(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 596 317 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
03.05.2023 Bulletin 2023/18

(21) Application number: **17711180.4**

(22) Date of filing: **17.03.2017**

(51) International Patent Classification (IPC):
F01L 1/08 *(2006.01)* ***F01L 9/12*** *(2021.01)*
F01L 1/24 *(2006.01)* ***F01L 1/245*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F01L 1/08; F01L 9/12; F01L 2001/2427; F01L 2001/256

(86) International application number:
PCT/EP2017/056340

(87) International publication number:
WO 2018/166612 (20.09.2018 Gazette 2018/38)

(54) **A CONTROL ARRANGEMENT FOR A GAS EXCHANGE VALVE IN AN INTERNAL COMBUSTION PISTON ENGINE AND METHOD OF OPERATING A CONTROL ARRANGEMENT FOR A GAS EXCHANGE VALVE IN AN INTERNAL COMBUSTION ENGINE**

STEUERANORDNUNG FÜR EIN GASWECHSELVENTIL IN EINER BRENNKRAFTMASCHINE UND VERFAHREN ZUM BETRIEB EINER STEUERANORDNUNG FÜR EIN GASWECHSELVENTIL IN EINER BRENNKRAFTMASCHINE

AGENCEMENT DE COMMANDE POUR UNE SOUPAPE D'ÉCHANGE DE GAZ DANS UN MOTEUR À PISTON À COMBUSTION INTERNE ET PROCÉDÉ DE FONCTIONNEMENT D'UN AGENCEMENT DE COMMANDE POUR UNE SOUPAPE D'ÉCHANGE DE GAZ DANS UN MOTEUR À COMBUSTION INTERNE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(43) Date of publication of application:
22.01.2020 Bulletin 2020/04

(73) Proprietor: **Wärtsilä Finland Oy**
65100 Vaasa (FI)

(72) Inventor: **HÄGGBLOM, Daniel**
FI-65380 Vaasa (FI)

(74) Representative: **Genip Oy**
Heikinkatu 7
48100 Kotka (FI)

(56) References cited:
EP-A1- 2 941 546
EP-B1- 2 941 546
FR-E- 15 118
US-A- 4 674 451
US-A1- 2006 081 213
US-B2- 7 484 483

EP 3 596 317 B1

Description

Technical field

[0001] The present invention relates to a control arrangement for a gas exchange valve adapted between a cam device and the gas exchange valve in an internal combustion piston engine according to the preamble of claim 1. Invention relates also to method of operating a control arrangement of a gas exchange valve in an internal combustion piston engine.

Background art

[0002] In an internal combustion engine the combustion of the fuel takes place in a confined space formed of a cylinder, a cylinder head and a piston of the engine, producing expanding gases that are used directly to provide mechanical power. During one cycle of the engine the gases in the confined space are changed to provide a fresh combustible charge in and remove exhaust gases from the cylinder. For that purpose the engine is provided with one or more gas exchange valves. The operation of the gas exchange valve is synchronized with the position of the piston in the cylinder. The gas exchange valve is connected to a valve lifting mechanism which moves the valve synchronous with the piston. The valve lifting mechanism may be mechanical, hydraulic, electronic or a combination therefor. Cam shafts are commonly used for providing the actuation of the lifting mechanism. Cam shaft is provided with a cam surface with a cam profile which define and cause the operation of the valve lifting mechanism. The cam profile may also be used for providing additional functionalities, examples of which can be found in the following documents.

[0003] WO2010012864 A1 discloses a control arrangement for gas exchange in a piston engine adapted between a cam device of a camshaft of the engine and an inlet valve mechanism arranged to open and close the inlet valve in association with a cylinder of the engine. The control arrangement comprises a body part in which a piston device is movably arranged to be in force transmission connection with the camshaft and the valve mechanism. The cam device includes a cam profile having a portion arranged under a base circle of the cam profile which portion of the cam profile is arranged to control gas exchange through the inlet valve for providing a delay in the closing of the inlet valve.

[0004] WO2012156573 A1 discloses at least one cam-operated valve lifting device for each cylinder of an engine, the valve lifting device being arranged to open a gas exchange valve. The engine further comprises an arrangement for injecting additional oxygen containing gas into the cylinders of the engine, the arrangement comprising a pressure medium source for supplying the additional oxygen containing gas, an injection valve in connection with each cylinder, means for connecting the pressure medium source to the injection valves, and a control valve for each cylinder of the engine for controlling the operation of the injection valve. Each control valve is arranged to be operated by a gas exchange cam of the respective cylinder.

[0005] WO2012156584 A1 discloses a multi-cylinder piston engine comprising at least one cam-operated valve lifting device for each cylinder of the engine, the valve lifting device being arranged to open a gas exchange valve, and a starting arrangement comprising a pressure medium source, at least one starting valve for introducing pressure medium into a cylinder of the engine, means for connecting the pressure medium source to the starting valves, and a control valve for each cylinder that is provided with a starting valve for controlling the operation of the starting valve. Each control valve is arranged to be operated by a gas exchange cam of the respective cylinder.

[0006] The gas exchange is controlled by means of opening and closing timings of the valve, and the lift of the valve which should accurately controllable. The operation of the engine is very sensitive to the operation of the gas exchange performance. Thus, any clearance or lash in the force transmission chain of the valve lifting mechanism should be minimised. There are a number of solutions relating hydraulic lash adjustment or valve lifting arrangement, a few of which are referred to in the following.

[0007] Document JPH08284620 A discloses a hydraulic type lash adjuster interposed in the valve system of an internal combustion engine. It is provided with a check valve allowing oil flow from a reservoir chamber to a pressure chamber, when a pressure difference over a fixed value is generated between the pressure chamber and the reservoir chamber. A non-return valve is opening when the pressure in the pressure chamber is over a fixed value.

[0008] Document EP0375742 B1 discloses a hydraulic engine valve lifter including a pair of pistons defining a pressure chamber there between and a separate lash adjusting piston which defines a lash adjustment chamber with one of the pistons in the pair. One-way valve structures permit fluid to flow from the pressure chamber into the lash adjustment chamber thereby displacing the lash adjusting piston to, in turn, adjust valve lash.

[0009] US 4674451 A discloses a control arrangement for a gas exchange valve adapted between a cam device and the gas exchange valve in an internal combustion piston engine. The arrangement comprises a cam profile in the cam device having a base circle and a portion arranged radially radially outside the base circle, a cam follower unit adapted to reciprocate under control of the cam profile, a first piston unit in force transmission connection via a hydraulic chamber with the cam follower unit, and configured to transmit valve lifting force from the cam device to the gas exchange valve for lifting the gas exchange valve, a hydraulic control space arranged between the first piston unit and the cam follower unit, a mechanical limiter configured to prevent movement of

the first piston unit in a direction closing the valve at a predetermined location of the first piston unit, and a hydraulic fluid flow path opening into the hydraulic control space and connectable to a hydraulic fluid supply, adapted to fill the hydraulic control space with the hydraulic fluid.

[0010] Even though there are solutions aiming to improve the operation of the gas exchange valve the problem still exist with the internal combustion engines to achieve more accurate valve timing.

[0011] An object of the invention is to provide a control arrangement by means of which the clearance in a force transmission system for actuating a gas exchange valve may be minimized.

Disclosure of the Invention

[0012] Objects of the invention can be met substantially as is disclosed in the independent claims and in the other claims describing more details of different embodiments of the invention.

[0013] A control arrangement for a gas exchange valve according to claim 1 is provided.

[0014] With this arrangement it is possible to adjust the valve force transmission system to practically zero clearance on every cycle of the cam surface i.e. before each valve lift.

[0015] The cam device is advantageously a cam shaft which comprises a cylindrical rod or a shaft running the length of the cylinder bank(s) with a number of oblong lobes protruding from it, one for each gas exchange valve or a pair of valves, if so desired. The cam lobes force the valves open by pressing on the valve, or on the force transmission system, as they rotate.

[0016] According to an embodiment of the invention the hydraulic fluid flow path is provided with a non-return valve allowing flow in a direction towards the hydraulic control space and retaining the hydraulic fluid in the hydraulic control space.

