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(54) Title: UNIT FOR ADJUSTING THE LIFT OF THE VALVES OF AN INTERNAL COMBUSTION ENGINE

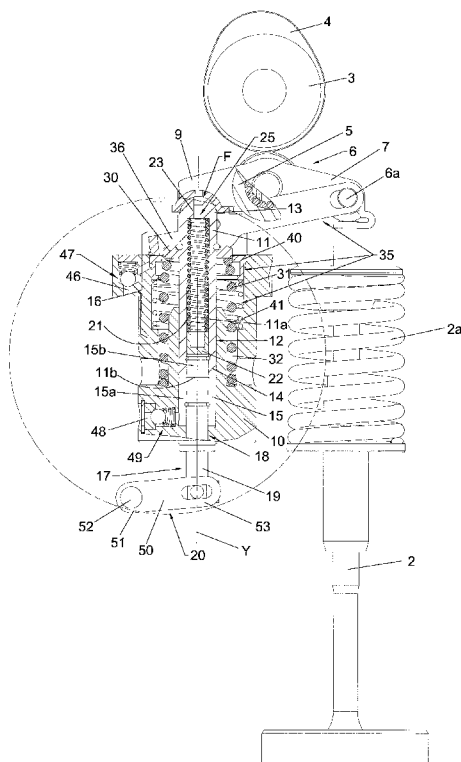


Fig.6

(57) Abstract: A unit (1) for adjusting the lift of the valves (2) of an internal combustion engine comprising one or more camshafts (3) with one or more cams (4) each arranged at contact with an idler roller (5) of a rocker arm (6) having a first part (7) associated to one of the valves (2), comprising: a mobile rod (11) slidingly inserted into a housing (10) and interposed between a fulcrum area (F) for the rotation of the rocker arm (6) and a hydraulic chamber (15, 15a, 15b) containing oil; elastically yieldable means (16) cooperating with the mobile rod (11) and coaxial thereto; a mobile shutter (17) arranged in the hydraulic chamber (15); actuator means (20) for displacing the mobile shutter (17) in the hydraulic chamber (15). The mobile rod (11) and the elastically yieldable means (16) are configured to synergically cooperate and modify the position of the fulcrum area (F) when, during the rotation of the camshaft (3), the actuator means (20) modify the position of the shutter (17) with respect to the mobile rod (11). The mobile rod (11), the elastically yieldable means (16) and the mobile shutter (17) are coaxial to each other according to a longitudinal axis (Y), the elastically yieldable means (16) being arranged externally with respect to the mobile rod (11) and the mobile rod (11) being aligned to the mobile shutter (17).

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UNIT FOR ADJUSTING THE LIFT OF THE VALVES OF AN INTERNAL COMBUSTION ENGINE.

DESCRIPTION

The invention regards a unit for adjusting the lift of the valves of an internal
5 combustion engine.

As known, internal combustion engines are combustion vehicles that thermodynamically process an operating fluid that is exchanged with the external environment through inlet and outlet openings controlled by means of valves.

10 The valves are directly or indirectly controlled through mechanical means called tappets which comprise rocker arms actuated by rotating cams whose profile determines the degree and speed of the opening and closure of the aforementioned valves.

The cams are associated to a rotating shaft, thus called camshaft, which
15 rotates at half the speed of the driving shaft and it is controlled by the latter by means of a kinematic unit comprising pulleys driven in rotation by clogged belts, gearwheels and chains, or a gear train.

Current motor vehicle manufacturing developments and studies carried out in this industry reveal that it is advantageous to be able to vary the opening,
20 also referred to as lift, of the valves regardless of the opening value imparted thereto by the cams upon the variation of the engine load and rotational speed conditions.

In addition, should the lift of the valve be nullified, the engine displacement capacity may be varied by deactivating one or more cylinders with an ensuing
25 considerable reduction of consumption and pollutant emissions of the engine.

Lastly, the cyclic exclusion of cylinders may represent an efficient method for reducing pumping losses and to increase the actual mean pressure in the operating cylinders, so as to ensure a clean and stable combustion.

There are various technical solutions for controlling the lift of the valves and
30 which are attained according to different embodiments that all reveal the drawback of being costly to obtain, thus justifying the use thereof only on vehicles part of the high market price bracket.

Furthermore, the operation of such known solutions is rather sensitive.

Lastly, such known solutions have a high overall dimension which justifies the
35 use thereof almost exclusively on large-displacement vehicles.

The present invention intends to overcome the aforementioned drawbacks.

In particular, a first object of the present invention is to obtain a unit for adjusting the lift of the valves of an internal combustion engine that is less expensive to obtain with respect to equivalent adjustment units of the prior art.

5 Another object is that the adjustment unit of the invention has smaller overall dimensions with respect to equivalent prior art adjustment units.

Last but not least, the adjustment unit of the invention has the object of also enabling recovering the clearance of the tappets when the engine is running.

The aforementioned objects are attained by an adjustment unit of the invention
10 according to the main claim to which reference is made.

Advantageously, being less costly and having smaller dimensions with respect to adjustment units of the known type, the adjustment unit of the invention may be installed on a wide range of motor vehicles.

Still advantageously, given that the adjustment unit of the invention also
15 enables automatically recovering the clearance of the tappets, it substantially behaves like known hydraulic tappets, with respect to which it also reveals substantially similar overall dimensions.

The objects and advantages listed above shall be further outlined in the description of a preferred embodiment of the invention provided hereinafter by
20 way of non-limiting example with reference to the attached drawings, wherein:

- fig. 1 represents an axonometric view of the adjustment unit of the invention associated to the tappet of an engine, regarding which in the figure there are represented the camshaft and a valve;
- fig. 2 represents a detail of the adjustment unit of the invention represented
25 in fig. 1;
- fig. 3 represents an exploded view of a detail of fig. 2;
- fig. 4 represents an exploded view of another detail of fig. 2;
- fig. 5 represents a detail of fig. 2 and fig. 3;
- fig. 6 represents the longitudinal section of fig. 1;
- 30 - fig. 7 represents a detail of fig. 6 in enlarged view;
- fig. 8 represents a detail of fig. 6 and fig. 7 in enlarged view;
- figures 9 to 15 represent the longitudinal section of the assembly of fig. 1 in different operative positions.

The adjustment unit subject of the invention is represented in axonometric view
35 in fig. 1 and in sectional view in figures 6 and from 9 to 15 where it is indicated

in its entirety with **1**.

It is used for adjusting the lift of the valves of an internal combustion engine regarding which, in the figures mentioned now, there are represented:

- a valve **2** with relative return spring **2a**;
- 5 - the valve-seat **2b** and the valve-guide **2c**;
- the camshaft **3** provided with a cam **4**;
- the rocker arm **6** which contrasts with the cam **4** by interposing an idler roller **5** belonging to the rocker arm **6** itself.

10 In the latter, in particular, there are identified a first part **7** which is associated to a valve **2** of the engine and a second part **9** which is arranged on the opposite side of the first part **7** with respect to the idler roller **5**.

It should be observed that the rocker arm could simultaneously control several valves given that the one represented in the mentioned figures is only a possible reference embodiment for description.

15 As concerns the adjustment unit **1**, it should be observed that it comprises a housing **10** in which there are contained a mobile rod **11** inserted into a sliding seat **12** present in the housing **10** and having a first end **13** arranged at contact with the second part **9** of the rocker arm **6**.

20 A second end **14** of the mobile rod **11**, opposite to the first end **13**, is arranged in a hydraulic chamber **15** present in the housing **10** and suitable to contain oil. It should be observed that the housing **10**, in the embodiment described herein, takes the shape of a cartridge body.

25 However, other embodiments in which the housing **10** can belong to the engine and be obtained, for example, in the cylinder head of the engine or in other parts thereof, are possible.

