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(54) **A VALVE TRAIN FOR OPERATING A CYLINDER VALVE ASSEMBLY FOR AN INTERNAL
COMBUSTION ENGINE**

EIN VENTILTRIEB FÜR DEN BETRIEB EINER ZYLINDERVENTILBAUGRUPPE EINER
BRENNKRAFTMASCHINE

UN TRAIN DE SOUPAPES POUR ACTIONNER UN ENSEMBLE DE VALVE DE CYLINDRE POUR
UN MOTEUR À COMBUSTION INTERNE

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Description

Field of the invention

[0001] The present invention relates to a valve train employing disablement of main Valve events, in particular in the field of large displacement internal combustion engines for trucks and work vehicles.

Description of the prior art

[0002] Cylinder deactivation (CDA) is an efficient measure to realize thermal management and improve fuel consumption at low loads. CDA is realized by deactivating the valve lifts and the fueling of some or all cylinders.

[0003] This is usually done by interrupting the connection of cam and valve. Very common are hydraulic lash adjusting (HLA) elements which can collapse or elements within the valve train which can open the connection (e.g. at the valve bridge). All these systems can lead to very high valve seating velocity, if the connection from cam to valve is interrupted during a period of large valve lift.

[0004] Efficient engine braking systems (e.g. 2-stroke) require also the deactivation of the valve lift profiles implemented for fired operation. The deactivation of the valve lift profiles is usually not crank angle synchronized per cylinder, which means the valve can close from any position. This can lead to extreme seating velocities and engine durability problems.

[0005] US2014251266 discloses a deactivation mechanism disposed within a main valve train capable to disable conveyance of main valve events from a main valve motion source to a valve via the main valve train.

[0006] Here, a rocker arm is arranged to swing over a rocker shaft. This shaft is provided with an oil passage to supply a rocker arm duct in any rocker arm positions. The rocker arm duct supplies a lost motion assembly arranged on the bridge of two valves.

[0007] The lost motion assembly includes an outer plunger arranged in a valves bridge casing and arranged to be pushed downwards by the rocker arm and an inner plunger, arranged in a cavity of the outer plunger.

[0008] The outer plunger has a side opening extending through the outer plunger wall for receiving a wedge roller or ball. The inner plunger includes one or more recesses shaped to securely receive the one or more wedge rollers or ball when the inner plunger is pushed downward against an inner plunger spring interposed between the bottom of its axial, cavity of the outer plunger and the inner plunger. The central casing of the valves bridge also includes one or more recesses for receiving the one or more wedge rollers or balls in a manner that permits the rollers or balls to lock the outer plunger and the valves bridge together, as shown in figure 1. The outer plunger spring may bias the outer plunger upward in the central casing of the valve bridge. The inner plunger spring may bias the inner plunger upward in the outer plunger cavity.

[0009] When hydraulic oil is pressurized through the rocker arm, the inner plunger is pushed downwards, therefore, its recess permits the one or more wedge rollers or balls to decouple or unlock the outer plunger from the valves bridge body. As a result, during this "unlocked" state, valve actuation motion applied to the lost motion assembly is not transmitted to the valves bridge body, thus the latter does not move downward to actuate the valves. This downward motion causes the outer plunger to slide downward within the central casing of the valves bridge body against the bias of the outer plunger spring, whose bias force is less relevant than the valve springs one.

[0010] The hydraulic oil can be pressurized while the hump of the cam is forcing the rocker arm to push the lost motion assembly with the result that valves are immediately closed, impacting against their seats.

[0011] A solution to avoid this problem is to synchronize the pressurization of the oil in such a way to disconnect the outer plunger from valves bridge only when the rocker arm is in released condition, namely when it is contacting the base circumference of the cam.

[0012] This synchronization should be carried independently for each of the deactivated/braked cylinders. At high rotation speed, it is difficult to obtain a satisfactory synchronization. In addition, the hydraulic circuit should be complicated due to the implementation of a fast solenoid valve for each cylinder.

[0013] Therefore, the problem of a fast biasing of the valves in their sites is currently present at least with the scheme disclosed in US2014251266.

[0014] A valve train according to claim 1 without a tapered pin affixed to penetrate a passing through opening can also be found in US9790824B2.

Summary of the invention

[0015] The main object of the present invention is to provide an auxiliary valve motions employing disablement of main valve events, which overcomes the above problems/drawbacks.