[0017] According to an embodiment of the invention the hydraulic fluid flow path is arranged to be closed or opened based on the location of the cam follower unit in respect to the body of the arrangement. Advantageously the respective openings of the hydraulic fluid flow path in the cam follower unit and in the body are coinciding when the cam follower unit rests on the portion of the cam profile radially inside the base circle of the cam profile. Respectively the engageable, mating openings of the hydraulic fluid flow path in the cam follower unit and in the body are dislocated by the movement of the cam follower unit and the flow path is arranged to be closed.

[0018] According to an embodiment of the invention the hydraulic fluid flow path between the hydraulic control space and the hydraulic fluid supply is configured to open and to close on the basis of the position of the cam follower unit.

[0019] According to an embodiment of the invention the first piston unit is in force transmission connection with the cam follower via one or more mechanical links. The system of one or more mechanical links between the first piston unit and the cam follower unit may be referred to simply as a force transmission system. There is an intentional play arranged to the force transmission system between the first piston unit and the cam follower unit when the hydraulic control space is not pressurized.

[0020] According to an embodiment of the invention the hydraulic control space is formed by a cylinder bore arranged to the cam follower unit and a piston part extending from the first piston unit into the cylinder bore.

[0021] According to another embodiment of the invention the hydraulic control space is formed by a cylinder bore arranged in the first piston unit and a piston part extending from the cam follower unit into the cylinder bore.

[0022] According to an embodiment of the invention the first piston unit is configured to transmit valve lifting force in a hydraulic manner to the gas exchange valve for lifting the gas exchange valve.

[0023] According to an embodiment of the invention the cam follower unit is arranged to a block of the engine and the first piston unit is arranged to a cylinder head of the engine.

[0024] According to an embodiment of the invention the first piston unit is affected by a spring with a force that is stronger than hydraulic force obtainable from the hydraulic control space.

[0025] A method of operating a control arrangement according to claim 9 is provided.

[0026] According to an embodiment of the invention the hydraulic fluid is retained in the hydraulic control space by arranging a non-return valve into a hydraulic fluid flow path between the hydraulic control space and the hydraulic fluid supply, allowing flow in a direction towards the hydraulic control space.

[0027] According to an embodiment of the invention hydraulic fluid is retained in the hydraulic control space such that a hydraulic fluid flow path is closed by a non-return valve and allowing a gradual discharge of hydraulic fluid from the hydraulic control space via a gap between the piston part and the cylinder bore bordering the control space.

[0028] According to a further embodiment of the invention hydraulic fluid is retained in the hydraulic control space such that a hydraulic fluid flow path is closed by dislocation of mating openings of the hydraulic fluid flow path in the cam follower unit and in the body due to their relative movement.

[0029] The exemplary embodiments of the invention presented in this patent application are not to be interpreted to pose limitations to the applicability of the appended claims. The verb "to comprise" is used in this patent application as an open limitation that does not exclude the existence of also unrecited features. The features recited in depending claims are mutually freely combinable unless otherwise explicitly stated. The novel features which are considered as characteristic of the

invention are set forth in particular in the appended claims.

Brief Description of Drawings

[0030] In the following, the invention will be described with reference to the accompanying exemplary, schematic drawings, in which

Figure 1 illustrates a gas exchange valve system according to an embodiment of the invention,
Figure 2 illustrates a cam device according to another embodiment of the invention,
Figure 3 illustrates a gas exchange valve system according to another embodiment of the invention,
Figure 4 illustrates a hydraulic control space according to an embodiment of the invention, and
Figure 5 illustrates a gas exchange valve system according to another embodiment of the invention.

Detailed Description of Drawings

[0031] Figure 1 and 2 depicts schematically a gas exchange valve system 10 for an internal combustion piston engine 100. The gas exchange valve system 10 comprises firstly a valve 12 arranged in connection with a gas channel 14 in a cylinder head 102 of the engine 100 (shown in the figure 3). The gas exchange valve 12 opens or closes flow connection between the gas channel 14 and a combustion chamber 16 of the engine 100. The valve 12 is moved, which is called as lifting, into its opening direction, by moving the valve against a biasing spring (not shown) by a valve control arrangement 20 in the engine 100. The valve control arrangement 20 comprises a body 24 into which a generally cylindrical space 26 having a central axis 28 has been arranged. Even if not shown here, the different parts of the valve control arrangement 20 may be of different diameter. The valve control arrangement 20 comprises or it functionally relates to a cam device 18, arranged rotatably in for example a cam shaft having a longitudinal axis 18'. The cam device 18 is shown enlarged in the figure 2. As can be seen in the figures 1 and 2 the cam device 18 has a base circle 18.1 which is defined by a constant radius. The cam profile is provided with a portion 18.4 arranged radially inside, i.e. below, the base circle 18.1 and a portion 18.3 radially outside, i.e. above, the base circle 18.1. The cam profile means the outline of the cross section of the cam device 18.

[0032] The cam device 18 is configured to rotate in synchronous manner with a crank shaft of the engine 100 and thus also with the position of the piston(s) of the engine 100. The valve control arrangement 20 further comprises a cam follower unit 22. The cam follower unit comprises a body part 30 arranged into the space 26 of the body. The body part 30 of the cam follower unit 22 has cylindrical guide surface 32 coaxial with the center axis 28 which guide surface 32 is arranged against the generally cylindrical space 26 of the body 24. The cam follower unit 22 comprises also a cylindrical roller 23 which is arranged to rotate parallel to the longitudinal axis 18' of the cam device. The cam follower unit 22 reciprocates under control of the cam profile when the roller 23 follows the cam surface. The valve control arrangement 20 comprises a first piston unit 34 which is in force transmission connection with the cam follower unit 22 and configured to transmit valve lifting force from the cam device 18 to the gas exchange valve 12. Thus the first piston unit 34 is in force transmission connection 52 with the gas exchange valve 12. The force transmission connection 52 between the gas exchange valve 12 and the first piston unit 34 is arranged to be substantially free from any play when the cam follower unit 22 is under guidance of the portions of the cam follower surface which are either on the base circle 18.1 or on the portion 18.3 radially outside, i.e. above, the base circle 18.1.. The force transmission connection is advantageously realized by hydraulic force transmission system using substantially incompressible fluid, such as lubrication oil of the engine 100. The hydraulic force transmission system is coupled with the first piston unit 34 by mean of a stem 53.

[0033] Another option to provide corresponding effect is a direct, or solely mechanical integration of the gas exchange valve 12 with the first piston unit 34.

[0034] The first piston unit 34 and the cam follower unit 22 are connected by a hydraulic control space 36 arranged between the first piston unit 34 and the cam follower unit 22, such that the hydraulic control space 36 belongs to the force transmission system. The hydraulic control space 36 is used for controlling an effective distance between the cam follower unit 22 and the first piston unit 34. The arrangement is provided with a force device such as a spring 38 configured to push the first piston unit 34 towards the cam follower unit 22.

[0035] The first piston unit 34 is arranged here to the common cylindrical space 26 with the cam follower unit 22. As depicted by the cut portion in the figure 1, the first piston unit 34 and the cam follower unit 22 may be arranged to separate bodies 24 but being mechanically connected via one or more mechanical links 40, which may be simply a push rod, as is shown in the figure 1.