There is also identified a fulcrum area **F** for the rotation of the rocker arm **6** which, as observable in figures 6 and from 9 to 15, is defined in the contact area between the first end **13** of the mobile rod **11** and the second part **9** of the rocker arm **6**.

30 In particular, the first end **13** of the mobile rod **11** and the second part **9** of the rocker arm **6** are configured with a suitable profile respectively concave and convex so that the contact area that forms the fulcrum area **F** is substantially the surface of a spherical cover.

35 Also the elastically yieldable means **16** that cooperate with the mobile rod **11** and a mobile shutter **17** are part of the adjustment unit **1**.

As observable, the mobile shutter projects into the hydraulic chamber **15** and it is slidably housed in a through hole **18** obtained in the housing **10**.

In addition, the mobile shutter **17** has a projecting end **19** faced towards the external of the housing **10** which is connected to actuator means, indicated in their entirety with **20**, which will be described in detail hereinafter.

As regards the mobile rod **11** and the elastically yieldable means **16**, they are configured to synergically cooperate and change the position of the fulcrum area **F** when, during the rotation of the camshaft **3**, the actuator means **20** displace the shutter **17** in the hydraulic chamber **15**, as described in detail hereinafter when illustrating the operating method of the adjustment unit of the invention.

Particularly, it should be observed that the mobile rod **11**, as described in detail hereinafter, contrasts with an elastic element **31** belonging to the elastically yieldable means **16**, which is coaxial to the mobile rod **11** and contrasts with it through an interposed compression ring nut **30**.

It should be also observed that the mobile rod **11**, the elastically yieldable means **16** and the shutter **17** are coaxial to each other according to a longitudinal axis **Y** which also defines the longitudinal axis of the housing **10**.

Furthermore, the elastically yieldable means **16** are arranged externally with respect to the mobile rod **11** and the latter is aligned coaxial to the shutter **17**.

The mobile rod **11**, in particular, has an inner longitudinal channel **11a** and the hydraulic chamber **15** is divided into two parts comprising a pressure chamber **15a** into which the shutter **17** is submerged and a compensation chamber **15b** which is defined in a portion of the inner longitudinal channel **11a** of the mobile rod **11**.

As observable, the aforementioned chambers **15a**, **15b** are placed in communication with each other and in particular the pressure chamber **15a** is placed in communication with a duct **48** for supplying pressurised oil through a one-way valve **49** which enables the oil to flow from the aforementioned supply duct **48** towards the pressure chamber **15a**.

In the inner longitudinal channel **11a** of the mobile rod **11** there is inserted an elastic element **21** which is comprised between an annular area **23** obtained in the first end **13** of the mobile rod **11** and a slidable sealing cap **22** arranged at the second end **14** of the mobile rod **11** and faced towards the mobile shutter **17**.

The elastic element **21** has a rigidity and assembly load such that in inoperative conditions it is compressed just for a minute section by the pressure of the oil coming from the one-way valve **49**.

It should be observed that in the annular area **23** of the mobile rod **11** there is
5 obtained a through hole **25** which places the inner longitudinal channel **11a** of the mobile rod **11** in communication with the outer part of the first end **13** of the latter, so that the oil that flows into the inner longitudinal channel **11a** can reach the fulcrum area **F** and lubricate it.

As concerns the elastically yieldable means **16**, it should be observed that
10 they comprise the previously mentioned compression ring nut **30** arranged externally coaxial to the mobile rod **11** in proximity of the first end **13** thereof and the previously mentioned elastic element **31** arranged externally coaxial to the mobile rod **11** and axially comprised between the compression ring nut **30** and an annular seat **32** obtained in the housing **10**.

15 The compression ring nut **30** may also be possibly obtained in a single body with the mobile rod **11**.

The elastically yieldable means **16** also comprise a damper unit, indicated in its entirety with **35**, which serves to decelerate the valve **2** during the closing and opening step, as described during the illustration of the operation of the
20 adjustment unit.

The aforementioned damper unit **35**, which is also observable in the detailed figures 2 to 5, comprises an auxiliary rocker arm **36** pivoted to the rocker arm **6** through the previously mentioned first pin **6a** at the end of the valve **2** and to the housing **10** through a second pin **38**.

25 Furthermore, the auxiliary rocker arm **36** has an area with a shaped profile **39** which rests on a compression ring **40** housed in a cylindrical seat **42** obtained in the housing **10** externally with respect to the elastic element **31**.

Furthermore, the compression ring **40** is arranged externally coaxial to the compression ring nut **30** and it is axially comprised between the shaped profile
30 **39** and an elastic body **41**.

In addition, the elastic body **41** is housed in a cylindrical chamber **43** obtained in longitudinal continuity with the annular seat **32** that houses the elastic element **31**.

In particular, it should be observed that the compression ring **40** has an
35 annular recession **44** which defines with the cylindrical chamber **42** in which

it is received an annular channel **45**.

As observable, the annular channel **45** communicates with a duct **46** for supplying pressurised oil through a one-way valve **47** having the opening direction enabling the flow of oil from the aforementioned supply duct **46** towards the annular channel **45** through a supply duct **48**.

As regards the actuator means **20**, according to an embodiment thereof described herein, they comprise a connecting rod **50** having a first end **51** fixed to a rotary shaft **52** associated to a driving member (not represented) and a second end **53** associated to the projecting end **19** of the shutter **17**.

The connection between the second end **53** of the connecting rod **50** and the projecting end **19** of the shutter **17** occurs through a sliding joint belonging to the mobile shutter **17** and indicated in its entirety with **54**, comprising a pin **54a** inserted into a slotted hole **55** obtained in the second end **53** of the connecting rod **50**.

Thus, when the shaft **52** is driven in rotation by the drive means to which it is connected, the sliding joint **54** transforms the rotation of the connecting rod **50** into an axial movement of the mobile shutter **17** which, being guided by the through hole **18**, coaxially approaches towards or moves away from the mobile rod **11** along the longitudinal direction **Y** depending on the direction of rotation of the rotary shaft **52**.

As mentioned, the described embodiment is just one of the possible embodiments according to which the actuator means **20** for controlling the mobile shutter **17** can be obtained.

In particular, as regards the shutter **17**, it is observed in the detail of fig. 8 that the end thereof present in the pressure chamber **15a**, indicated in its entirety with **60**, is provided with a terminal collar **61** having a smaller diameter with respect to the body of the shutter **17**, so as to enable the fitting insertion thereof into the terminal opening **11b** of the mobile rod **11** and thus into the compensation chamber **15b** defined in the portion of the inner longitudinal channel **11a** of the mobile rod **11**.

As described further in detail hereinafter, such particular embodiment of the end **60** of the mobile shutter **17** serves to adjust the gradient according to which the pressure varies when the oil contained in the hydraulic chamber **15** is transferred between the pressure chamber **15a** and the compensation chamber **15b**.

Actually, the coupling precision represents a valid impediment to the pressure drop of the oil in the pressure chamber **15a** due to seeping.

However, the one-way valve **49** possibly provides for supplementing possible losses due to seepage.

5 Operatively, the adjustment unit **1** of the invention enables continuously varying the lift of the valve **2**, regardless of the positions the cam **4** takes with respect to the rocker arm **6** and independently from the design geometric features of the cam **4**.

Regarding this, it should be observed that in the engine the valve **2** in question
10 may indistinctly be the intake valve or the discharge valve, or both.

As will be observable in the description that follows, the variation of the lift occurs by varying the position of the fulcrum area **F** of the rocker arm **6** during the rotation of the camshaft **3**.

Substantially, the adjustment unit **1** of the invention intervenes during the
15 rotation of the camshaft **3** imposing a displacement to the fulcrum area **F** of the rocker arm **6** which modifies the value of the lift of the valve **2** imposed by the profile of the cam **4**.

