the valve actuation system of the present invention.

[0020] Fig. 4 is a schematic diagram of a third embodiment of the valve actuation system of the present invention.

[0021] Fig. 5 is a schematic diagram of a fourth embodiment of the valve actuation system of the present invention.

[0022] Figs. 6a – Fig. 6c are valve lift diagrams according to the valve actuation system of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0023] Reference will now be made in detail to embodiments of the system and method of the present invention, examples of which are illustrated in the accompanying drawings. As embodied herein, the present invention includes systems and methods of actuating one or more engine valves.

[0024] A first embodiment of the present invention is shown schematically in Fig. 1 as valve actuation system **10**. The valve actuation system **10** includes a means for imparting motion **100** operatively connected to a valve actuator assembly **300**, which in turn is operatively connected to one or more engine valves **200**. The motion imparting means **100** is adapted to apply motion to the valve actuator **300**. The valve actuator **300** may be selectively controlled to transfer or not transfer motion to the engine valve **200**.

[0025] When in the motion transfer mode, the valve actuator **300** is adapted to actuate the engine valve **200** to produce an engine valve event, such as, but not limited to, main intake, main exhaust, exhaust gas recirculation, compression release braking, and/or bleeder braking. The valve actuator **300** may also modify the amount and timing of the motion transferred to the engine valves **200**. In this manner, the valve actuator **300** is adapted to provide multiple valve lift profiles. The valve actuation system **10**, including the valve actuator **300**, may transfer, not transfer, and/or modify the imparted motion in response to a signal or input from a controller **400**. The engine valves **200** may be one or more exhaust valves, intake valves, or auxiliary valves, such as, a dedicated valve.

[0026] The motion imparting means **100** may comprise any combination of cam(s), push tube(s), and/or rocker arm(s), or their equivalents, adapted to impart motion to the valve actuator **300**. In at least one embodiment of the present invention, the motion imparting means **100** comprises a cam **110**. The cam **110** may comprise an exhaust cam, an intake cam, an injector cam, and/or a dedicated cam. As shown in Fig. 2, the cam **110** may include one or more cam lobes for producing an engine valve event(s). For example, the cam may include lobes, such as, for example, a main (exhaust or intake) event lobe **112**, an engine braking lobe **114**, and an EGR lobe **116**. The depictions of the lobes on the cam **110** are intended to be illustrative only, and not limiting. It is appreciated that the number, combination, size, location, and shape of the lobes may vary markedly without departing from the scope of the present invention.

[0027] The motion imparted by the cam **110** to produce an engine valve main event may be used to provide an EGR valve event. For example, a main event (e.g., intake or exhaust) lobe **112** may be used to additionally actuate one or more valves **200** for an EGR valve event. Because the full motion of the main event may provide more valve lift than required for the EGR valve event, the motion may be modified by the valve actuator **300**.

[0028] The EGR valve event may be carried out by different valve(s) than those used to carry out the main engine valve event. These "different valves" may be of the same or different type (intake versus exhaust) as those used for the main valve event, and may be associated with a different or the same cylinder as the valves used for the main valve event.

[0029] The controller **400** may comprise any electronic or mechanical device for communicating with the valve actuator **300** and causing the valve actuator **300** to either transfer the motion input to it, modify the motion input to it, or not transfer the motion, to the engine valves **200**. The controller **400** may include a microprocessor, linked to other engine component(s), to determine and select the appropriate operation of the valve actuator **300**. EGR may be achieved and optimized at a plurality of engine operating conditions (e.g., speeds, loads, etc.) by controlling the valve actuator **300** based upon information collected by the microprocessor from the engine component(s). The information collected may include, without limitation, engine speed, vehicle speed, oil temperature, manifold (or port) temperature, manifold (or port) pressure, cylinder temperature, cylinder pressure, particulate information, and/or crank angle.

[0030] A second embodiment of the present invention will now be described with reference to Fig. 3. The valve actuator **300** comprises master piston assembly **310** slidably disposed in a first bore **311** formed in a housing **302** such that it may slide back and forth in the bore while maintaining a hydraulic seal with the housing **302**. The valve actuator **300** further includes a slave piston assembly **320** disposed in a second bore **321** formed in the housing **302** such that it may slide back and forth in the bore while maintaining a hydraulic seal with the housing **302**. The slave piston assembly **320** is in fluid communication with the master piston assembly **310** through a hydraulic passage **304** formed in the housing **302**. A spring **322** biases the slave piston **320** upward in the bore **321**, away from the engine valve **200**. The spring **324** holds the slave piston **320** up against any low hydraulic pressure in the passage **304** that may be acting on the piston. This prevents the slave piston assembly **320** from "jacking," a condition which can cause damage to the system.