[0036] There is a mechanical limiter 42 arranged to the body 24 of the first piston unit 34 longitudinally between the first piston unit 34 and the cam follower unit 22.. The limiter 42 is configured to prevent and stop movement of the first piston unit 34 in a direction closing the valve 12, at a predetermined location of the first piston unit 34 in the body 24. The direction corresponds the direction towards the cam follower unit 22 in the configuration shown in the figure 1, where the limiter 42 stops the movement of the first piston unit 34 at a predetermined distance from the cam device. The limiter 42 is positioned such that the first piston unit 34 is against the limiter 42 when the cam follower unit 22 rests on the portion 18.4 of the cam profile radially inside the base circle 18.1. This position is shown

in the Figure 5. In the position which is shown in the figure 5 there is also shown a predetermined gap 35 which is formed between the first piston unit 34 and a stem 53. The stem 53 belongs to the force transmission connection 52 between the gas exchange valve 12 and the first piston unit 34. The stem 53 abuts on the body 24 of the valve arrangement by a shoulder or alike provided to the stem 53. When the cam follower unit 22 rests on the portion 18.4 of the cam profile radially inside the base circle 18.1 the spring 38 moves the first piston unit 34 against the limiter 42 while the movement of the stem 53 towards the cam follower unit 22 is prevented. Therefore, the gap 35 between the first piston unit 34 and a stem 53 is formed when the cam follower unit 22 shifts from the support of the base circle 18.1 to the support of the portion 18.4 arranged radially inside, i.e. below, the base circle 18.1 and the first piston unit 34 follows that movement. The force device, such as a spring 38 causes the first piston unit 34 to move against the limiter 42. In the situation shown in the figure 1 the cam follower unit 22 rests on the base circle 18.1 of the cam profile and at this position there is a gap 37 between the limiter 42 and the first piston unit 34. The limiter 42 may be a notch or notches, a ring or a radial extension arranged inside the circular space provided for stopping the movement of the first piston unit 34. The limiter may be realized also by a change of diameter of circular space for the first piston unit 34 in the body 24.

[0037] The first piston unit 34 and the cam follower unit 22 are connected in force transmission with each other via the hydraulic control space 36 arranged between the first piston unit 34 and the cam follower unit 22. The hydraulic control space 36 is used for controlling the effective distance between the cam follower unit 22 and the first piston unit 34, including any possible links 40 adapted between the cam follower unit and the piston unit 34. The hydraulic space 36 is filled with hydraulic fluid. The arrangement is provided with the spring 38 which is configured to provide force which is greater than the force which the hydraulic control space is capable to provide. When the hydraulic fluid is lubrication oil of the engine the force which the hydraulic control space is capable to provide is proportional to the pressure of the lubrication oil. The spring 38 is arranged behind the first piston unit, at opposite side to the hydraulic control space 36.

[0038] The hydraulic control space 36 is formed by a cylinder bore 46 in the cam follower unit 22 and a piston part 44 in the first piston unit 34 configured into the cylinder bore 46. In other words the piston part 44 is arranged to extend from the first piston unit 34 into the cylinder bore 46. It should be understood that the link 40 is considered to be a part of the first piston unit 34.

[0039] The hydraulic control space 36 has a volume, and as is shown in the Figure 5, when the cam follower rests on the portion of the cam profile below or radially inside the base circle of the cam profile, the first piston unit 34 is against the limiter 42. The length of the link 40 is such that when the first piston unit is against the limiter 42 and the cam follower rests on portion of the cam profile radially inside the base circle 18.1 of the cam profile there is a play between the link 40 and the cam follower unit 22.When the engine is running the hydraulic fluid is pressurized and the volume in the hydraulic control space 36 is filled with pressurized fluid which removes the play in the force transmission system of the valve arrangement.

[0040] The valve control arrangement comprises a hydraulic fluid flow path 48 opening into the hydraulic control space 36 and also being connectable to a hydraulic fluid supply 50. The hydraulic fluid flow path 48 is adapted to fill hydraulic control space with the hydraulic fluid obtainable from the hydraulic fluid supply 50. The hydraulic fluid flow path is arranged to the cam follower unit 22 and it is connectable with the hydraulic fluid supply 50 via respective engageable openings 50', 50" in the cam follower unit 22 and the body 24 of the cam follower unit. This way the hydraulic fluid flow path 48 between the hydraulic control space 36 and the hydraulic fluid supply 50 is configured to open and to close on the basis of the position of the cam follower unit in respect to the body 24 thereof. The fluid flow path is open only when the cam follower rests on portion of the cam profile radially inside the base circle 18.1 of the cam profile. When the flow path is open the pressurized fluid is supplied into the hydraulic control space. The hydraulic fluid flow path 48 is provided with a non-return valve 51 configured to allow fluid flow only in the direction towards the hydraulic control space 36. This provides the effect of supporting the maintenance of the pressure of the hydraulic fluid applied to the hydraulic control space 36 during the lift of the valve. The piston part and the cylinder bore are configured so that only a minimal flow of hydraulic fluid takes place out from the control space 36 via a gap between the piston part 44 the cylinder bore 46 bordering the control space 36. The gap is dimensioned so that mainly gas can escape through the gap. This provides an effect of bleeding any gas, such as the air, out of the hydraulic system

[0041] Thus, when the engine 100 is running the cam device is at rotation about its longitudinal axis 18' which causes back and forth movement of the cam follower unit 22 and the first piston unit 34, as well as the link or links 40 between them.

[0042] Since the first piston unit 34 is in force transmission connection via the link 40 with the cam follower unit 22 valve lifting force from the cam device to the gas exchange valve may be transmitted. The hydraulic space, when filled with pressurized hydraulic fluid, advantageously lubrication oil, participates in the force transmission system between the gas exchange valve and the cam follower unit and removes any lash otherwise present in the connections between the link of links 40, the cam follower unit and the first piston unit. The gas exchange valve is opened i.e. lifted while the cam follower unit rests on the portion of the cam profile radially outside the base circle, and closed by the movement of the cam follower unit from the portion of the cam profile radially

outside the base circle back to the base circle.

[0043] When the cam follower rests on the portion of the cam profile radially inside the base circle 18.1 of the cam profile, the force transmission system between the first piston unit and the cam follower unit is adjusted to zero clearance. This is performed by supplying hydraulic fluid into the hydraulic control space such it fills and pressurizes the hydraulic control space, which removes the clearance. According to an embodiment of the invention the flow path of the hydraulic fluid is closed by a non-return valve 51 which causes retaining the hydraulic fluid in the hydraulic control space while the lifting of the gas exchange valve is practised.

[0044] The hydraulic fluid is retained in the hydraulic control space by arranging a non-return valve 51 into a hydraulic fluid flow path 48 between the hydraulic control space 36 and the hydraulic fluid supply 50. Only a minimized discharge of hydraulic fluid from the hydraulic control space is allowed via a gap between the piston part and the cylinder bore bordering the control space 36.

[0045] According to another embodiment of the invention, which is shown in the Figure 5, the flow path supply of the hydraulic fluid is closed without a one-way valve. This is accomplished by misaligning the openings 50', 50" in the hydraulic fluid flow path 48, which causes retaining the hydraulic fluid in the hydraulic control space while the lifting of the gas exchange valve is practised. In this case the play between the cam follower unit 30 and the body must be adequately small to provide proper operation.

[0046] This way the arrangement functions so that the hydraulic control space 36 adjusts the force transmission system to practically zero clearance on every cycle while the cam follower rests on the portion of the cam profile radially inside the base circle 18.1 of the cam profile. This is accomplished in it part by the fact that limiter 42 is positioned such that the first piston unit 34 is against the limiter 42 when the cam follower unit 22 rests on the portion 18.4 of the cam profile radially inside the base circle 18.1, and a corresponding gap 35 is formed between the stem 53 and the first piston unit 34 because the movement of the stem 53 is prevented by its shoulder abutting against the bode 24. The gap 35 formed between the stem 53 and the first piston unit 34 and the gap 37 formed 37 between the limiter 42 and the first piston unit 34 are substantially of equal size. The size of the gaps is also substantially equal to the distance from the base circle 18.1 to the minimum radius 18.5 within the portion 18.4 of the cam profile radially inside the base circle 18.1. According to an embodiment of the invention said system is provided with an intentional play between the first piston unit 34 and the cam follower unit 22 which may be up to 2 mm, advantageously 1-2 mm. The play is then compensated by the hydraulic control space 36. In practical solution the actual play depends on e.g. the size of the engine, but in large engines with push rods the tolerance chain can be very long from camshaft to cylinder head. By means of the invention, when an intentional mechanical play can be provided to the force transmission system, it can be ensured that that such a push rod isn't too long. The play exist when the hydraulic control space is not pressurized. The distance between a counter surface 34' in the first piston unit 34 and the limiter 42 i.e. the gap 37, when the cam follower unit 22 rests on the base circle 18.1, is advantageously equal to the distance from the base circle 18.1 to the minimum radius 18.5 within the portion 18.4 of the cam profile radially inside the base circle 18.1. This way the tolerance chain is reduced to just one accurate measure which is utilized to adjust the system in accurate and efficient manner.