Fig. 9 represents the inoperative condition in which the valve **2** is closed against the respective seat **2b** and the idler roller **5** of the rocker arm **6** is at
20 contact with the base circle **4a** of the cam **4**.

In such configuration, the end **60** of the shutter **17** is spaced from the terminal opening **11b** of the mobile rod **11**, thus the pressure chambers **15a** and the compensation chambers **15b** are placed in communication with each other.

Starting from this position, the rotation of the camshaft **3** moves the shaped
25 profile **4b** of the cam **4** in contrast with the idler roller **5** lowering the rocker arm **6** up to the maximum lowering condition represented in fig. 10, that is achieved when the contact of the cam **4** with the idler roller **5** occurs in the end point of the shaped profile **4b** of the cam **4**.

Fig. 10 shows that the fulcrum area **F** lowered with respect to the initial
30 inoperative condition represented in fig. 9 but the valve **2** remained closed against the respective seat **2b** during the entire rotation of the cam **4**.

Actually, the lowering that the fulcrum area **F** of the rocker arm **6** has been subjected to by the thrust of the cam **4** has caused the elastic lowering of the mobile rod **11** that has absorbed the entire potential lift of the cam, without
35 such lift being transferred to the valve.

The lowering of the fulcrum area **F** ensuing the lowering in the vertical direction of the mobile rod **11** is caused by the thrust that the cam **4** exerts on the rocker arm **6** and it is enabled by the lower rigidity of the elastic element **31** placed at contact with the compression ring nut **30** and arranged externally coaxial to the mobile rod **11**, with respect to the return spring **2a** of the valve **2**.

During the lowering of the mobile rod **11**, the end **60** of the mobile shutter **17** does not obstruct the passage of oil from the pressure chamber **15a** to the compensation chamber **15b** and thus the oil acts against the slidable sealing cap **22** compressing the elastic element **21**.

Thus, as long as the position of the end **60** of the shutter **17** is such not to prevent the overflow of the oil from the pressure chamber **15a** to the compensation chamber **15b**, the valve **2** will remain closed regardless of the angular position of the camshaft **3** and the respective cam **4**.

When the adjustment of the actuator means **20** obtains such configuration, the latter corresponds to the conditions in which the operation of the cylinder affected by the valve is excluded.

The situation now described and represented in fig. 10 remains until when, through the actuation of the actuator means **20**, the end **60** of the shutter **17** ends up obstructing the terminal opening **11b** of the inner longitudinal channel **11a** of the mobile rod **11**, so as to prevent the overflow of oil from the pressure chamber **15a** to the compensation chamber **15b**.

When this occurs, given that the volume of the pressure chamber **15a** is substantially constant, the pressure of the oil therein increases due to the incompatibility thereof and exerts a thrust on the surface of the circular crown **11c** which delimits the terminal opening **11b** of the mobile rod **11**, preventing any further displacement by the latter.

The fact that the volume of the pressure chamber **15a** remains substantially constant enables the fine control of the adjustment.

Thus, generally, during the rotation of the cam **4** the position of the fulcrum area **F** lowers until the end **60** of the shutter **17** closes the terminal opening **11b** of the mobile rod **11** and the lowering travel thereof depends on the position that the actuator means **20** impose on the shutter **17** inside the longitudinal channel **11a** of the mobile rod **11**.

When the end **60** of the shutter **17** closes the terminal opening **11b** of the mobile rod **11**, the displacement of the fulcrum area **F** ends and the valve **2**

begins the opening thereof through the action of the cam **4**.

Figures 11 to 13 illustrate, by way of example, different conditions for the lift of the valve **2** as a function of the position of the shutter **17** in the internal longitudinal channel **11a** of the mobile rod **11**.

5 Thus, fig. 11 shows the adjustment condition in which the adjustment unit **1** maintains the lift **H1** of the valve **2** equivalent to 1/4 of the maximum design lift **H** defined by the shaped profile **4b** of the cam **4** as observable in fig. 13.

Fig. 12 represents the adjustment condition in which the adjustment unit of the invention maintains the lift **H2** of the valve equivalent to half the maximum
10 design lift **H** defined by the shaped profile **4b** of the cam **4** as observable in fig. 13.

Lastly, fig. 13 represents the adjustment condition in which the adjustment unit of the invention maintains the lift of the valve equivalent to the maximum design lift **H**.

15 Upon the occurrence of the condition in which the actuator means **20** adjust the shutter **17** so that the end **60** thereof penetrates into the inner longitudinal channel **11a** of the mobile rod **11** already when the contact between the idler roller **5** of the rocker arm **6** and the cam **4** occurs on the base circle **4a** of the latter, then the entire lift imposed by the cam **4** will be transformed into a useful
20 lift for the valve **2**, as observable in fig. 13.

Vice versa, if the actuator means **20** impose to the shutter **17** a position in which the end **60** thereof never penetrates into the inner longitudinal channel **11a** of the mobile rod **11**, the travel of the latter will never be stopped and will lead to the continuous lowering of the fulcrum area **F** and thus the valve **2** will
25 always remain closed during the entire rotation of the cam **4**.

Under these operating conditions, the oil contained in the hydraulic chamber **15** will be alternatively transferred from the pressure chamber **15a** to the compensation chamber **15b** and vice versa, depending on which section of the shaped profile **4b** of the cam **4** is at contact with the rocker arm **6**.

30 When the engine is operating in the conditions in which the shutter **17** is arranged in intermediate positions in the inner longitudinal channel **11a** of the mobile rod **11**, as observable for example in figures 14 and 15, the contact of the idler roller **5** of the rocker arm **6** occurs, as observable, along the intermediate sections of the cam **4** which impose high displacement speeds to
35 the valve **2**.

As a matter of fact, both the start of the opening motion of the valve **2** - i.e. when the valve detaches from the valve seat **2b** in which it is housed - and the end of the closing motion - when the valve **2** settles in the seat **2b** again - occur on sections of the cam indicated with **4e** and **4f** in figures 14 and 15 which impose high valve translation speeds.

Thus, there arises the need to provide for suitable solutions to absorb such accelerations and decelerations which would otherwise cause mechanical damage to the various components.

Firstly, it has already been said that the end **60** of the shutter **17** has a terminal collar **61** which increases the pressure in the pressure chamber **15a** with a desired gradient so as to progressively decelerate the mobile rod **11** which supports the rocker arm **6** and thus progressively decelerate the valve **2**.

In order to decelerate the valve **2** during the settling in the seat **2b** in the closing step there is also provided for the previously described damper unit **35**, which is arranged on the top part of the housing **10** and comprises the auxiliary rocker arm **36** hinged to the rocker arm **6** and the housing **10**.

The hydraulic reaction of the damper unit **35**, generated by the compression of the fluid contained in the hydraulic chamber **43** and the elastic body **41**, is transferred to the valve **2** through the auxiliary rocker arm **36** articulated between the rocker arm **6** and the housing **10** through the pins **6a** and **38** respectively.

As previously mentioned, the area with shaped profile **39** of the auxiliary rocker arm **36** which is arranged resting against the compression ring **40** of the damper unit **35** is shaped in a manner such that the damper intervenes only for given distances of the valve **2** from the inoperative position.

During the operative step of the damper unit **35**, the contact between the idler roller **5** and the cam **4** is never lost given that all clearances are recovered by the elasticity of the mobile rod **11**.

Thus, in the light of the above, it is clear that the adjustment unit subject of the invention attains all pre-set objects.

Firstly, according to the outlined description it is clear that the adjustment unit of the invention is easier to construct with respect to the equivalent prior art adjustment units and thus it is less expensive to manufacture.