[0016] The teaching of the present invention is to design a system with an intrinsic mechanical fail-safe cylinder deactivation system, which does not depend on any kind of synchronization.

[0017] The basic idea of the present invention is based on a metered oil relief valve defined between the outer plunger and its casing in the valve bridge.

[0018] In other words, the clearance between the base of the outer plunger and the casing is filled of oil and in case of sudden activation of the lost motion assembly, the oil relief dumps the relative motion between the two set of components.

[0019] In other words, the valve train comprises a valve bridge including a casing wherein a lost motion assembly is slidably inserted, wherein the lost motion assembly includes an outer plunger having a longitudinal development arranged to receive a main rocker arm action and to

transmit such action to the valve bridge through a locking element, wherein, said outer plunger includes an axial cavity where an inner plunger is suitable to slide in response of oil pressurization; the lost motion assembly being configured to define a clearance between a bottom portion of the casing and a bottom portion of the outer plunger configured to receive pressurized oil and wherein said casing is provided of a passing through opening to discharge said pressurized oil in such a way to dump a sudden restriction of the clearance caused by lost motion activation.

[0020] The outer plunger is provided of a tapered pin arranged to penetrate the opening by metering the oil discharge.

[0021] When the outer plunger is suddenly disconnected from the valves bridge while the rocker arm is pushing the swivel foot, the pin and the opening are arranged so that

- In a first stage of approaching of the outer plunger to the bottom portion of the casing, the oil outflow is progressively throttled,
- In a second stage of approaching of the outer plunger to the bottom portion of the casing, an oil cushion is trapped between the casing and the outer plunger, which dumps the valves closing towards the respective seats.

[0022] As in prior art, the rocker arm is provided of an oil passage to supply with oil the lost motion assembly through a swivel foot.

[0023] The oil is continuously supplied, however, during cylinder deactivation, the oil pressure is increased such that to force the lost motion assembly to disconnect the outer plunger from the valve bridge.

[0024] Between the swivel foot and the inner plunger a chamber is defined to permit the exertion of the lowering force during pressurization. From the chamber, an oil passage is defined within the body of the outer plunger to continuously refill the clearance between outer plunger and valves bridge casing.

[0025] These and further objects are achieved by means of the attached claims, which describe preferred embodiments of the invention, forming an integral part of the present description.

Brief description of the drawings

[0026] The invention will become fully clear from the following detailed description, given by way of a mere exemplifying and non limiting example, to be read with reference to the attached drawing figures, wherein:

- Fig. 1 shows the lost motion system disclosed in US2014251266;
- Fig. 2 discloses the modification of such assembly in order to render such solution one of the possible embodiments of the present invention.

[0027] The same reference numerals and letters in the figures designate the same or functionally equivalent parts. According to the present invention, the term "second element" does not imply the presence of a "first element", first, second, etc.. are used only for improving the clarity of the description and they should not be interpreted in a limiting way.

Detailed description of the preferred embodiments

[0028] Figure 2 discloses a preferred embodiment of the invention.

[0029] In particular such figure discloses

- a valves bridge VB connected to a pair of valve stems VS (only partially disclosed),
- the lost motion assembly LMA arranged in a casing CS of the valve bridge.

[0030] The device can be completed with a rocker arm suitable to swing over its rocker shaft and provided of a finger disposed to push downwards the bridge through the lost motion assembly as disclosed in figure 1 of the prior art. Thus, a camshaft is provided with at least a hump to define a valve lift event forcing the rocker arm to swing pushing the lost motion assembly such to force the valves opening. As usual, the rocker arm can be provided of a roller arranged at the opposite end of the finger, but it could be disposed at the same side of the finger with respect the fulcrum defined by the rocker shaft with camshaft shaped complementary with respect to the one disclosed in figure 1.

[0031] According to the solution disclosed in US2014251266, the lost motion assembly LMA includes an outer plunger OP and an inner plunger IP arranged inside a cavity CS of the outer plunger, such that the inner plunger can slide in the cavity according to the X axis, as a cylinder/piston coupling.

[0032] According to the same X axis, the rocker arm exerts its action, pushing downwards the swivel foot SFO arranged on the top of the outer plunger OP.

[0033] In other words, the inner plunger is encapsulated in the outer plunger and the swivel foot, which closes the outer plunger cavity as a cap.