[0047] Figure 3 shows an embodiment of the invention in which the cam follower unit 22 (as well as a cam shaft) is arranged to a block 101 of the engine 100 and the first piston unit 34 is arranged to a cylinder head 102 of the engine 100. In this kind of configuration the mechanical links 40 providing force transmission connection between is more complicated than just a single push rod, which increases the risk of additional play. Thus, the present invention is particularly advantageous in the configuration shown in the figure 3. Mechanical links usually comprise pivoting lever arms to change the direction of the movement of the link. Also in this embodiment the first piston unit 34 is in force transmission connection 52 with the gas exchange valve 12. The force transmission connection 52 between the gas exchange valve 12 and the first piston unit 34 is arranged to be substantially free from any play. The force transmission connection is advantageously realized by hydraulic force transmission system using substantially incompressible fluid, such as lubrication oil of the engine 100. Another option is a direct integration of the valve 12 with the first piston unit 34. In this embodiment the hydraulic control space 36 is operated in similar manner as in the embodiment of figure 1 for removing play in the links 40 between the first piston unit 34 and the cam follower unit 22.

[0048] In the figure 4 there is shown an embodiment the hydraulic control space 36 which is formed by a cylinder bore 46 arranged at the end of the link 40 connected to the first piston unit, and a piston part 44 in the cam follower unit 22. Thus, the piston part is extending from the cam follower unit 22 into the cylinder bore 46. The operation is substantially similar to shown in the other figures.

[0049] While the invention has been described herein by way of examples in connection with what are, at present, considered to be the most preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but is intended to cover various combinations or modifications of its features, and several other applications included within the scope of the invention, as defined in the appended claims. The details mentioned in connection with any embodiment above may be used in connection with another embodiment when such combination is technically feasible.

Claims

1. Control arrangement (20) for a gas exchange valve (12) of an internal combustion piston engine, comprising

   - a cam device (18) with a cam profile, the cam profile having a base circle (18.1) and a portion arranged radially inside (18.4) and radially outside (18.3) the base circle,
   - a cam follower unit (22) adapted to reciprocate under control of the cam profile,
   - a first piston unit (34) in force transmission connection with the cam follower unit (22), and configured to transmit valve lifting force from the cam device (18) to the gas exchange valve (12) for lifting the gas exchange valve (12),
   - a hydraulic control space (36) arranged between the first piston unit (34) and the cam follower unit (22), wherein the first piston unit (34) is affected by a spring (38) configured to push the first piston unit (34) towards the cam follower unit (22) with a force that is stronger than hydraulic force obtainable from the hydraulic control space (36),

   characterized by

   - a mechanical limiter (42) configured to prevent movement of the first piston unit (34) in a direction closing the valve at a predetermined location of the first piston unit (34), which limiter (42) is positioned at a predetermined distance from the first piston unit (34) when the cam follower unit (22) rests on the base circle of the cam profile, when the hydraulic control space (36) is pressurized, said predetermined distance is equal to a maximal radial deviation of the portion of the cam profile radially inside (18.4) the base circle from said base circle of the cam profile,
   - a hydraulic fluid flow path (48) opening into the hydraulic control space (36) and connectable to a hydraulic fluid supply (50), adapted to fill the hydraulic control space (36) with the hydraulic fluid, wherein the hydraulic fluid flow path (48) is configured to open and to close on the basis of the position of the cam follower unit (22).

2. Control arrangement (20) for a gas exchange valve (12) according to claim 1, **characterized in that** the hydraulic fluid flow path (48) is provided with a non-return valve (51) allowing flow in a direction towards the hydraulic control space (36).

3. Control arrangement (20) for a gas exchange valve (12) according to claim 1, **characterized in that** the first piston unit (34) is in force transmission connection with the cam follower via one or more mechanical links (40).

4. Control arrangement (20) for a gas exchange valve (12) according to claim 1, **characterized in that** an intentional play to the force transmission system between the first piston unit 34 and the cam follower unit 22 is arranged when the hydraulic control space is not pressurized.

5. Control arrangement (20) for a gas exchange valve (12) according to claim 1, **characterized in that** the hydraulic control space (36) is formed by a cylinder bore (46) arranged to the cam follower unit (22) and a piston part (44) extending from the first piston unit (34) into the cylinder bore (46).

6. Control arrangement (20) for a gas exchange valve (12) according to claim 1, **characterized in that** the hydraulic control space (36) is formed by a cylinder bore (46) in the first piston unit (34) and a piston part (44) extending from the cam follower unit (22) into the cylinder bore (46).

7. Control arrangement (20) for a gas exchange valve (12) according to claim 1, **characterized in that** the first piston unit (34) is configured to transmit valve lifting force in a hydraulic manner to the gas exchange valve (12) for lifting the gas exchange valve (12).

8. Control arrangement (20) for a gas exchange valve (12) according to claim 1, **characterized in that** the cam follower unit (22) is arranged to a block of the engine (100) and the first piston unit (34) is arranged to a cylinder head of the engine (100).

9. Method of operating a control arrangement (20) for a gas exchange valve (12) in an internal combustion piston engine (100) comprising steps of:

   a. arranging a cam profile in the cam device (18) having a base circle (18.1) and a portion arranged radially inside (18.4) and a portion arranged radially outside (18.3) the base circle (18.1), and rotating the cam device (18) about its longitudinal axis (18'),
   b. arranging a cam follower unit (22) to reciprocate under control of the cam profile transforming the rotational movement of the cam device (18) into reciprocating movement of the cam follower unit (22),
   c. arranging a first piston unit (34) in force transmission connection with the cam follower unit (22), for transmitting valve lifting force from the cam device (18) to the gas exchange valve (12),
   d. arranging a hydraulic control space (36) between the first piston unit (34) and the cam follower unit (22), wherein the first piston unit (34) is affected by a spring (38) configured to push the first piston unit (34) towards to cam follower

unit (22) with a force that is stronger than hydraulic force obtainable from the hydraulic control space (36),

e. lifting the gas exchange valve (12) while the cam follower unit (22) rests on the portion of the cam profile radially outside (18.3) the base circle,

f. closing the gas exchange valve (12) while the cam follower unit (22) shifts from the portion of the cam profile radially outside (18.3) the base circle back to the base circle,

characterized in that while the valve is maintained closed

g. preventing movement of the first piston unit (34) in a direction closing the valve at a predetermined location of the first piston unit (34), by a mechanical limiter (42) which limiter (42) is positioned at a predetermined distance from the first piston unit (34) when the cam follower unit (22) rests on the base circle of the cam profile, said predetermined distance is equal to a maximal radial deviation of the portion of the cam profile radially inside (18.4) the base circle (18.1), from the base circle (18.1) of the cam profile,

h. when the cam follower rests on the portion of the cam profile radially inside (18.4) the base circle of the cam profile supplying hydraulic fluid into the hydraulic control space (36) such it fills and pressurizes the hydraulic control space (36),

i. retaining the hydraulic fluid in the hydraulic control space (36) while lifting of the gas exchange valve (12) is practised.

10. Method of operating in a control arrangement (20) for a gas exchange valve (12) according to claim 9, **characterized in that** hydraulic fluid is retained in the hydraulic control space (36) by arranging a non-return valve (51 into a hydraulic fluid flow path (48) between the hydraulic control space (36) and the hydraulic fluid supply (50), allowing flow in a direction towards the hydraulic control space (36).

11. Method of operating in a control arrangement (20) for a gas exchange valve (12) according to claim 9, **characterized in that** hydraulic fluid is retained in the hydraulic control space (36) such that a hydraulic fluid flow path (48) is closed by a non-return valve (51) and allowing a gradual discharge of hydraulic fluid from the hydraulic control space (36) via a gap between the piston part (44) and the cylinder bore (46) bordering the control space (36).