Advantageously, this enables mounting the adjustment unit of the invention in engines that are installed on a wide range of motor vehicles and especially

on vehicles of the low-price bracket.

Furthermore, the operation of the invention has smaller overall dimensions with respect to the equivalent prior art adjustment units.

In addition, the embodiment of the adjustment unit of the invention is such to enable it to also perform the function of recovering the clearance of the tappets which is normally carried out by the known hydraulic tappets.

It should be observed that the adjustment unit of the invention thus described may also be obtained according to embodiments different from the one illustrated in the figures.

Thus, for example, the housing **10**, which is configured in the form of a cartridge body in the figures, may also be constituted by a seat or a housing obtained in the cylinder head or cylinder block of the engine or in any part thereof suitable for the purpose.

Furthermore, in the implementation step, the described elements that form the adjustment unit may be subjected to variants or modifications such to enable the arrangement thereof in different ways inside the housing **10**, as long as they enable the same operation.

Lastly, the actuator means **20** for the actuation of the shutter **17** may be of any type and obtained in any form as long as they are suitable to generate the displacement of the shutter **17** in the chambers.

Should such and other possible variants fall within the scope of protection of the claims that follow, they shall definitely be deemed to be protected by the present patent.

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CLAIMS

1) Unit (1) for adjusting the lift of the valves (2) of an internal combustion engine comprising at least one camshaft (3) provided with at least one cam (4) arranged at contact with an idler roller (5) of a rocker arm (6) having a first part
5 (7) associated to at least one of said valves (2), comprising:

- a mobile rod (11) slidingly inserted into a housing (10) and interposed between a fulcrum area (F) for rotating said rocker arm (6) and a hydraulic chamber (15, 15a, 15b) containing oil;
- elastically yieldable means (16) cooperating with said mobile rod (11) and
10 coaxial thereto;
- a mobile shutter (17) arranged in said hydraulic chamber (15);
- actuator means (20) for displacing said mobile shutter (17) in said hydraulic chamber (15);

said mobile rod (11) and said elastically yieldable means (16) being configured
15 to synergically cooperate and modify the position of said fulcrum area (F) when, during the rotation of said camshaft (3), said actuator means (20) modify the position of said shutter (17) with respect to said mobile rod (11),

characterised in that said mobile rod (11), said elastically yieldable means (16) and said mobile shutter (17) are coaxial to each other according to a
20 longitudinal axis (Y), said elastically yieldable means (16) being arranged externally with respect to said mobile rod (11) and said mobile rod (11) being aligned to said mobile shutter (17).

2) Adjustment unit (1) according to claim 1, **characterised in that** said mobile rod (11) is inserted into a sliding seat (12) belonging to said housing
25 (10) and it comprises:

- a first end (13) arranged at contact with a second part (9) of said rocker arm (6) arranged on the opposite side of said first part (7) and with which it defines said fulcrum area (F);
- a second end (14) arranged in said hydraulic chamber (15) obtained in said
30 housing (10);
- an internal longitudinal channel (11a) which extends from an annular area (23) created in said first end (13) up to the terminal opening (11b) present in said second end (14) of said mobile rod (11);
- an elastic element (21) arranged in said internal longitudinal channel (11a).

35 3) Adjustment unit (1) according to claim 2, **characterised in that** said

elastic element (21) is comprised between said annular area (23) and a slidable sealing cap (22) housed in said internal longitudinal channel (11a) and faced towards said mobile shutter (17).

4) Adjustment unit (1) according to claim 3, **characterised in that** said hydraulic chamber (15) comprises a pressure chamber (15a) in which there is submerged said shutter (17) and a compensation chamber (15b) defined in a portion of said internal longitudinal channel (11a) of said mobile rod (11) delimited by said slidable sealing cap (22), said chambers (15a, 15b) being in communication with each other.

5) Adjustment unit (1) according to any one of the preceding claims, **characterised in that** said mobile shutter (17) is slidingly housed in a through hole (18) obtained in said housing (10) and it has a projecting end (19) faced towards the external of said housing (10) and connected to actuator means (20) for the displacement of said mobile shutter (17).

6) Adjustment unit (1) according to claim 2 or 3, **characterised in that** it provides for a through hole (25) obtained in said annular area (23) for the communication of said internal longitudinal channel (11a) of said mobile rod (11) with said fulcrum area (F).

7) Adjustment unit (1) according to any one of the preceding claims, **characterised in that** said elastically yieldable means (16) comprise a compression ring nut (30) arranged externally to said mobile rod (11) and an elastic element (31) arranged externally coaxial to said mobile rod (11) and axially comprised between said compression ring nut (30) and said housing (10).

8) Adjustment unit (1) according to any one of the preceding claims, **characterised in that** said elastically yieldable means (16) also comprise a damper unit (35) for the deceleration of said at least one valve (2), said damper unit (35) comprising:

- an auxiliary rocker arm (36) connected through a first pin (6a) to said rocker arm (6) at the end of said at least one valve (2) and through a second pin (38) to said housing (10), said auxiliary rocker arm (36) being provided with a shaped profile (39);
- a compression ring (40) housed in a cylindrical seat (42) obtained in said housing (10) externally to said elastic element (31), said compression ring (40) being arranged externally coaxial to said compression ring nut (30) and

being axially comprised between said shaped profile (39) and an elastic body (41) housed in a cylindrical chamber (43) and arranged externally coaxial to said elastic element (31).

9) Adjustment unit (1) according to claim 8, **characterised in that** said
5 compression ring (40) is provided with an annular recession (44) which defines, with said cylindrical seat (42), an annular channel (45) which communicates with a duct (46) for supplying pressurised oil through a one-way valve (47).

10) Adjustment unit (1) according to any one of claims 4 to 9,
10 **characterised in that** said pressure chamber (15a) communicates with a duct (48) for supplying pressurised oil through a one-way valve (49).

11) Adjustment unit (1) according to any one of the preceding claims,
characterised in that said actuator means (20) comprise a connecting rod
(50) having a first end (51) fixed to a rotating shaft (52) and a second end (53)
15 associated to said mobile shutter (17) through a sliding joint (54) belonging to said mobile shutter (17) which comprises at least one pin (54a) inserted into a slotted hole (55) obtained in said second end (53) of said connecting rod (50).