[0034] The rocker shaft is provided of a duct to convey hydraulic oil to the lost motion assembly, through the swivel foot SFO of the lost motion assembly. The swivel foot itself is preferably configured as a ball joint with its duct FD arranged to interconnect the rocker arm duct with a chamber CH defined within the outer plunger and in particular between the swivel foot and the top portion of the inner plunger IP.

[0035] In view of the hydraulic communication between the rocker shaft and the swivel foot, a pressurization commanded by a (fast) solenoid valve causes the lowering of the inner plunger IP in the cavity of the outer plunger, such that its recess IPR faces the locking element LE, therefore, when the finger starts pushing the

swivel foot, the locking element, shaped as a ball or a wedge, interacts with its seat LES defined in the body of the valves bridge and slides in the recess LES unlocking the lost motion assembly from the valve bridge. Therefore, the finger pushing causes the compression of the outer plunger spring OPS. The latter is interposed between the outer plunger and the bottom portion BP of the casing OCS defined in the valve bridge. Therefore, in the valves bridge

- a casing OCS to accommodate the lost motion assembly LMA having a development axis coincident with the X axis and
- at least one seat LES extending transversally with respect to the X axis to cooperate with at least one locking member LE

are defined.

[0036] When the pressurization ends, the inner spring IPS pushes upwards the inner plunger and the recess IPR is shaped to force the locking element to return in the locking condition, namely partially within seat LES.

[0037] The inner spring IPS is interposed between the inner plunger and a bottom portion BP1 of the cavity CS of the outer plunger.

[0038] According to the present invention, the casing OCS of the valves bridge VB is provided with a bottom portion BP where a passing through opening MO is arranged to discharge oil in a reservoir ORS.

[0039] The clearance CC between the bottom portion BP of the casing OCS and the bottom portion BP1 of the outer plunger is continuously filled with oil due to an oil passage connecting such clearance with the chamber CH described above.

[0040] When the rocker arm acts on the swivel foot and the sudden pressurization of the chamber causes the lost motion assembly activation, a sudden restriction of the above clearance is avoided due to the metered oil discharge.

[0041] The avoidance of the sudden restriction of the clearance implies the avoidance of any valve impact against the relative seat.

[0042] According to the invention, the oil outflow is metered according to the size of the clearance. The more the clearance is restricted, the more is throttled the passing through opening MO.

[0043] This is obtained by means of a tapered pin MPN affixed on the bottom portion of the outer plunger to penetrate the passing through opening MO of the casing.

[0044] The pin has a first section, contiguous with the outer plunger surface, having a shape complimentary with the passing through opening MO. Preferably, both, the first section and the opening are cylindrical.

[0045] The pin has a second section, namely a tip, tapered, to carry out the metering of the oil flow during reduction of the clearance.

[0046] When the outer plunger is suddenly disconnected from the valves bridge while the rocker arm is

pushing the swivel foot, the pin and the opening are arranged so that

- In a first stage the pin approaches the passing through opening with the tapered tip and the oil outflow is progressively throttled,
- In a second stage of approaching the pin closes the passing through opening almost completely, so as an oil cushion is trapped between the casing and the outer plunger, which dumps the valves closing towards the respective seats.

[0047] In the example of figure 2, the outer plunger OP has a bottom portion tapered such that the spiral spring OPS is partially enslaved on the outer plunger. The filling channel FP is arranged in the outer plunger connecting the chamber CH with the external surface of the outer plunger in the bottom portion.

[0048] It should be noted that, a further oil passage RP is realized in the valve assembly to discharge oil eventually trapped between the inner plunger and the outer plunger. Such oil would oppose the depression of the inner plunger. Preferably, a first portion of the further oil passage RP is realized in the inner plunger connecting the lower portion of the cavity CV with the recess IPR. A second portion of the further oil passage is realized in the outer plunger according to a transversal direction with respect to the X axis, such that to connect the recess IPR with the seat LES of the locking element LE. Finally, another portion of the further oil passage RP is realized to reach the external surface of the valve bridge. It should be considered that further and different paths can be decided to relief oil trapped between the inner plunger and the bottom portion BP1 of the outer plunger.

[0049] It is clear from the drawings that such clearance between the inner plunger and the bottom portion BP1 of the outer plunger is partially occupied by the spiral spring IPS and is arranged opposite to the above chamber CH with respect to the inner plunger.