[0031] The valve actuator **300** may further comprise a fluid supply valve, such as, a solenoid valve **330** disposed in a low-pressure hydraulic passage **306** formed in the housing **302**. The first solenoid valve **330** may selectively supply hydraulic fluid from a fluid supply means (not shown) through the low-pressure passage **306** to the passage **304** in response to a signal received from the controller **400**. A first check valve **332** may be disposed in the low-pressure passage **306** so as to primarily allow only one-way fluid flow from the low-pressure passage **306** to the passage **304**. In alternative embodiments, the check valve **332** may comprise, for example, a control valve, or other type of valve adapted to primarily allow only one-way fluid flow from the low-pressure passage **306**.

[0032] The valve actuator may further comprise a solenoid valve **350** in communication with a control valve **355**. The control valve **355** may comprise, for example, a spool valve, a shuttle valve, or another valve capable of being operated between a plurality of positions. The solenoid valve **350** may operate the control valve **355** between a first position, as shown in Fig. 3, and a second position, in response to a signal received from the controller **400**.

[0033] The valve actuator **300** further comprises an accumulator **340** having a first open end **342** and a second open end **344**. A stroke–limiting accumulator spring **346** is disposed between the first open end **342** and the second open end **344**. The specifications of the spring **346**, for example, when it bottoms out, may be adjusted based on system requirements. In the embodiment of the present invention shown in Fig. 3, the first end **342** is in communication with an accumulator passage **308**, and the second end **344** is in communication with ambient pressure.

[0034] In the valve actuator **300** embodiment shown in Fig. 3, the motion imparting means **100** includes a rocker arm **120** having a central opening **122** for receiving a rocker shaft, and a contact surface **124** for contacting the master piston **310**. The rocker arm **120** may be operatively connected to the cam **110** such that the motion of the cam **110** is imparted through the rocker arm **120** to the master piston **310**.

[0035] In the valve actuator **300** embodiment shown in Fig. 3, the slave piston **320** may act on a rocker arm **220**, which in turn, acts on the one or more engine valves **200**. The rocker arm **220** includes a central opening **222** for receiving a rocker shaft, and a contact extension **224** for contacting the slave piston **320** and the valve **200**. In alternative embodiments of the present invention, it is contemplated that the slave piston **320** may act on a pin slidably disposed in the contact extension **224**, or on the engine valve **200** directly. In still another alternative embodiment, the slave piston may act on a plurality of engine valves **200**, through, for example, a valve bridge.

[0036] As discussed above, the cam and the rocker arm **120** may be a different "type" (e.g., intake versus exhaust), and from the same or different cylinder than the rocker arm **220** and the valve **200**. For example, in a multi-cylinder engine, the rocker arm **120** may comprise an intake rocker arm from a first cylinder, and the rocker arm **220** may comprise an exhaust rocker arm from the first cylinder. This arrangement may be useful in providing an appropriately timed valve event, such as, for example, an exhaust gas recirculation event during the main intake event.

[0037] In one embodiment of the present invention, the valve actuator **300** may further comprise a lash assembly **360** disposed above the slave piston **320**. The lash assembly **360** comprises an adjustable screw **364** extending into the slave piston bore **321**, and a locking nut **362**. The locking nut **362** may be adjusted to extend the screw **364** a desired distance within the bore **321** to adjust any lash that may exist between the slave piston **320** and the rocker arm **220**.

[0038] Operation of the valve actuator **300** shown in Fig. 3 will now be described. For illustrative purposes, operation of the valve actuator **300** will be described in connection with producing an EGR engine valve event. As discussed above, the valve actuator **300** may be operated as described to provide other engine valve events.

[0039] When EGR is not required, the solenoid valve **330** is not activated. As a result, no hydraulic fluid is supplied to the passage **304**. Because there is insufficient hydraulic pressure in the passage **304**, the motion of the master piston **310** is not transferred to the slave piston **320**. Correspondingly, the slave piston **320** does not act on the engine valve **200** and no engine valve event is produced. The resulting valve lift diagram is shown in Fig. 6a, wherein only the main exhaust event **212** occurs.