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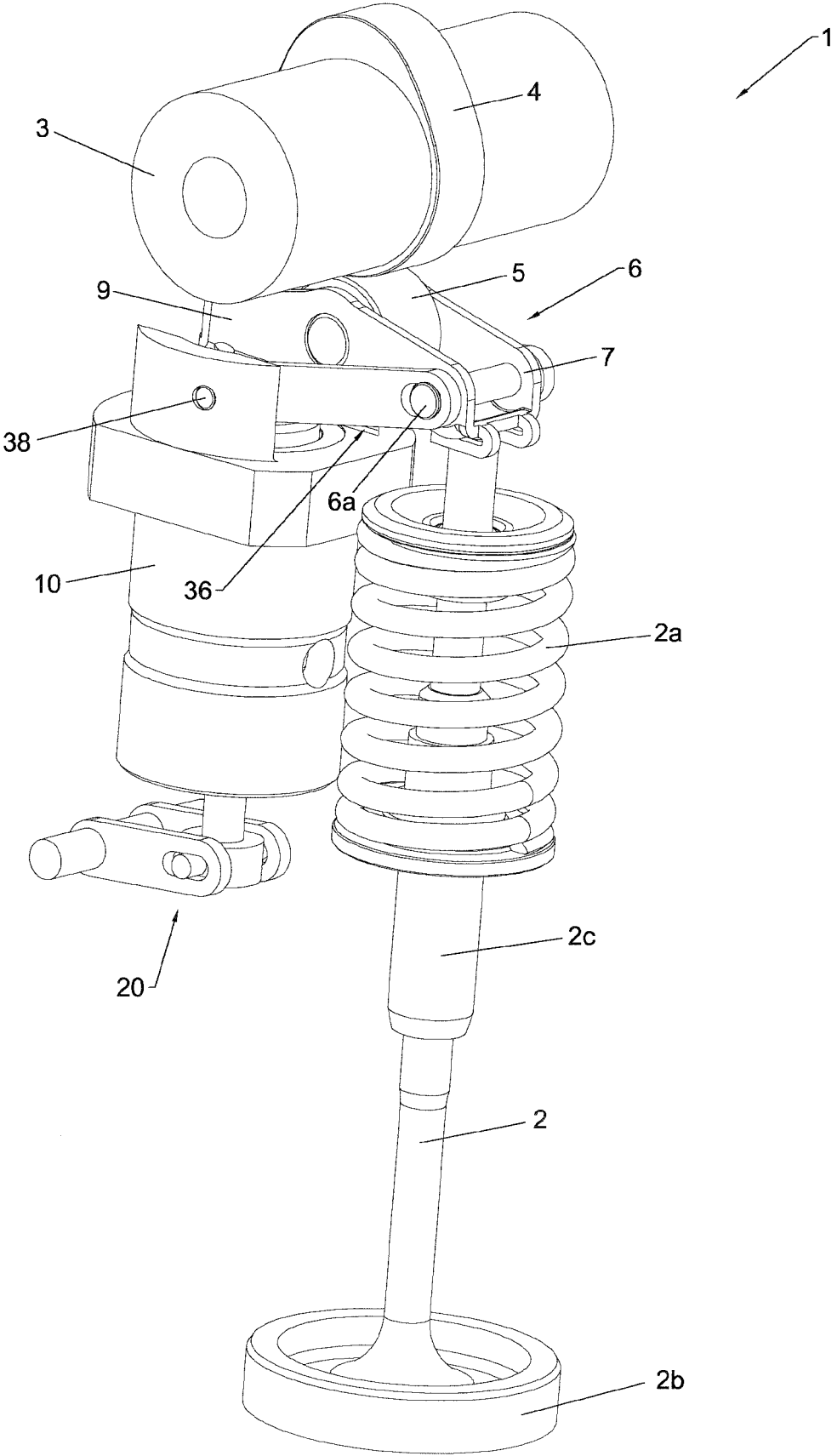