[0050] Many changes, modifications, variations and other uses and applications of the subject invention will become apparent to those skilled in the art after considering the specification and the accompanying drawings which disclose preferred embodiments thereof as described in the appended claims.

[0051] The features disclosed in the prior art background are introduced only in order to better understand the invention and not as a declaration about the existence of known prior art. In addition, said features define the context of the present invention, thus such features shall be considered in common with the detailed description.

[0052] Further implementation details will not be described, as the man skilled in the art is able to carry out the invention starting from the teaching of the above descript.

Claims

1. A valve train for operating a cylinder valve assembly for an internal combustion engine comprising:

- a main event motion source configured to provide main event valve motions to the valve assembly,
 - a main rocker arm, arranged to swivel on a corresponding rocker shaft and operatively connected to the main event motion source, in such a way to assume an active condition at main event and a released condition otherwise,
 - a valve bridge (VB) including a casing (CS) wherein is slidably inserted
 - a lost motion assembly (LMA), wherein the lost motion assembly includes an outer plunger (OP) having a longitudinal development (X) arranged to receive a main rocker arm action and to transmit such action to the valve bridge through a locking element (LE), wherein the locking element is arranged to assume
 - a locking condition with a first portion disposed in a corresponding seat (LES) of the valve assembly and a second portion disposed in a passing through opening of the outer plunger,
 - an unlocking condition where the locking element is completely outside the seat (LES) of the valve assembly,
 wherein, said outer plunger (OP) includes an axial cavity (CV) where an inner plunger (IP) is suitable to slide under in response of oil pressurization, wherein said oil pressurization transmitted by the rocker arm, and wherein said inner plunger includes a recess (IPR) suitable to accommodate said locking element during oil pressurization such that to define said unlocking condition; the lost motion assembly being configured to define a clearance (CC) between a bottom portion (BP) of the casing and a bottom portion (BP1) of the outer plunger (OP) configured to receive said pressurized oil and wherein said casing (CS) is provided of a passing through opening (MO) to discharge said pressurized oil in such a way to dump a sudden restriction of the clearance (CC);
 the train being **characterized in that** the bottom portion (BP1) of the pin (MPN) of the outer plunger (OP) is provided of a tapered pin (MPN) affixed to penetrate the passing through opening (MO) at least in a predetermined operating condition.

2. System according to claim 1, wherein the inner plunger is arranged to slide according to said longitudinal direction (X), transversal to a movement of the locking element between the locking and unlocking condition.

3. System according to claim 1 or 2, wherein a first spring (IPS) is arranged within the inner plunger cavity such that to return the inner plunger in a relaxed condition after oil pressurization ending.

4. System according to claim 3, wherein said recess (IPR) is shaped to force the locking element to assume said locking condition when said first spring return the inner plunger in said relaxed condition.

5. System according to anyone of the previous claims 1 - 4, wherein the pin (MPN) has a first section, contiguous with the outer plunger surface, having a shape complimentary with the passing through opening MO and a second section, namely a tip, tapered, to carry out a metering of the oil flow during a progressive reduction of the clearance (CC).

6. System according to any one of the previous claims, wherein the outer plunger is provided of a swivel foot (SFO) arranged to be contacted by the rocker arm and wherein a first oil passage (FD) is defined in the swivel foot to receive said pressurized oil.

7. System according to any one of the previous claims wherein the outer plunger is provided of a second oil passage (FP) arranged to communicate said first oil passage (DF) with said clearance (CC).

8. System according to any one of the previous claims, further comprising a second spring (OPS) arranged in the clearance to force the outer plunger to assume a predetermined position with respect to the casing (CS) after ending of a main event motion.

9. Internal combustion engine including a cylinder, a piston and a head associated to the cylinder and at least a valve assembly to selectively open and close the head and a system for operating the valve assembly according to any one of claims 1 - 7.