[0040] When an EGR event is desired, the solenoid valve **330** may operate in response to a signal from the controller **400** to provide low-pressure hydraulic fluid to the passage **304**. As motion is imparted to the master piston **310**, the master piston **310** moves upward within the bore **311**. The master piston motion is transferred through the hydraulic pressure in the passage **304** to the slave piston **320**. This causes the slave piston **320** to translate in a downward direction, resulting in actuation of the engine valve **200**. When the control valve **355** is in its first position, as shown in Fig. 3, the hydraulic fluid pressure in the passage **304** is prevented from communicating through the passage **308** to the accumulator **340**. Accordingly, all of the motion imparted to the master piston

310 is transferred to the slave piston 320, and a full-lift EGR valve event 216 is produced, as shown, for example, in Fig. 6b.

[0041] When a lower lift engine valve event is desired, the motion imparted to the master piston 310 may be modified. In response to a signal from the controller 400, the solenoid 350 may operate the control valve 355 into its second position. In this position, hydraulic fluid pressure in the passage 304 may now communicate through the passage 308 to the first open end 342 of the accumulator 340. The hydraulic pressure in the passage 304 is sufficient to overcome the bias of the accumulator spring 346. Accordingly, as motion is imparted to the master piston 310, the hydraulic pressure in the passage 304 is absorbed by the accumulator spring 346 rather than transferred to the slave piston 320. The accumulator 340 absorbs the motion until the spring 346 reaches a mechanical stop within the accumulator. At this point, the remaining motion imparted to the master piston 310 is transferred to the slave piston 320, and the valve 200. The result is a modified lift EGR valve event 216, as shown, for example, in Fig. 6c.

[0042] In one embodiment of the present invention, as shown in Fig. 3, a second check valve 334 may be disposed in the low-pressure passage 306. When the solenoid valve 330 is activated to provide low-pressure fluid to the passage 304, hydraulic fluid may also flow through the check valve 334 to the first end of the accumulator 342. When the control valve 355 is in its second position and high pressure fluid is provided through the passage 308, the presence of the low-pressure oil may facilitate transfer of the high pressure fluid to the accumulator 340. This may result in improved response time for the system 10.

Because the low-pressure fluid itself is insufficient to overcome the bias of the accumulator spring **346**, the stroke of the accumulator **340** is not affected when modified motion is not required. The check valve **334** may allow primarily one-way fluid flow such that the high-pressure fluid provided through the passage **308** does not flow into the low-pressure passage **306**.

[0043] Another embodiment of the valve actuator **300** is shown with reference to Fig. 4, in which like reference characters refer to like elements. The first end **342** of the accumulator **340** is in constant communication with the passage **304** through the passage **308**. The control valve **355** may be operated between a first position, as shown in Fig. 4, in which the second end **344** of the accumulator **340** communicates with ambient through an opening **356** in the control valve **355**; and a second position, in which the second end **344** of the accumulator **340** communicates with the passage **304**. When the control valve **355** is in its first position, the high pressure hydraulic fluid in the passage **304** may communicate through the passage **308** to the first open end **342** of the accumulator **340**. Because the pressure at the second end **344** of the accumulator **340** is ambient, the high pressure from the passage **308** is sufficient to overcome the bias of the accumulator spring. Accordingly, as motion is imparted to the master piston **310**, the hydraulic pressure in the passage **304** is absorbed by the accumulator **340** rather than transferred to the slave piston **320**. The result is a modified lift EGR valve event **216**, as shown, for example, in Fig. 6c.

[0044] When the control valve **355** is in its second position, the high pressure hydraulic fluid in the passage **304** may communicate through the passage **308** to the first open end **342** of the accumulator **340**, and to the second open end **344** of the accumulator **340**. The pressure at the second end **344** of the accumulator **340** is now substantially equal to the high pressure at the first end **342**. Because of the lack of pressure differential, the accumulator spring **346** does not actuate. Accordingly, as motion is imparted to the master piston **310**, the hydraulic pressure in the passage **304** is not absorbed by the accumulator **340**, and the complete motion is transferred to the slave piston **320**. The result is a full-lift EGR valve event **216**, as shown, for example, in Fig. 6b.

[0045] Another embodiment of the valve actuator **300** is shown with reference to Fig. 5, in which like reference characters refer to like elements. The solenoid valve **350** may comprise a high speed fluid supply valve in communication with the fluid supply means. When a full-lift event is required, the solenoid valve **350** may be activated to supply high pressure fluid through the control valve **355** to the second end **344** of the accumulator **340**. Because high-pressure is acting on both the first end and the second end of the accumulator **340**, the accumulator spring **346** does not actuate and no motion is absorbed. When a modified valve lift is required, the solenoid valve **350** is not activated. The high pressure acting solely on the first end **342** of the accumulator **340** is now sufficient to overcome the bias of the accumulator spring **346**, and the accumulator **340** absorbs a portion of the imparted motion.