12. Method of operating in a control arrangement (20) for a gas exchange valve (12) according to claim 9, **characterized in that** hydraulic fluid is retained in the hydraulic control space (36) such that a hydraulic fluid flow path (48) is closed by dislocation of mating openings of the hydraulic fluid flow path in the cam follower unit and in the body due to their relative movement.

Patentansprüche

1. Steueranordnung (20) für ein Gaswechselventil (12) eines Kolbenverbrennungsmotors, die Folgendes umfasst:

- eine Nockenvorrichtung (18) mit einem Nockenprofil, wobei das Nockenprofil einen Grundkreis (18.1) und einen Abschnitt, der in Radialrichtung innerhalb (18.4) und in Radialrichtung außerhalb (18.3) des Grundkreises angeordnet ist, aufweist,
- eine Nockenstößeleinheit (22), die angepasst ist, um sich unter der Steuerung des Nockenprofils hin- und herzubewegen,
- eine erste Kolbeneinheit (34) in einer Kraftübertragungsverbindung mit der Nockenstößeleinheit (22) und dafür konfiguriert, zum Anheben des Gaswechselventils (12) eine Ventilhebekraft von der Nockenvorrichtung (18) zu dem Gaswechselventil (12) zu übertragen,
- einen hydraulischen Steuerraum (36), der zwischen der ersten Kolbeneinheit (34) und der Nockenstößeleinheit (22) angeordnet ist, wobei die erste Kolbeneinheit (34) durch eine Feder (38) beeinflusst wird, die dafür konfiguriert ist, die erste Kolbeneinheit (34) mit einer Kraft, die stärker ist als eine hydraulische Kraft, die von dem hydraulischen Steuerraum (36) zu erlangen ist, hin zu der Nockenstößeleinheit (22) zu drängen,

gekennzeichnet durch

- einen mechanischen Begrenzer (42), der dafür konfiguriert ist, eine Bewegung der ersten Kolbeneinheit (34) in einer Richtung, die das Ventil bei einer vorbestimmten Position der ersten Kolbeneinheit (34) schließt, zu verhindern, wobei der Begrenzer (42) bei einer vorbestimmten Entfernung von der ersten Kolbeneinheit (34) angeordnet ist, wenn die Nockenstößeleinheit (22) auf dem Grundkreis des Nockenprofils ruht, wenn der hydraulische Steuerraum (36) unter Druck gesetzt ist, wobei die vorbestimmte Entfernung gleich einer maximalen radialen Abweichung des Abschnitts des Nockenprofils, in Radialrichtung innerhalb (18.4) des Grundkreises, von dem Grundkreis des Nockenprofils ist,
- eine Hydraulikfluid-Strömungsbahn (48), die sich in den hydraulischen Steuerraum (36) öffnet und mit einer Hydraulikfluidzufuhr (50) verbunden werden kann, die angepasst ist, um den hydraulischen Steuerraum (36) mit dem Hydraulikfluid zu füllen, wobei die Hydraulikfluid-

Strömungsbahn (48) dafür konfiguriert ist, sich auf der Grundlage der Position der Nockenstößeleinheit (22) zu öffnen und zu schließen.

2. Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Hydraulikfluid-Strömungsbahn (48) mit einem Rückschlagventil (51) versehen ist, das einen Strom in einer Richtung, hin zu dem hydraulischen Steuerraum (36), ermöglicht.

3. Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 1, **dadurch gekennzeichnet, dass** die erste Kolbeneinheit (34) über eine oder mehrere mechanische Verknüpfungen (40) in einer Kraftübertragungsverbindung mit dem Nockenstößel steht.

4. Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 1, **dadurch gekennzeichnet, dass** ein beabsichtigtes Spiel an dem Kraftübertragungssystem zwischen der ersten Kolbeneinheit (34) und der Nockenstößeleinheit (22) angeordnet ist, wenn der hydraulische Steuerraum nicht unter Druck gesetzt ist.

5. Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 1, **dadurch gekennzeichnet, dass** der hydraulische Steuerraum (36) durch eine Zylinderbohrung (46), die an der Nockenstößeleinheit (22) angeordnet ist, und einen Kolbenteil (44), der sich von der ersten Kolbeneinheit (34) in die Zylinderbohrung (46) erstreckt, gebildet wird.

6. Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 1, **dadurch gekennzeichnet, dass** der hydraulische Steuerraum (36) durch eine Zylinderbohrung (46) in der ersten Kolbeneinheit (34) und einen Kolbenteil (44), der sich von der Nockenstößeleinheit (22) in die Zylinderbohrung (46) erstreckt, gebildet wird.

7. Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 1, **dadurch gekennzeichnet, dass** die erste Kolbeneinheit (34) dafür konfiguriert ist, zum Anheben des Gaswechselventils (12) auf eine hydraulische Weise eine Ventilhebekraft zu dem Gaswechselventil (12) zu übertragen.

8. Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Nockenstößeleinheit (22) an einem Block des Motors (100) angeordnet ist und die erste Kolbeneinheit (34) an einem Zylinderkopf des Motors (100) angeordnet ist.

9. Verfahren zum Betreiben einer Steueranordnung (20) für ein Gaswechselventil (12) in einem Kolbenverbrennungsmotor (100), wobei das Verfahren die folgenden Schritte umfasst:

a. Anordnen eines Nockenprofils in der Nockenvorrichtung (18), das einen Grundkreis (18.1) und einen Abschnitt, der in Radialrichtung innerhalb (18.4) angeordnet ist, und einen Abschnitt, der in Radialrichtung außerhalb (18.3) des Grundkreises (18.1) angeordnet ist, aufweist, und Drehen der Nockenvorrichtung (18) um ihre Längsachse (18'),
b. Anordnen einer Nockenstößeleinheit (22), um sich unter der Steuerung des Nockenprofils hin- und herzubewegen, wobei die Drehbewegung der Nockenvorrichtung (18) in eine hin- und hergehende Bewegung der Nockenstößeleinheit (22) umgewandelt wird,
c. Anordnen einer ersten Kolbeneinheit (34) in Kraftübertragungsverbindung mit der Nockenstößeleinheit (22), zum Übertragen einer Ventilhebekraft von der Nockenvorrichtung (18) zu dem Gaswechselventil (12),
d. Anordnen eines hydraulischen Steuerraums (36) zwischen der ersten Kolbeneinheit (34) und der Nockenstößeleinheit (22), wobei die erste Kolbeneinheit (34) durch eine Feder (38) beeinflusst wird, die dafür konfiguriert ist, die erste Kolbeneinheit (34) mit einer Kraft, die stärker ist als eine hydraulische Kraft, die von dem hydraulischen Steuerraum (36) zu erlangen ist, hin zu der Nockenstößeleinheit (22) zu drängen,
e. Anheben des Gaswechselventils (12), während die Nockenstößeleinheit (22) auf dem Abschnitt des Nockenprofils, in Radialrichtung außerhalb (18.3) des Grundkreises, ruht,
f. Schließen des Gaswechselventils (12), während sich die Nockenstößeleinheit (22) von dem Abschnitt des Nockenprofils, in Radialrichtung außerhalb (18.3) des Grundkreises, zurück zu dem Grundkreis verlagert,
gekennzeichnet durch Folgendes, während das Ventil geschlossen gehalten wird,
g. Verhindern einer Bewegung der ersten Kolbeneinheit (34) in einer Richtung, die das Ventil bei einer vorbestimmten Position der ersten Kolbeneinheit (34) schließt, durch einen mechanischen Begrenzer (42), wobei der Begrenzer (42) bei einer vorbestimmten Entfernung von der ersten Kolbeneinheit (34) angeordnet ist, wenn die Nockenstößeleinheit (22) auf dem Grundkreis des Nockenprofils ruht, wobei die vorbestimmte Entfernung gleich einer maximalen radialen Abweichung des Abschnitts des Nockenprofils, in Radialrichtung innerhalb (18.4) des Grundkreises (18.1), von dem Grundkreis (18.1) des Nockenprofils ist,
h. wenn der Nockenstößel auf dem Abschnitt des Nockenprofils, in Radialrichtung innerhalb

(18.4) des Grundkreises des Nockenprofils, ruht, Zuführen von Hydraulikfluid in den hydraulischen Steuerraum (36), so dass es den hydraulischen Steuerraum (36) füllt und unter Druck setzt,

i. Zurückhalten des Hydraulikfluids in dem hydraulischen Steuerraum (36), während das Anheben des Gaswechselventils (12) praktiziert wird.