Fig.1

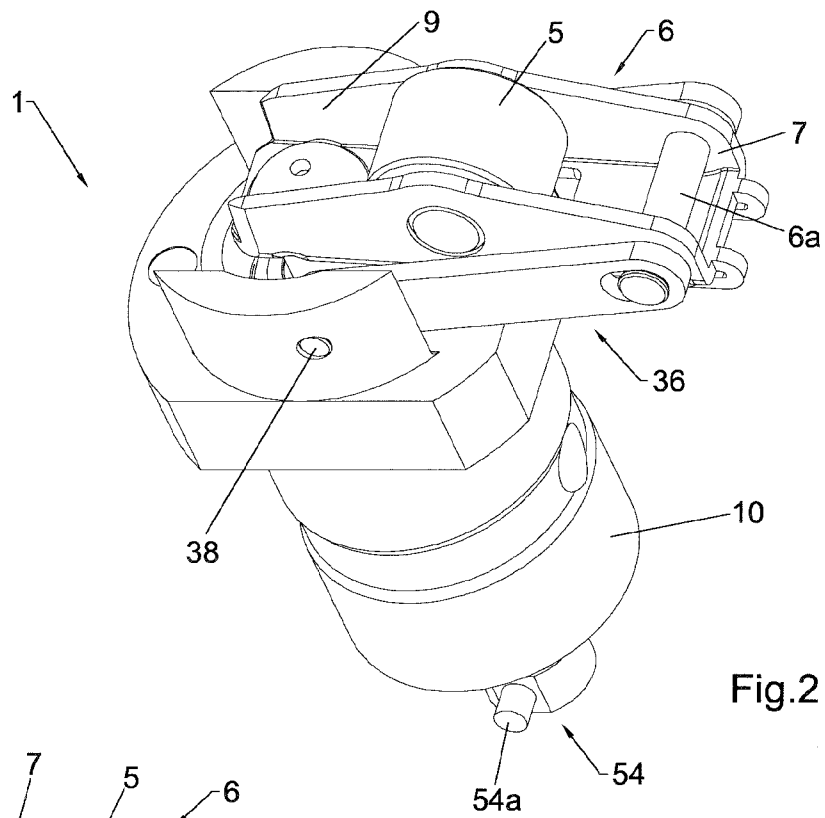


Fig.2

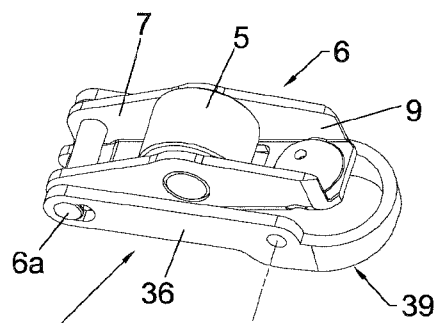


Fig.5

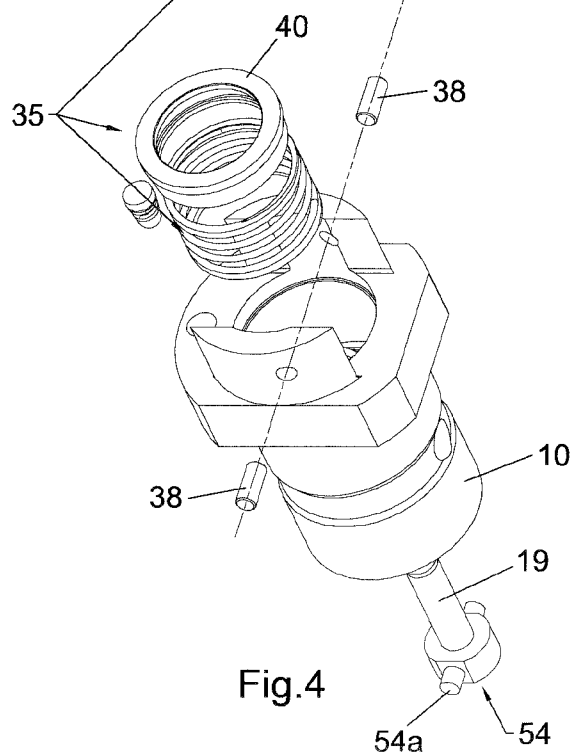


Fig.4

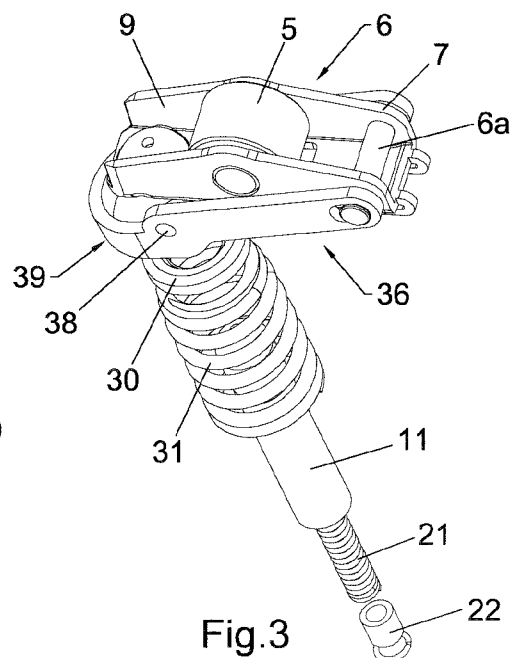


Fig.3