[0046] It will be apparent to those skilled in the art that variations and modifications of the present invention can be made without departing from the scope or spirit of the invention. Thus, it is intended that the present invention cover all such modifications and variations of the invention, provided they come within the scope of the appended claims and their equivalents.

WHAT IS CLAIMED IS:

1. A system of actuating one or more engine valves in an internal combustion engine to produce an engine valve event, said system comprising:

a housing;

an accumulator disposed in said housing having a first open end and a second open end;

a master piston slidably disposed in a first bore formed in said housing;

means for imparting motion to the master piston; and

a slave piston slidably disposed in a second bore formed in said housing, said slave piston in fluid communication with said master piston through a high pressure hydraulic passage,

wherein the first open end and the second open end of said accumulator are in selective communication with the high pressure hydraulic passage to modify the imparted motion.

2. The system of Claim 1, wherein the engine valve event comprises an exhaust gas recirculation.

3. The system of Claim 1, wherein the first open end of said accumulator is in communication with the high pressure hydraulic passage and the second open end is in communication with ambient pressure.

4. The system of Claim 3, wherein the imparted motion is modified to produce a low lift engine valve event.

5. The system of Claim 1, wherein the first open end and the second open end of said accumulator are in communication with the high pressure hydraulic passage.

6. The system of Claim 5, wherein the imparted motion is not modified.

7. The system of Claim 1, wherein said accumulator further comprises a stroke limiting piston disposed between the first open end and the second open end.

8. The system of Claim 1, further comprising:

a shuttle valve; and

a first solenoid valve for controlling said shuttle valve to selectively communicate the first open end and the second open end of said accumulator with said high pressure hydraulic passage.

9. The system of Claim 1, further comprising:

fluid supply means;

a low pressure hydraulic passage; and

a second solenoid valve for selectively supplying fluid from the fluid supply means to said high pressure hydraulic passage through said low pressure hydraulic passage.

10. A system of actuating one or more engine valves in an internal combustion engine to produce an exhaust gas recirculation engine valve event, said system comprising:

a housing;

an accumulator disposed in said housing having a first open end and a second open end;

a high pressure fluid passage;

a master piston slidably disposed in a first bore formed in said housing;

means for imparting motion to said master piston;

a slave piston slidably disposed in a second bore formed in said housing, said slave piston in fluid communication with said master piston through said high pressure hydraulic passage;

a shuttle valve; and

a first solenoid valve for controlling said shuttle valve to selectively communicate the first open end and the second open end of said accumulator with said high pressure hydraulic passage,

wherein the first open end and the second open end of said accumulator are in selective communication with said high pressure hydraulic passage to selectively modify the imparted motion.

11. The system of Claim 10, further comprising:

a first rocker arm disposed between the one or more engine valves and said master piston; and

a second rocker arm disposed between said motion imparting means and said slave piston,

12. The system of Claim 10, wherein the first open end of said accumulator is in communication with said high pressure hydraulic passage and the second open end is in communication with ambient pressure.

13. The system of Claim 12, wherein the imparted motion is modified to produce a low lift engine valve event.

14. The system of Claim 10, wherein the first open end and the second open end of said accumulator are in communication with said high pressure hydraulic passage.

15. The system of Claim 14, wherein the imparted motion is not modified.

16. The system of Claim 10, wherein said accumulator further comprises a stroke limiting piston disposed between the first open end and the second open end.

17. The system of Claim 10, further comprising:

fluid supply means;

a low pressure hydraulic passage; and

a second solenoid valve for selectively supplying fluid from the fluid supply means to said high pressure hydraulic passage through said low pressure hydraulic passage.