10. Verfahren zum Betreiben einer Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 9, **dadurch gekennzeichnet, dass** das Hydraulikfluid in dem hydraulischen Steuerraum (36) zurückgehalten wird durch Anordnen eines Rückschlagventils (51) in einer Hydraulikfluid-Strömungsbahn (48) zwischen dem hydraulischen Steuerraum (36) und der Hydraulikfluidzufuhr (50), was einen Strom in einer Richtung, hin zu dem hydraulischen Steuerraum (36), ermöglicht.

11. Verfahren zum Betreiben einer Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 9, **dadurch gekennzeichnet, dass** das Hydraulikfluid in dem hydraulischen Steuerraum (36) derart zurückgehalten wird, dass eine Hydraulikfluid-Strömungsbahn (48) durch ein Rückschlagventil (51) geschlossen wird und eine allmähliche Abgabe von Hydraulikfluid aus dem hydraulischen Steuerraum (36) über einen Spalt zwischen dem Kolbenteil (44) und der Zylinderbohrung (46), die den Steuerraum (36) begrenzen, ermöglicht wird.

12. Verfahren zum Betreiben einer Steueranordnung (20) für ein Gaswechselventil (12) nach Anspruch 9, **dadurch gekennzeichnet, dass** das Hydraulikfluid in dem hydraulischen Steuerraum (36) derart zurückgehalten wird, dass eine Hydraulikfluid-Strömungsbahn (48) durch eine Verlagerung von passenden Öffnungen der Hydraulikfluid-Strömungsbahn in der Nockenstößeleinheit und in dem Körper auf Grund von deren relativer Bewegung geschlossen wird.

Revendications

1. Agencement de commande (20) pour une soupape d'échange de gaz (12) d'un moteur à piston à combustion interne, comprenant

- un dispositif de came (18) avec un profil de came, le profil de came ayant un cercle de base (18.1) et une partie disposée radialement à l'intérieur (18.4) et radialement à l'extérieur (18.3) du cercle de base,
- une unité suiveuse de came (22) adaptée pour effectuer un mouvement alternatif sous le contrôle du profil de came,
- une première unité de piston (34) en liaison de transmission de force avec l'unité suiveuse de came (22), et configurée pour transmettre la force de levage de soupape du dispositif de came (18) à la soupape d'échange de gaz (12) pour soulever la soupape d'échange de gaz (12),
- un espace de commande hydraulique (36) agencé entre la première unité de piston (34) et l'unité suiveuse de came (22), dans lequel la première unité de piston (34) est affectée par un ressort (38) configuré pour pousser la première unité de piston (34) vers l'unité suiveuse de came (22) avec une force supérieure à la force hydraulique pouvant être obtenue à partir de l'espace de commande hydraulique (36) ,

caractérisé par

- un limiteur mécanique (42) configuré pour empêcher le mouvement de la première unité de piston (34) dans une direction fermant la soupape à un emplacement prédéterminé de la première unité de piston (34), lequel limiteur (42) est positionné à une distance prédéterminée de la première unité de piston (34) lorsque l'unité suiveuse de came (22) repose sur le cercle de base du profil de came, lorsque l'espace de commande hydraulique (36) est mis sous pression, ladite distance prédéterminée est égale à un écart radial maximal de la partie du profil de came radialement à l'intérieur (18.4) du cercle de base à partir dudit cercle de base du profil de came,
- un trajet d'écoulement de fluide hydraulique (48) débouchant dans l'espace de commande hydraulique (36) et pouvant être relié à une alimentation en fluide hydraulique (50), adapté pour remplir l'espace de commande hydraulique (36) avec le fluide hydraulique, dans lequel le trajet d'écoulement de fluide hydraulique (48) est configuré pour s'ouvrir et se fermer sur la base de la position de l'unité suiveuse de came (22).

2. Agencement de commande (20) d'une soupape d'échange de gaz (12) selon la revendication 1, **caractérisé en ce que** la voie d'écoulement du fluide hydraulique (48) est munie d'un clapet anti-retour (51) autorisant l'écoulement dans un sens vers l'espace de commande hydraulique (36).

3. Agencement de commande (20) d'une soupape d'échange de gaz (12) selon la revendication 1, **caractérisé en ce que** la première unité de piston (34) est en liaison de transmission d'effort avec la suiveuse de came via une ou plusieurs liaisons mécaniques (40).

4. Agencement de commande (20) pour une soupape

d'échange de gaz (12) selon la revendication 1, **caractérisé en ce qu'**un jeu intentionnel au système de transmission de force entre la première unité de piston (34) et l'unité suiveuse de came (22) est agencé lorsque l'espace de commande hydraulique n'est pas sous pression.

5. Agencement de commande (20) pour une soupape d'échange de gaz (12) selon la revendication 1, **caractérisé en ce que** l'espace de commande hydraulique (36) est formé par un alésage de cylindre (46) agencé à l'unité suiveuse de came (22) et une partie de piston (44) s'étendant depuis la première unité de piston (34) dans l'alésage de cylindre (46).

6. Agencement de commande (20) pour une soupape d'échange de gaz (12) selon la revendication 1, **caractérisé en ce que** l'espace de commande hydraulique (36) est formé par un alésage de cylindre (46) dans la première unité de piston (34) et une partie de piston (44) s'étendant de l'unité suiveuse de came (22) dans l'alésage de cylindre (46).

7. Agencement de commande (20) pour une soupape d'échange de gaz (12) selon la revendication 1, **caractérisé en ce que** la première unité de piston (34) est configurée pour transmettre la force de levage de la soupape de manière hydraulique à la soupape d'échange de gaz (12) pour soulever la soupape d'échange de gaz (12).

8. Agencement de commande (20) pour une soupape d'échange de gaz (12) selon la revendication 1, **caractérisé en ce que** l'unité suiveuse de came (22) est agencée à un bloc du moteur (100) et la première unité de piston (34) est disposé sur une culasse du moteur (100).

9. Procédé de fonctionnement d'un agencement de commande (20) pour une soupape d'échange de gaz (12) dans un moteur à piston à combustion interne (100) comprenant les étapes consistant à :

a. agencer un profil de came dans le dispositif de came (18) ayant un cercle de base (18.1) et une partie disposée radialement à l'intérieur de (18.4) et une partie disposée radialement à l'extérieur (18.3) du cercle de base (18.1), et faisant tourner le dispositif de came (18) autour de son axe longitudinal (18'),

b. agencer une unité suiveuse de came (22) pour aller et venir sous la commande du profil de came en transformant le mouvement de rotation du dispositif de came (18) en mouvement alternatif de l'unité suiveuse de came (22),

c. agencer une première unité de piston (34) en liaison de transmission de force avec l'unité suiveuse de came (22), pour transmettre la force de levage de soupape du dispositif de came (18) à la soupape d'échange de gaz (12),

d. agencer un espace de commande hydraulique (36) entre la première unité de piston (34) et l'unité suiveuse de came (22), dans lequel la première unité de piston (34) est affectée par un ressort (38) configuré pour pousser la première unité de piston (34) vers l'unité suiveuse de came (22) avec une force supérieure à la force hydraulique pouvant être obtenue à partir de l'espace de commande hydraulique (36),

e. soulever la soupape d'échange de gaz (12) tandis que l'unité suiveuse de came (22) repose sur la partie du profil de came radialement à l'extérieur (18.3) du cercle de base,

f. fermer la soupape d'échange de gaz (12) tandis que l'unité suiveuse de came (22) se déplace de la partie du profil de came radialement à l'extérieur (18.3) du cercle de base vers le cercle de base,

caractérisé en ce que tandis que la soupape est maintenue fermée

g. empêcher le mouvement de la première unité de piston (34) dans une direction fermant la soupape à un emplacement prédéterminé de la première unité de piston (34), par un limiteur mécanique (42) lequel limiteur (42) est positionné à une distance prédéterminée de la première unité de piston (34) lorsque l'unité suiveuse de came (22) repose sur le cercle de base du profil de came, ledit distance prédéterminée est égale à une déviation radiale maximale de la partie du profil de came radialement à l'intérieur (18.4) du cercle de base (18.1), à partir du cercle de base (18.1) du profil de came,

h. lorsque la suiveuse de came repose sur la partie du profil de came radialement à l'intérieur (18.4) du cercle de base du profil de came alimentant en fluide hydraulique l'espace de commande hydraulique (36) de sorte qu'il remplisse et mette sous pression l'espace de commande hydraulique (36),

i. retenir le fluide hydraulique dans l'espace de commande hydraulique (36) pendant que la levée de la soupape d'échange de gaz (12) est pratiquée.