Patentansprüche

1. Ventiltrieb zum Betreiben einer Zylinderventilanordnung für einen Verbrennungsmotor, umfassend:

- eine Hauptereignis-Bewegungsquelle, die so konfiguriert ist, dass sie Hauptereignis-Ventilbewegungen an die Ventilanordnung liefert,
 - einen Hauptkipphebel, der so angeordnet ist, dass er auf einer entsprechenden Kipphebelwelle schwenkbar ist und operativ mit der Hauptereignis-Bewegungsquelle verbunden ist, so dass er beim Hauptereignis einen aktiven Zustand und andernfalls einen gelösten Zustand einnimmt,
 - eine Ventilbrücke (VB) mit einem Gehäuse

(CS), in das verschiebbar eingesetzt ist
 - eine Totganganordnung (LMA), wobei die Totganganordnung einen äußeren Kolben (OP) mit einem Längsverlauf (X) umfasst, die so angeordnet ist, dass sie eine Hauptkipphelwirkung aufnimmt und diese Wirkung über ein Verriegelungselement (LE) an die Ventilbrücke überträgt, wobei das Verriegelungselement so angeordnet ist, dass es
 - einen Verriegelungszustand mit einem ersten Teil einnimmt, der in einem entsprechenden Sitz (LES) der Ventilanordnung angeordnet ist, und einem zweiten Teil, der in einer Durchgangsöffnung des äußeren Kolbens angeordnet ist,
 - einen Entriegelungszustand einnimmt, in dem sich das Verriegelungselement vollständig außerhalb des Sitzes (LES) der Ventilanordnung befindet, wobei der äußere Kolben (OP) einen axialen Hohlraum (CV) umfasst, unter dem ein innerer Kolben (IP) als Reaktion auf Öldruck gleiten kann, wobei der Öldruck durch den Kipphebel übertragen wird, und wobei der innere Kolben eine Aussparung (IPR) umfasst, die geeignet ist, das Verriegelungselement während der Öldruckbeaufschlagung aufzunehmen, um den Entriegelungszustand zu definieren; wobei die Totganganordnung ist so konfiguriert, dass sie ein Zwischenraum (CC) zwischen einem Bodenabschnitt (BP) des Gehäuses und einem Bodenabschnitt (BP1) des äußeren Kolbens (OP) definiert, der so konfiguriert ist, dass er das unter Druck stehende Öl aufnimmt, und wobei das Gehäuse (CS) mit einer Durchgangsöffnung (MO) versehen ist, um das unter Druck stehende Öl so abzulassen, dass eine plötzliche Einschränkung des Zwischenraums (CC) aufgehoben wird;

wobei der Trieb **dadurch gekennzeichnet ist, dass** der untere Teil (BP1) des äußeren Kolbens (OP) mit einem konischen Zapfen (MPN) versehen ist, der so befestigt ist, dass er zumindest in einem vorbestimmten Betriebszustand durch die Durchgangsöffnung (MO) dringt.

2. System nach Anspruch 1, wobei der innere Kolben so angeordnet ist, dass er gemäß der Längsrichtung (X) quer zu einer Bewegung des Verriegelungselements zwischen dem Verriegelungs- und dem Entriegelungszustand gleitet.
3. System nach Anspruch 1 oder 2, wobei eine erste Feder (IPS) innerhalb der Aussparung des inneren Kolbens angeordnet ist, um den inneren Kolben nach Beendigung der Öldruckbeaufschlagung in einen entspannten Zustand zurückzubringen.
4. System nach Anspruch 3, wobei die Aussparung

(IPR) so geformt ist, dass das Verriegelungselement gezwungen wird, den Verriegelungszustand einzunehmen, wenn die erste Feder den inneren Kolben in den entspannten Zustand zurückbringt.

5. System nach einem der vorhergehenden Ansprüche, wobei der Zapfen (MPN) einen ersten Abschnitt aufweist, der an die Oberfläche des äußeren Kolbens angrenzt und eine Form aufweist, die komplementär zur Durchgangsöffnung MO ist, und einen zweiten Abschnitt, nämlich eine Spitze, die konisch ist, um eine Dosierung des Ölflusses während einer fortschreitenden Verringerung des Zwischenraums (CC) durchzuführen.
6. System nach einem der vorhergehenden Ansprüche, wobei der äußere Kolben mit einem Schwenkfuß (SFO) versehen ist, der so angeordnet ist, dass er mit dem Kipphebel in Kontakt kommt, und wobei ein erster Öldurchgang (FD) im Schwenkfuß definiert ist, um das unter Druck stehende Öl aufzunehmen.
7. System nach einem der vorhergehenden Ansprüche, wobei der äußere Kolben mit einem zweiten Öldurchgang (FP) versehen ist, der so angeordnet ist, dass er den ersten Öldurchgang (DF) mit dem Zwischenraum (CC) verbindet.
8. System nach einem der vorhergehenden Ansprüche, das außerdem eine zweite Feder (OPS) umfasst, die im Zwischenraum angeordnet ist, um den äußeren Kolben zu zwingen, nach Beendigung einer Hauptereigniswirkung eine vorbestimmte Position in Bezug auf das Gehäuse (CS) einzunehmen.
9. Verbrennungsmotor mit einem Zylinder, einem Kolben und einem mit dem Zylinder verbundenen Kopf und mindestens einer Ventilanordnung zum selektiven Öffnen und Schließen des Kopfs und einem System zum Betreiben der Ventilanordnung nach einem der Ansprüche 1 bis 7.