18. The system of Claim 17, further comprising a check valve disposed in said low pressure hydraulic passage

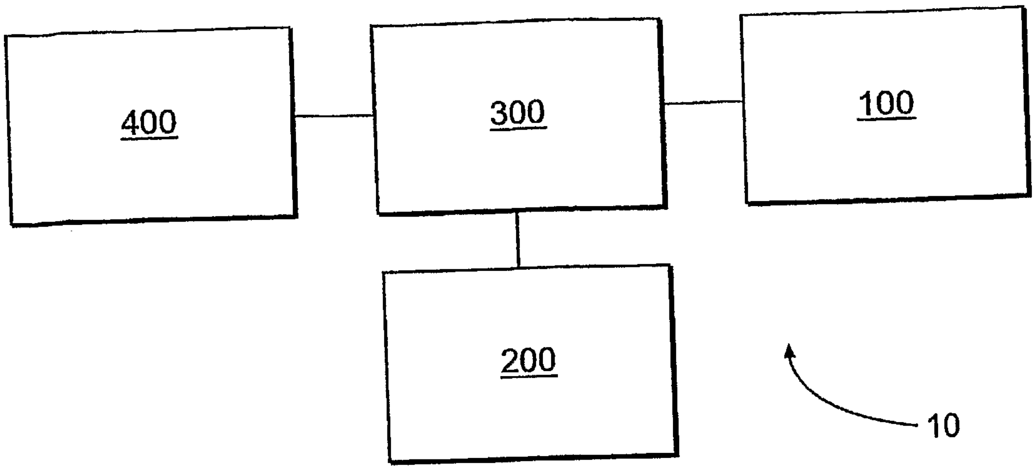