10. Procédé de fonctionnement dans un agencement de commande (20) d'une soupape d'échange de gaz (12) selon la revendication 9, **caractérisé en ce que** le fluide hydraulique est retenu dans l'espace de commande hydraulique (36) en agençant un clapet anti-retour (51) dans un trajet d'écoulement de fluide hydraulique (48) entre l'espace de commande hydraulique (36) et l'alimentation en fluide hydraulique (50), permettant l'écoulement dans une direction vers l'espace de commande hydraulique (36).

11. Procédé de fonctionnement dans un agencement de commande (20) pour une soupape d'échange de gaz (12) selon la revendication 9, **caractérisé en ce que** le fluide hydraulique est retenu dans l'espace de commande hydraulique (36) de telle sorte qu'un trajet de circulation de fluide hydraulique (48) soit obturé par un clapet anti-retour (51) et autorisant une décharge de fluide hydraulique de l'espace de commande hydraulique (36) via un espace entre la partie de piston (44) et l'alésage de cylindre (46) bordant l'espace de commande (36).

12. Procédé de fonctionnement dans un agencement de commande (20) d'une soupape d'échange de gaz (12) selon la revendication 9, **caractérisé en ce que** du fluide hydraulique est retenu dans l'espace de commande hydraulique (36) de sorte qu'un trajet d'écoulement de fluide hydraulique (48) soit obturé par la dislocation des ouvertures d'accouplement du trajet d'écoulement de fluide hydraulique dans l'unité suiveuse de came et dans le corps en raison de leur mouvement relatif.

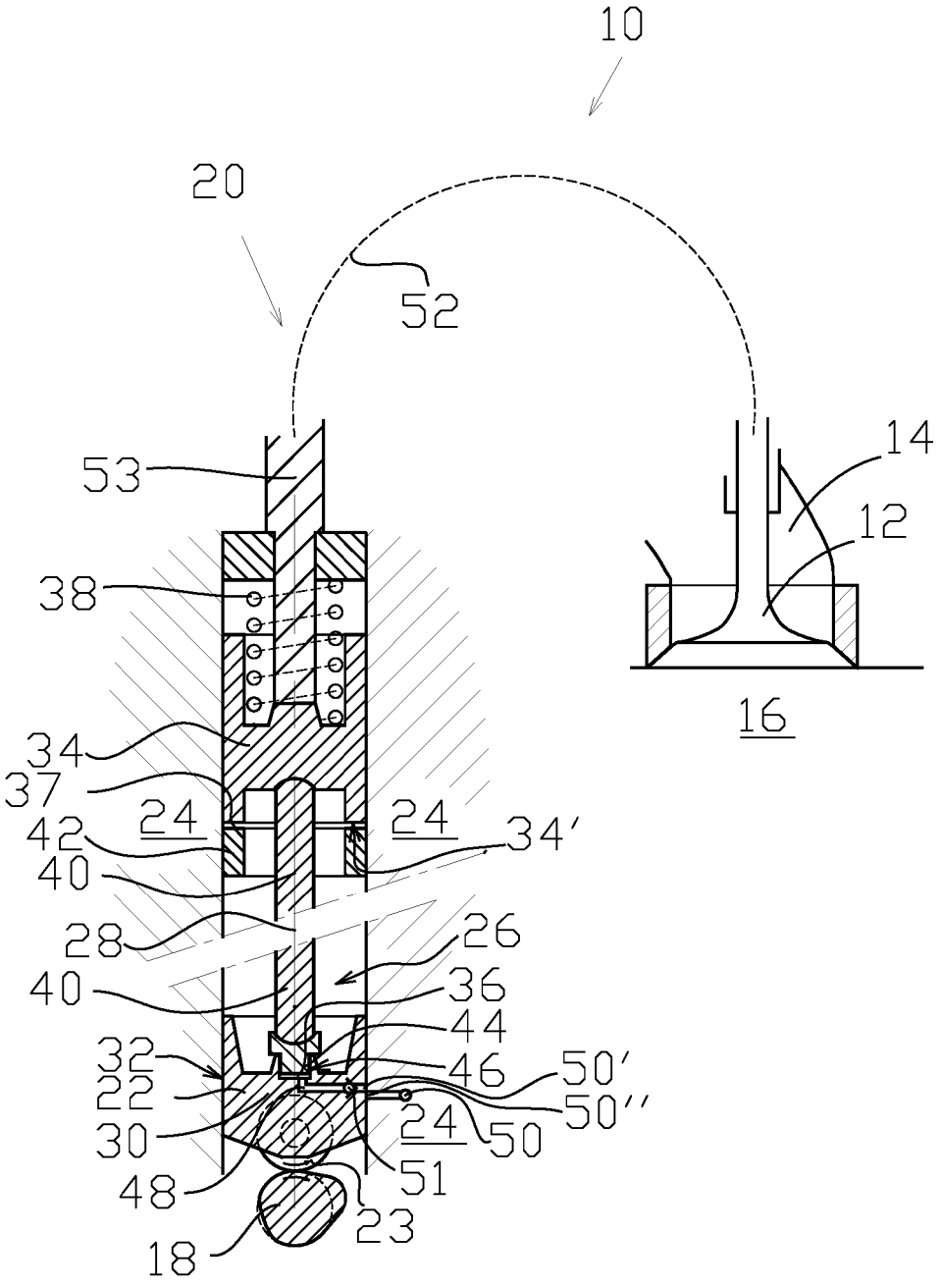
10
20
52
53
14
12
38
16
34
37
24
24
42
34'
40
28
26
40
36
44
32
46
50'
22
50''
30
24
50
51
48
23
18