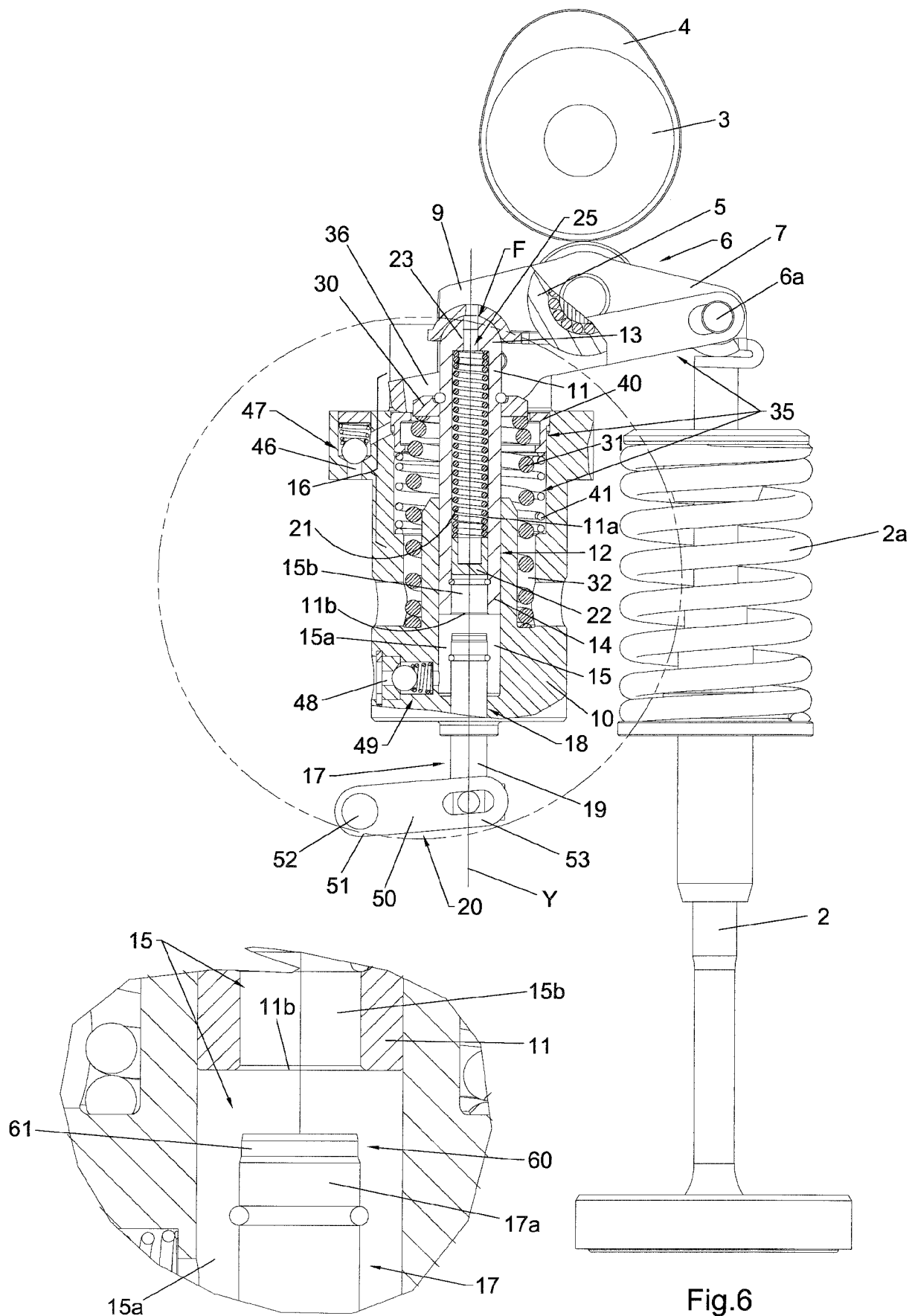


Fig.6

Fig.8

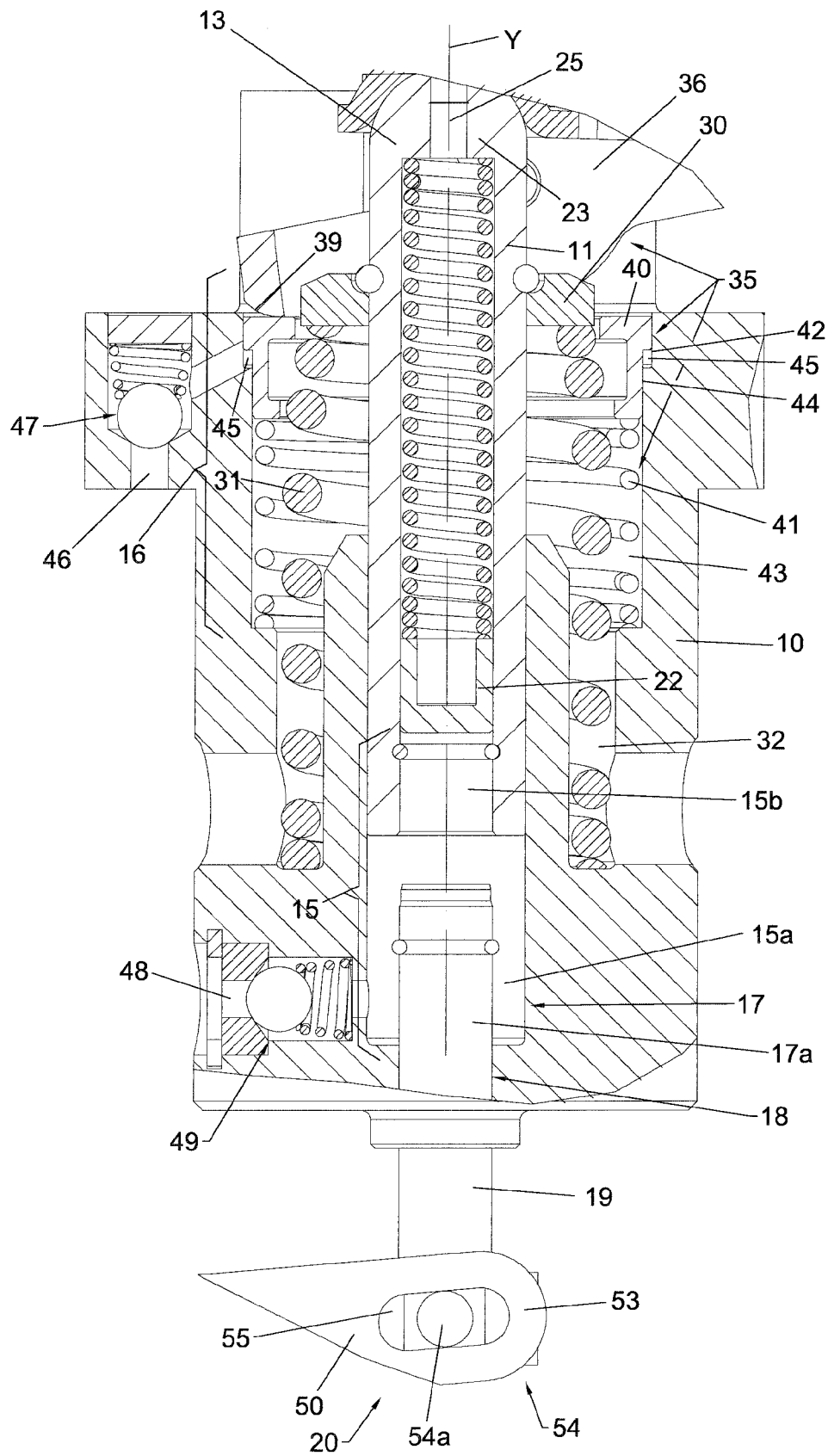


Fig.7

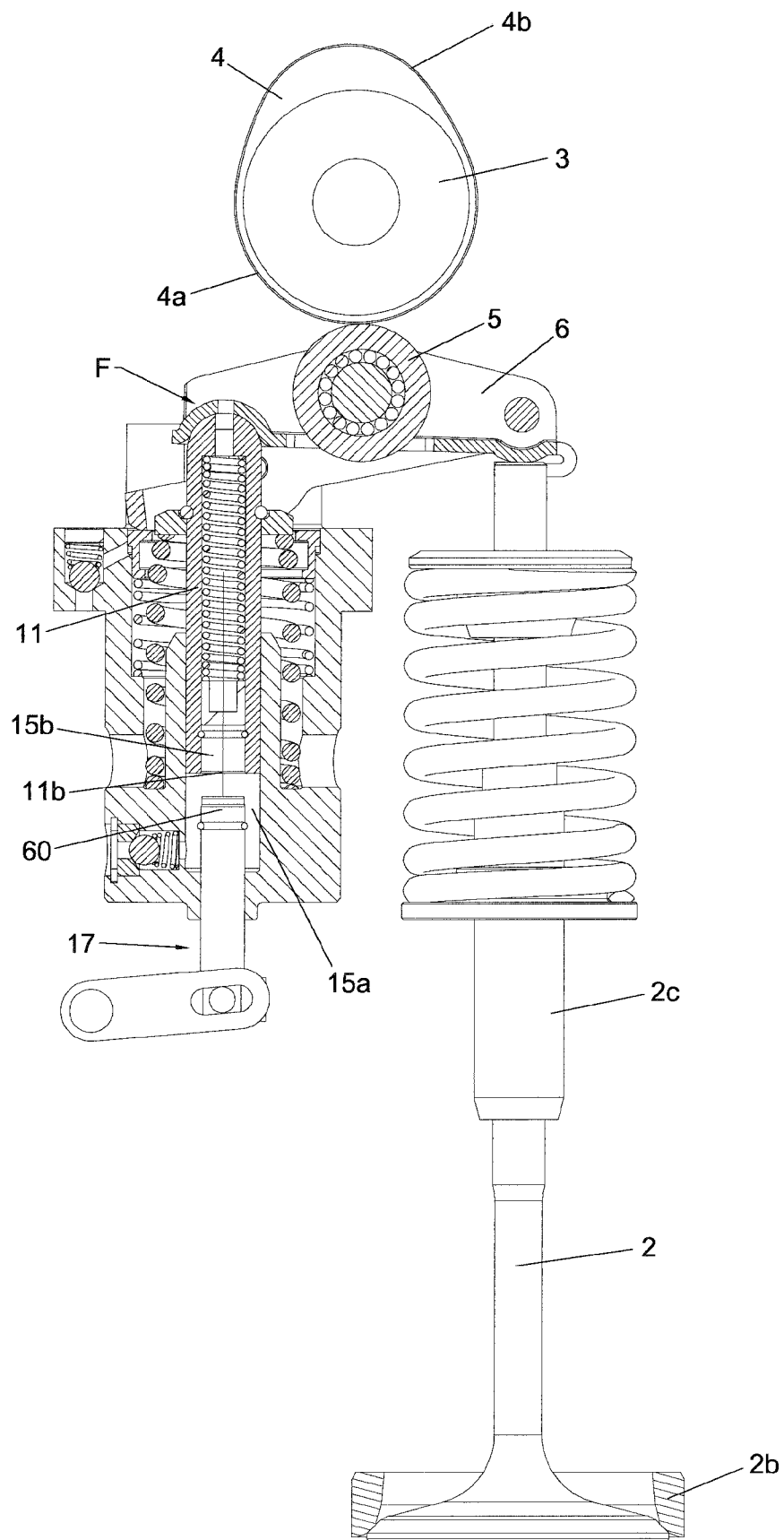


Fig.9

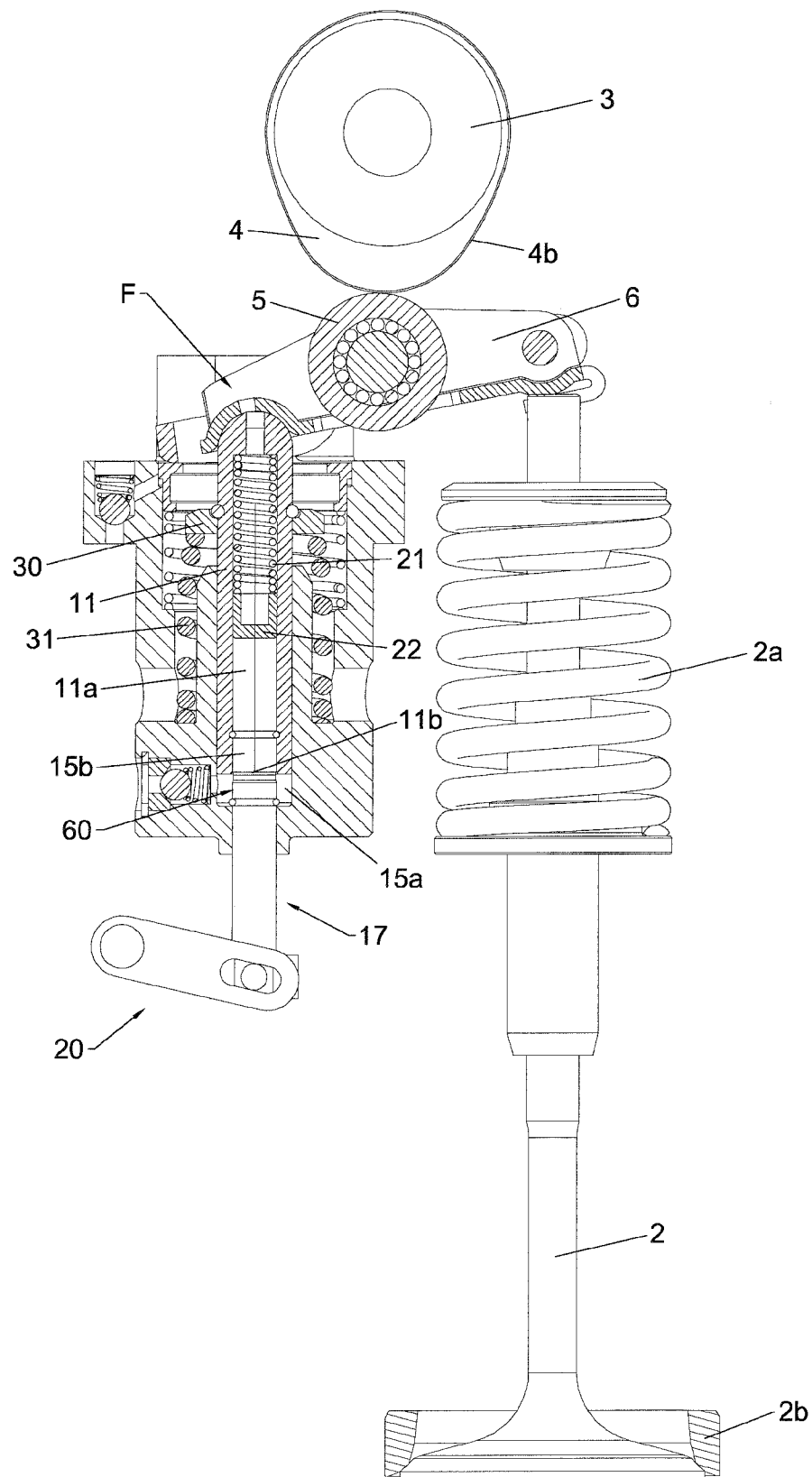
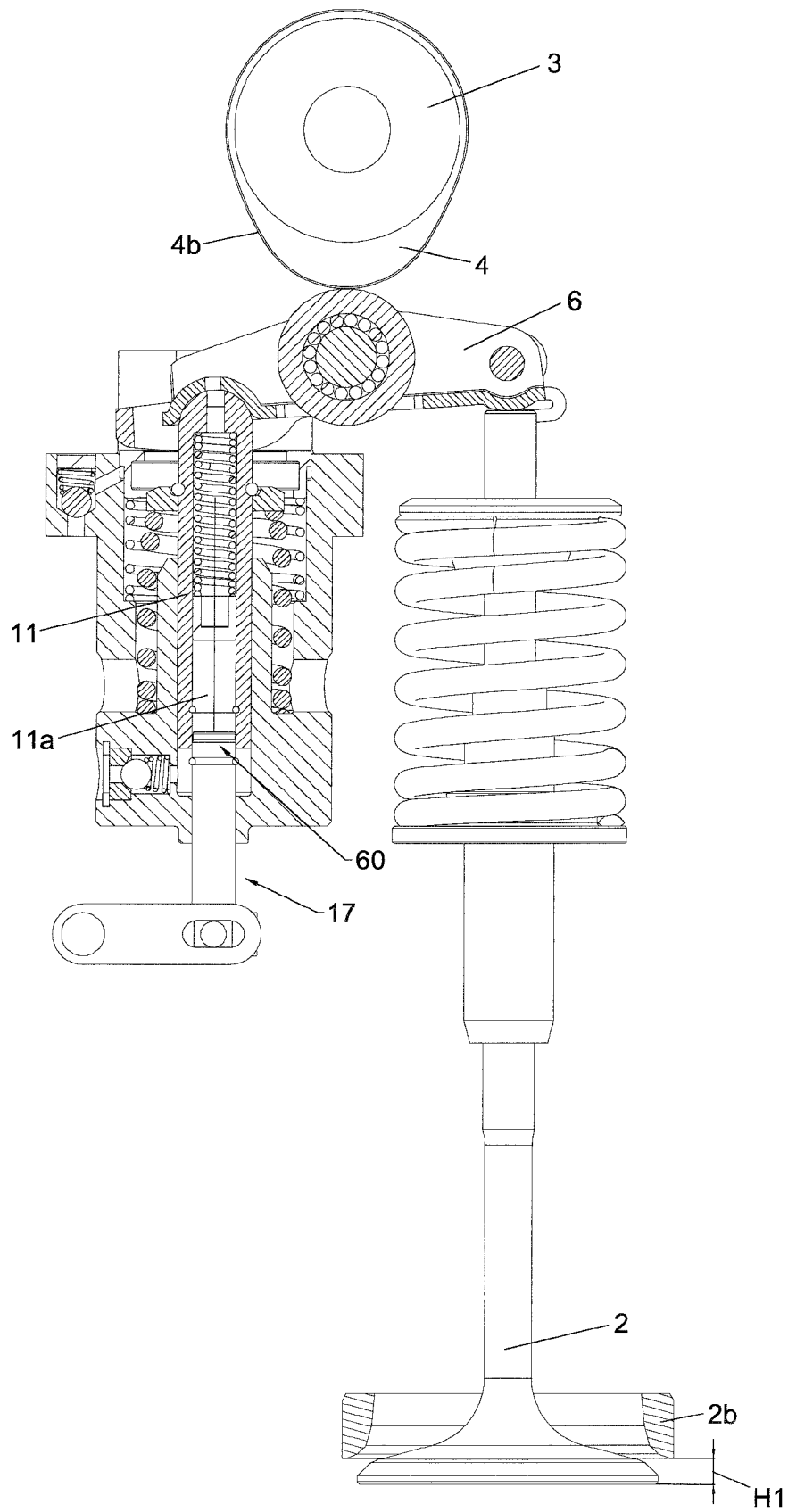