FIG. 1

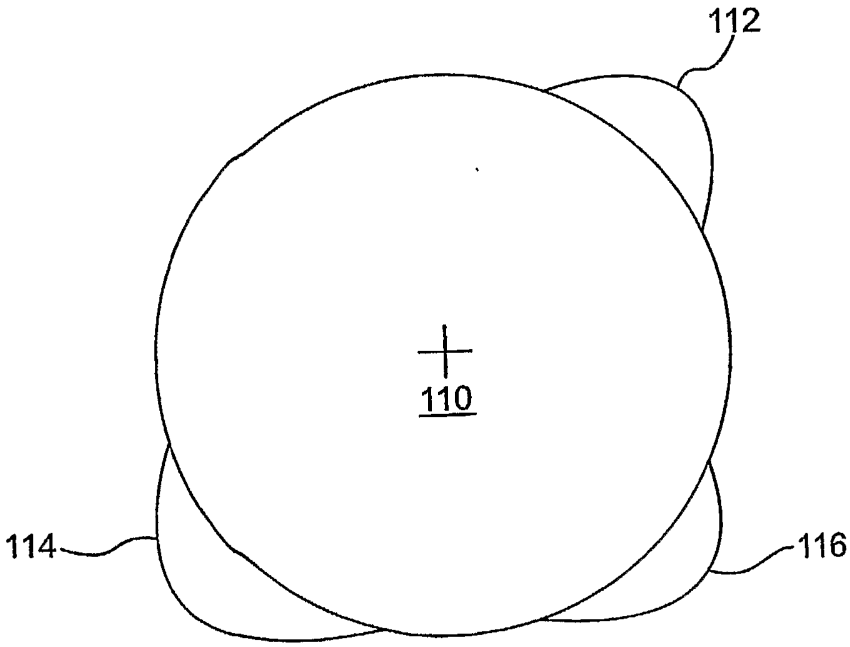


FIG. 2

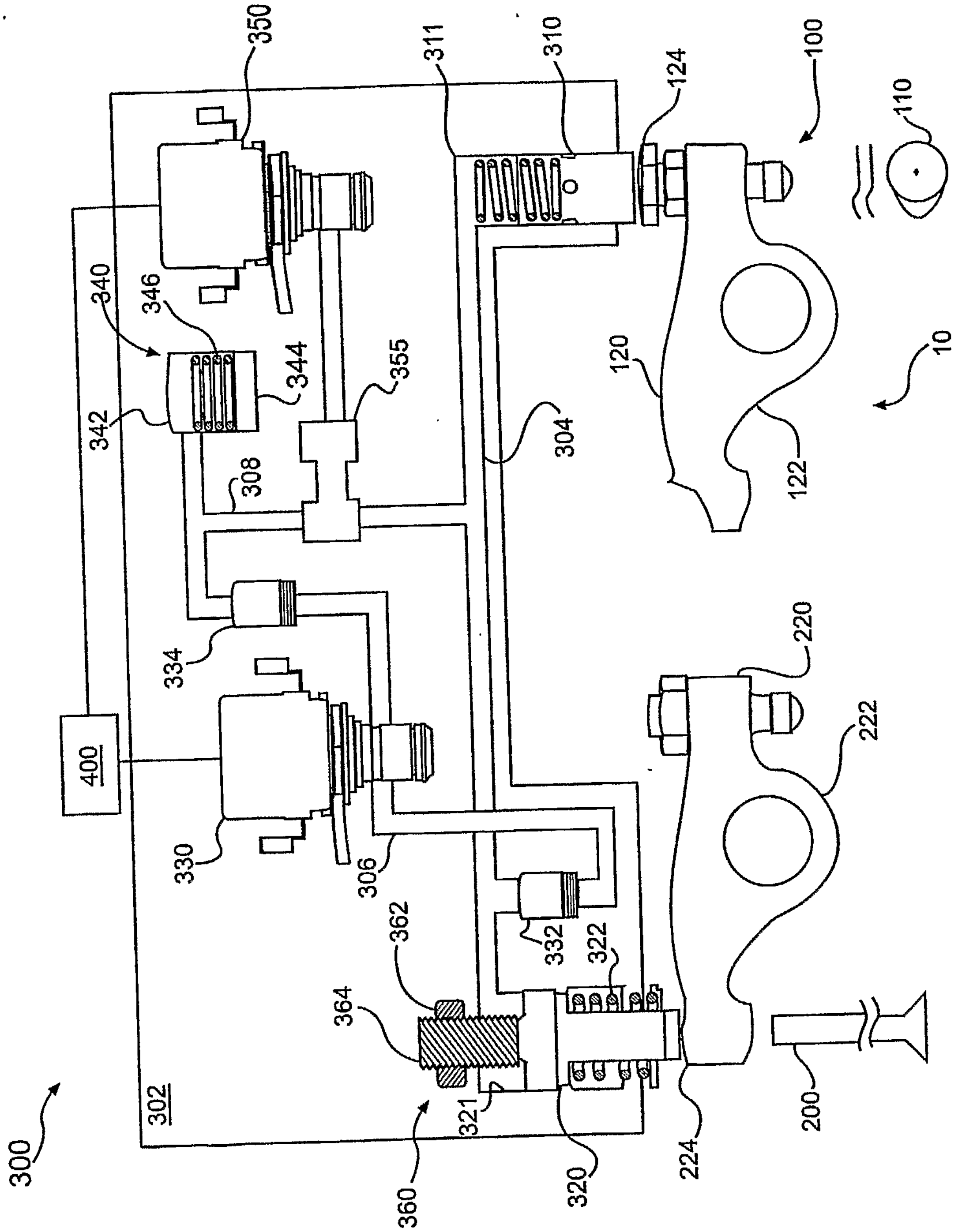
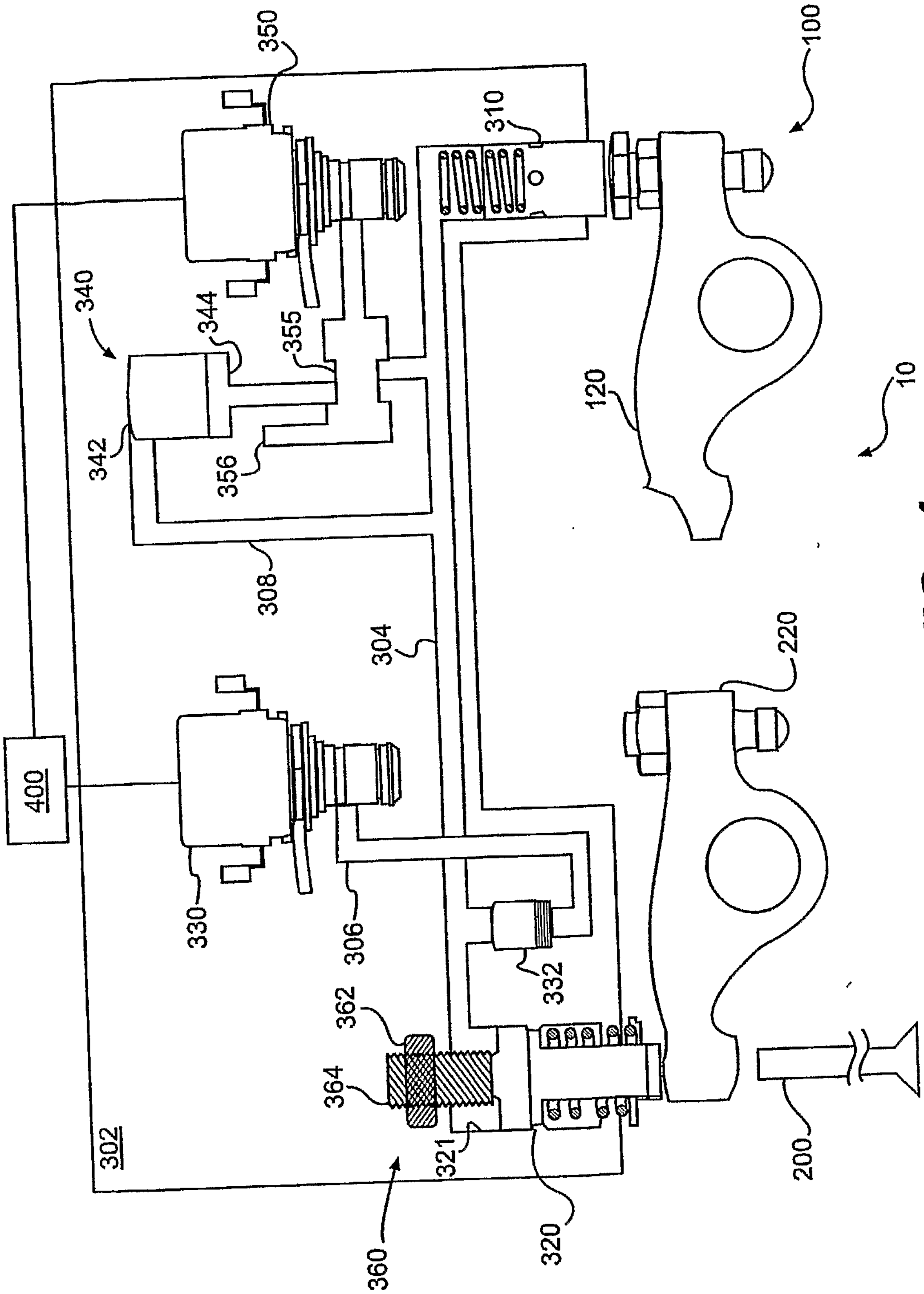