Revendications

1. Train de soupapes pour actionner un ensemble soupape de cylindre pour un moteur à combustion interne comprenant:
 - une source de mouvement d'événement principal configurée pour fournir des mouvements de soupape d'événement principal à l'ensemble soupape,
 - un culbuteur principal, agencé pour pivoter sur un arbre de culbuteur correspondant et relié de manière opérationnelle à la source de mouvement d'événement principal, de manière à ad-

- opter un état actif lors de l'événement principal et un état libéré dans le cas contraire,
- un pont de soupape (VB) comprenant un boîtier (CS) dans lequel est inséré de manière coulissante
 - un ensemble de mouvement perdu (LMA), dans lequel l'ensemble de mouvement perdu comprend un piston externe (OP) ayant un développement longitudinal (X) agencé pour recevoir une action de culbuteur principal et pour transmettre cette action au pont de soupape par l'intermédiaire d'un élément de verrouillage (LE), dans lequel l'élément de verrouillage est agencé pour adopter
 - un état de verrouillage avec une première partie disposée dans un siège correspondant (LES) de l'ensemble soupape et une deuxième partie disposée dans une ouverture traversante du piston externe,
 - un état de déverrouillage dans lequel l'élément de verrouillage est complètement à l'extérieur du siège (LES) de l'ensemble soupape, dans lequel ledit élément externe (OP) comprend une cavité axiale (CV) dans laquelle un piston interne (IP) est apte à coulisser en réponse à la pressurisation d'huile, dans laquelle ladite pressurisation d'huile est transmise par le culbuteur et dans laquelle ledit piston interne comprend une cavité (IPR) qui est apte à loger ledit élément de verrouillage pendant la pressurisation d'huile, pour définir ledit état de déverrouillage; le groupe de mouvement perdu étant configuré pour définir un évidement (CC) entre une partie de fond (BP) du boîtier et une partie de fond (BP1) du piston externe (OP), configuré pour recevoir ladite huile pressurisée et dans lequel ledit boîtier (CS) est pourvu d'une ouverture traversante (MO) pour décharger ladite huile pressurisée de sorte à abandonner une restriction soudaine de l'évidement (CC) ; le train étant **caractérisé en ce que** la partie de fond (BP1) du piston externe (OP) est pourvue d'une goupille conique (MPN) fixée pour pénétrer à travers l'ouverture traversante (MO) au moins dans un état de fonctionnement prédéterminé.
2. Système selon la revendication 1, dans lequel le piston interne est agencé pour coulisser selon ladite direction longitudinale (X), transversalement à un mouvement de l'élément de verrouillage entre l'état de verrouillage et l'état de déverrouillage.
 3. Système selon la revendication 1 ou 2, dans lequel un premier ressort (IPS) est disposé dans l'évidement du piston interne de manière à ramener le piston interne dans un état détendu après la fin de la pressurisation de l'huile.
 4. Système selon la revendication 3, dans lequel ledit évidement (IPR) est formé de manière à forcer l'élément de verrouillage à assumer ledit état de verrouillage lorsque ledit premier ressort ramène le piston interne dans ledit état détendu.
 5. Système selon l'une quelconque des revendications précédentes 1-4, dans lequel la goupille (MPN) présente une première partie, contiguë à la surface du piston externe, ayant une forme complémentaire de l'ouverture traversant MO et une deuxième partie, à savoir une pointe, conique, pour réaliser un dosage du débit d'huile lors d'une réduction progressive du jeu (CC).
 6. Système selon l'une quelconque des revendications précédentes, dans lequel le piston externe est pourvu d'un pied pivotant (SFO) agencé pour être mis en contact par le culbuteur et dans lequel un premier passage d'huile (FD) est défini dans le pied pivotant pour recevoir ladite huile pressurisée.
 7. Système selon l'une quelconque des revendications précédentes, dans lequel le piston externe est pourvu d'un deuxième passage d'huile (FP) agencé pour faire communiquer ledit premier passage d'huile (DF) avec ledit jeu (CC).
 8. Système selon l'une quelconque des revendications précédentes, comprenant en outre un deuxième ressort (OPS) agencé dans le jeu pour forcer le piston externe à prendre une position prédéterminée par rapport au boîtier (CS) après la fin d'un mouvement d'événement principal.
 9. Moteur à combustion interne comprenant un cylindre, un piston et une tête associée au cylindre et au moins un ensemble soupape pour ouvrir et fermer sélectivement la tête et un système pour actionner l'ensemble soupape selon l'une quelconque des revendications 1-7.