Fig. 1

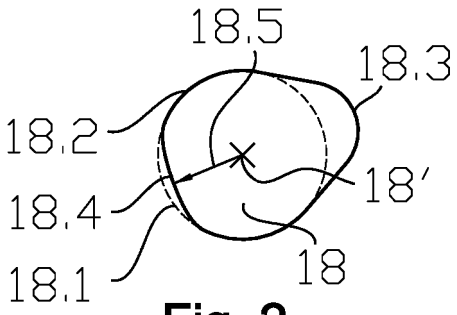

Fig. 2

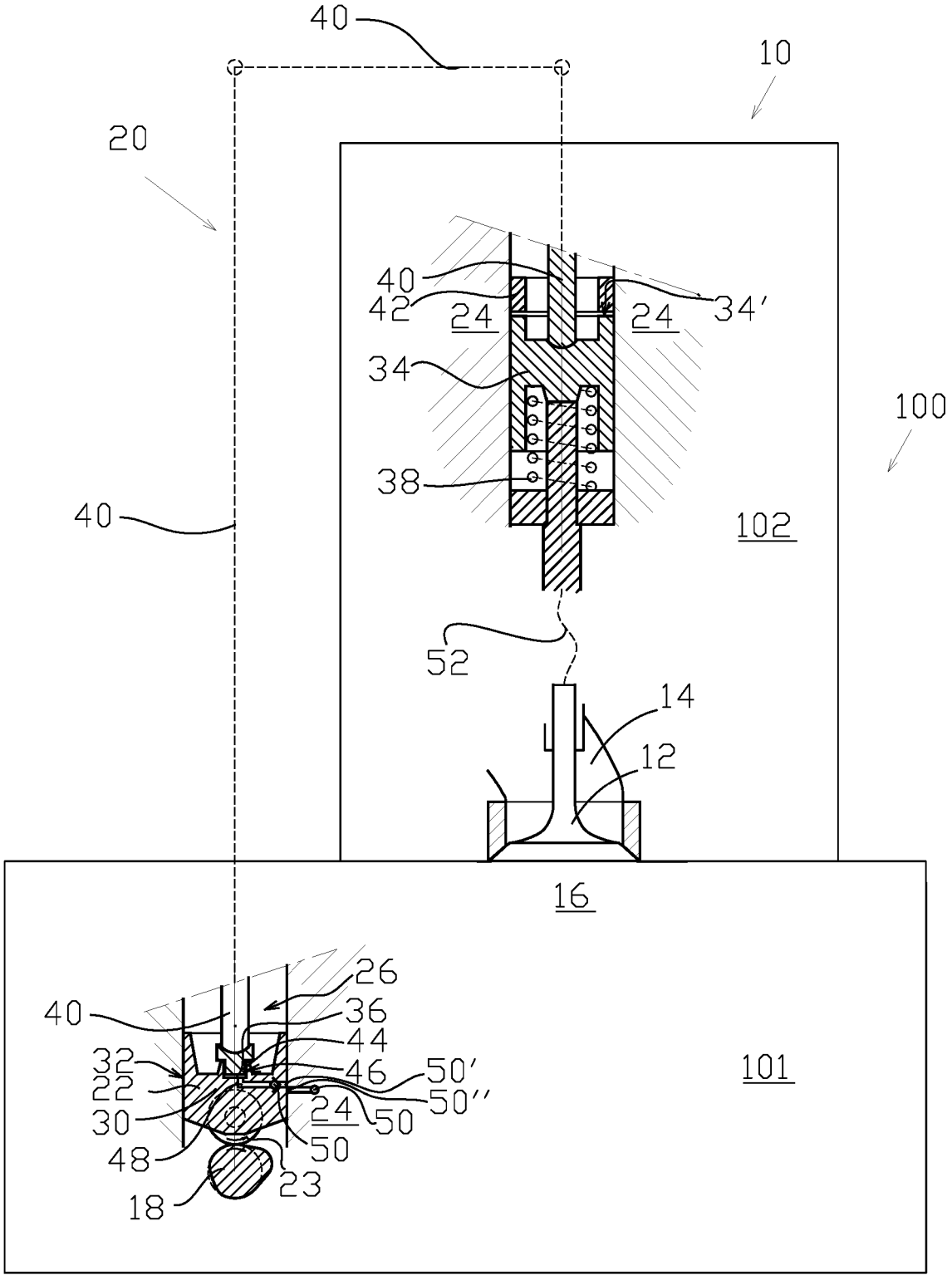
40
10
20
40
42
24
24
34'
34
38
100
40
102
52
14
12
16
26
40
36
44
32
46
50'
22
50''
24
30
50
48
50
23
18
101

Fig. 3

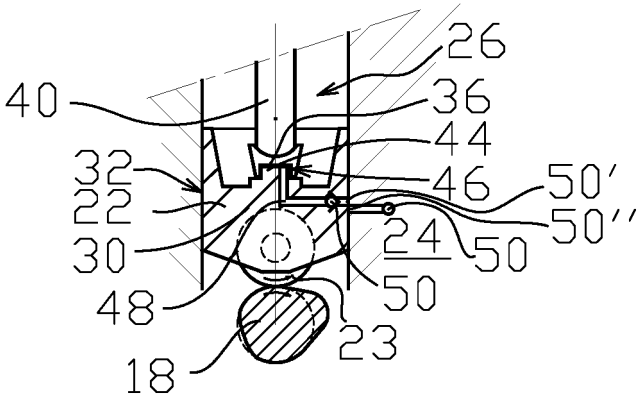

Fig. 4

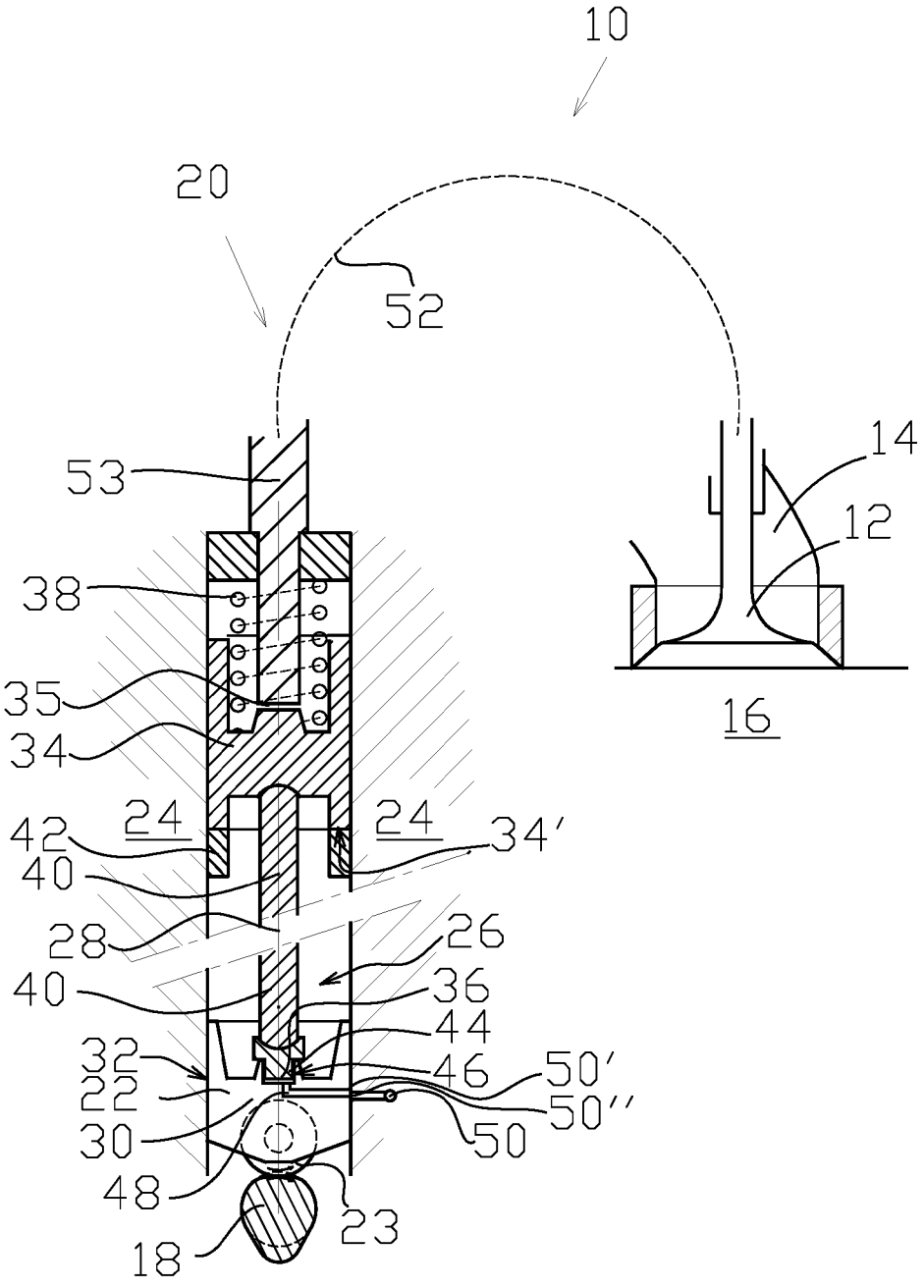
10
20
52
53
14
12
38
35
34
16
24
24
42
34'
40
28
26
40
36
44
32
46
50'
22
50''
30
50
48
23
18

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2010012864 A1 **[0003]**
- WO 2012156573 A1 **[0004]**
- WO 2012156584 A1 **[0005]**
- JP H08284620 A **[0007]**
- EP 0375742 B1 **[0008]**
- US 4674451 A **[0009]**