FIG. 3

SUBSTITUTE SHEET (RULE 26)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340
344
355
10
120
342
356
308
304
220
400
330
306
332
362
364
302
321
200
360
320

FIG. 4

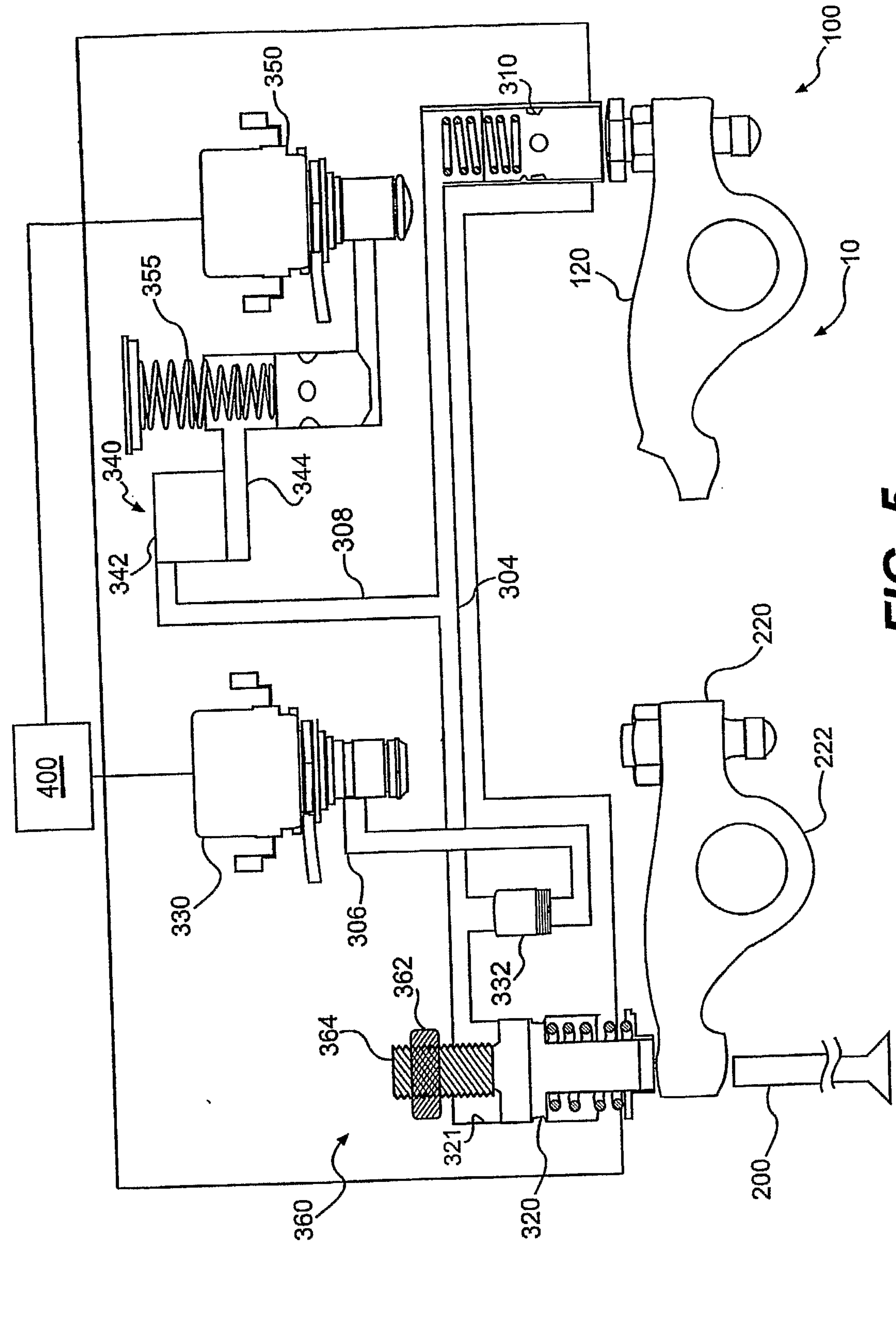
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FIG. 5