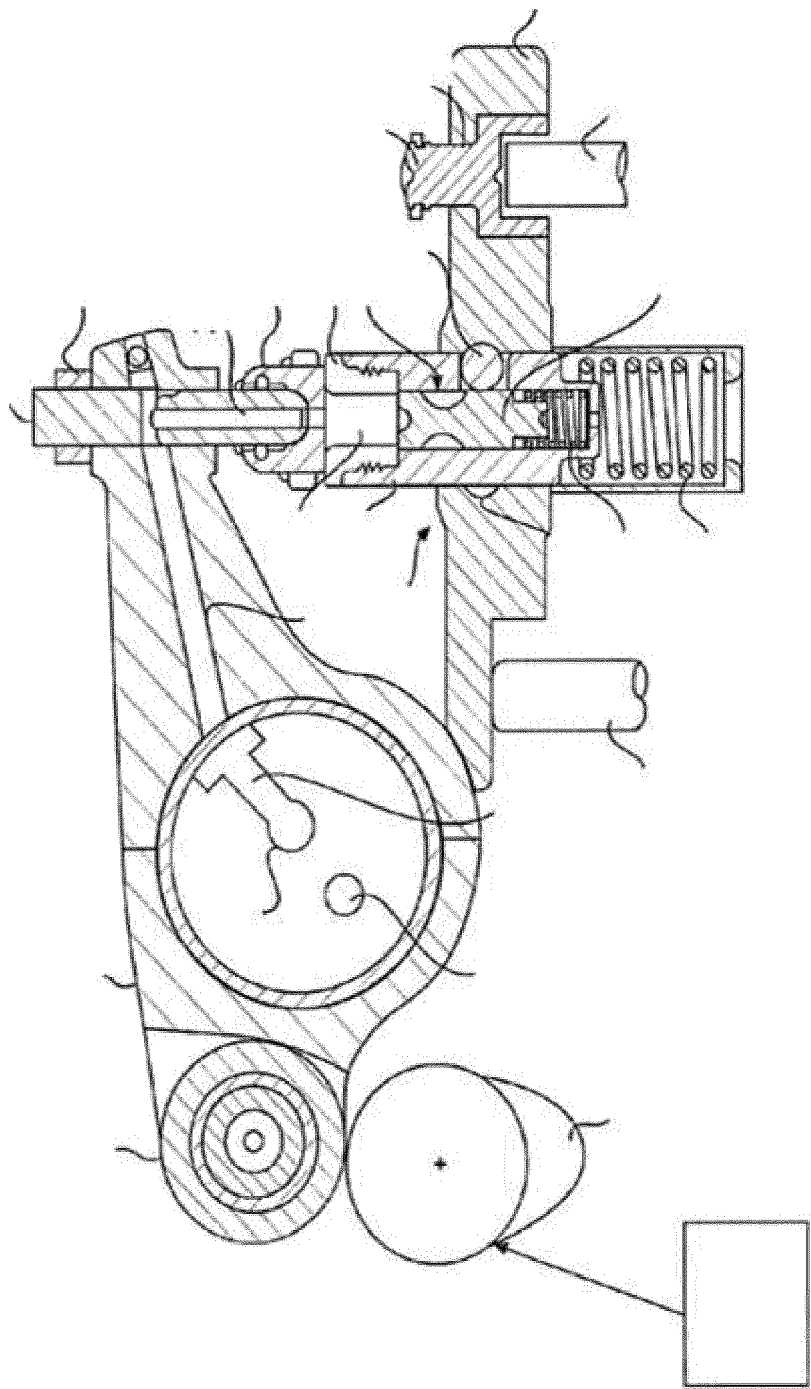


Fig. 1
(prior art)