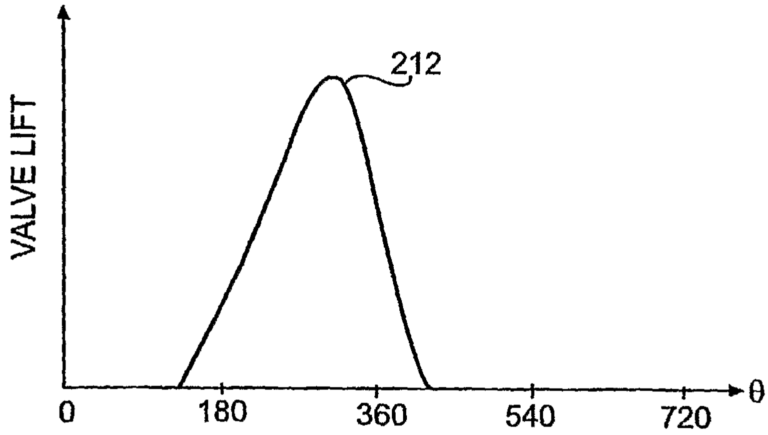

FIG. 6a

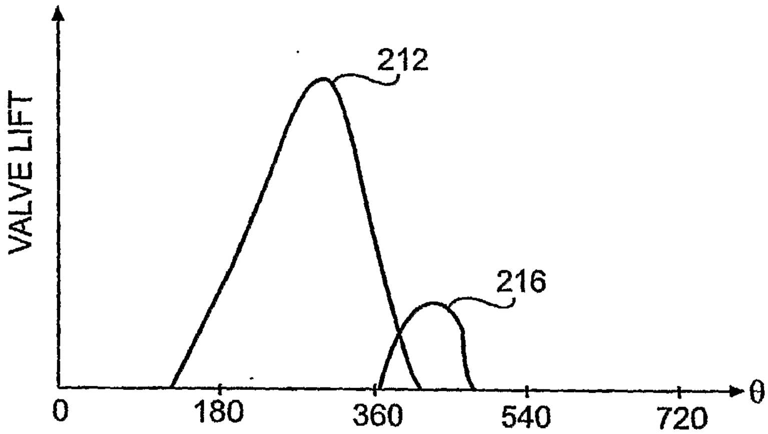

FIG. 6b

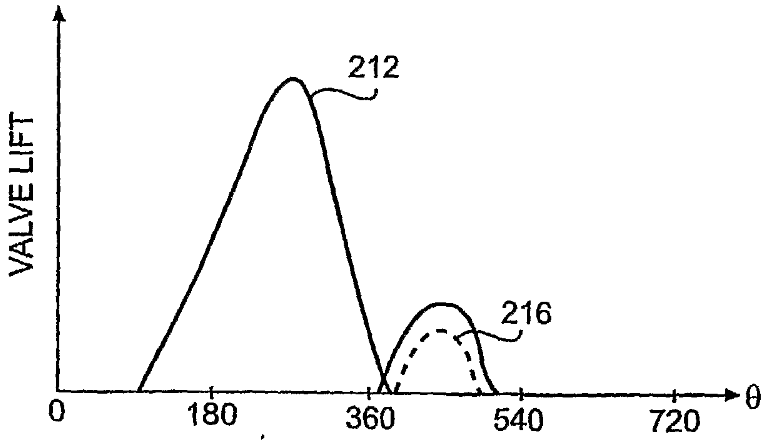

FIG. 6c