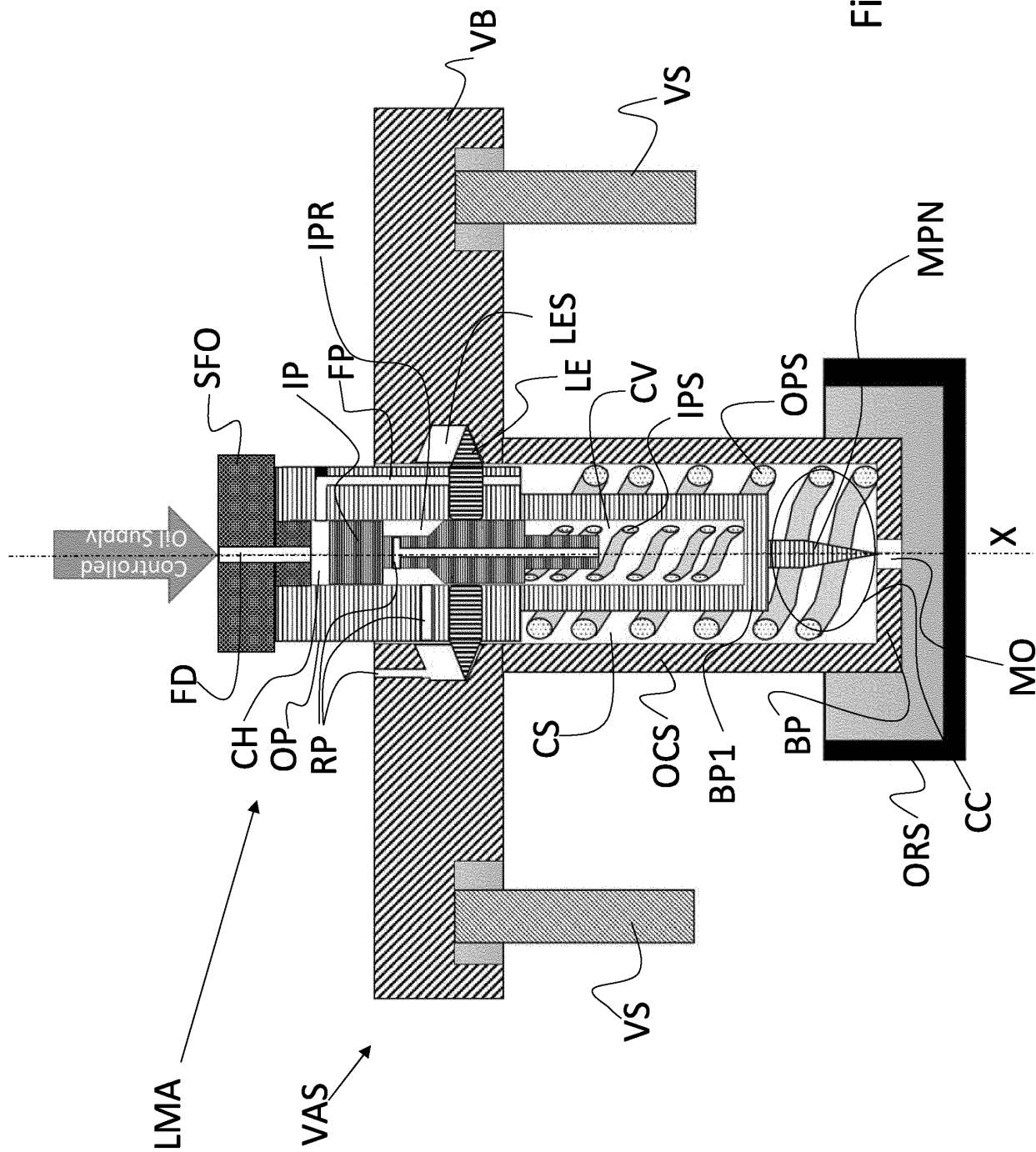


Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- US 9790824 B2 [0014]