Fig.10



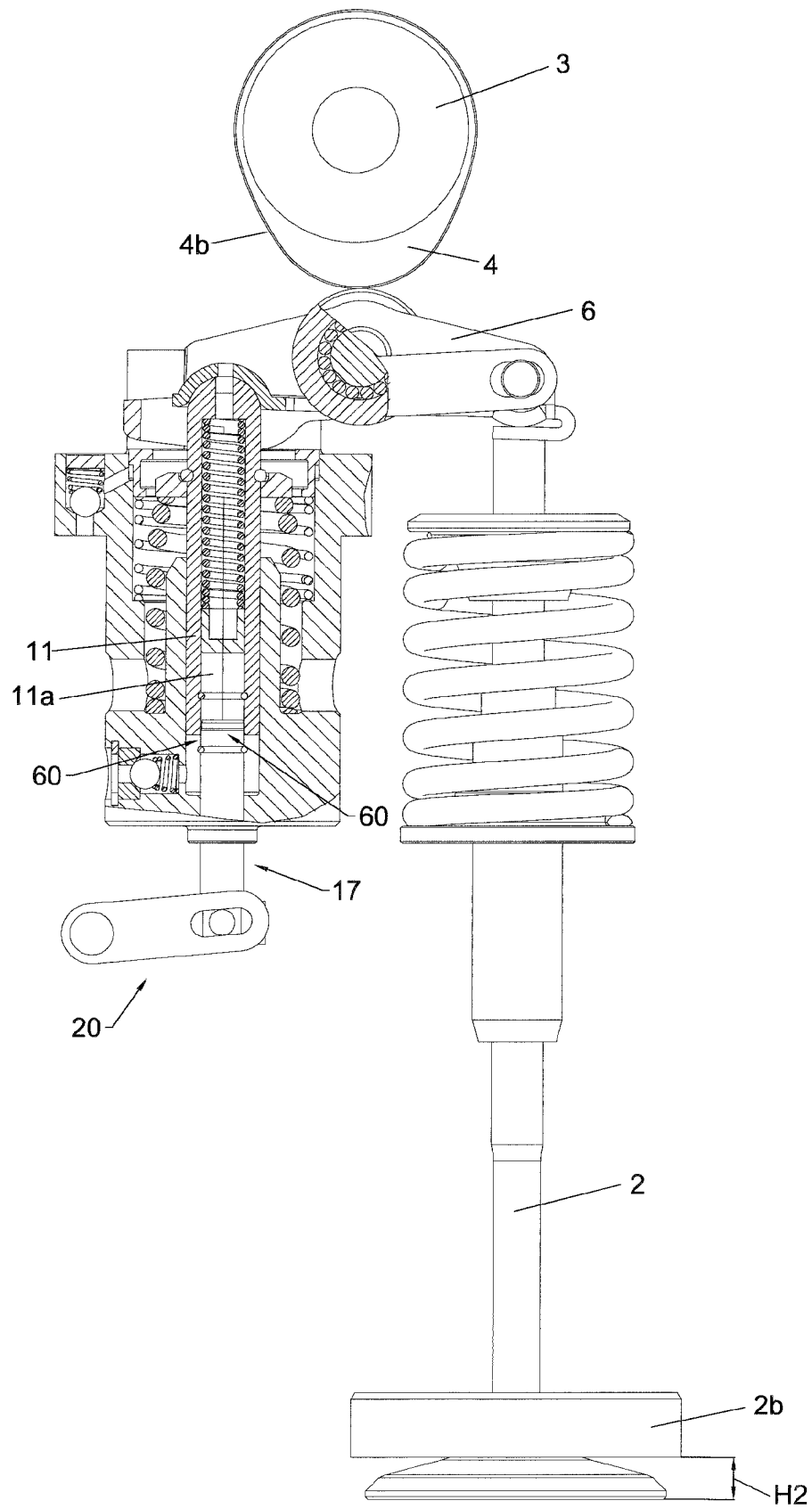


Fig.12

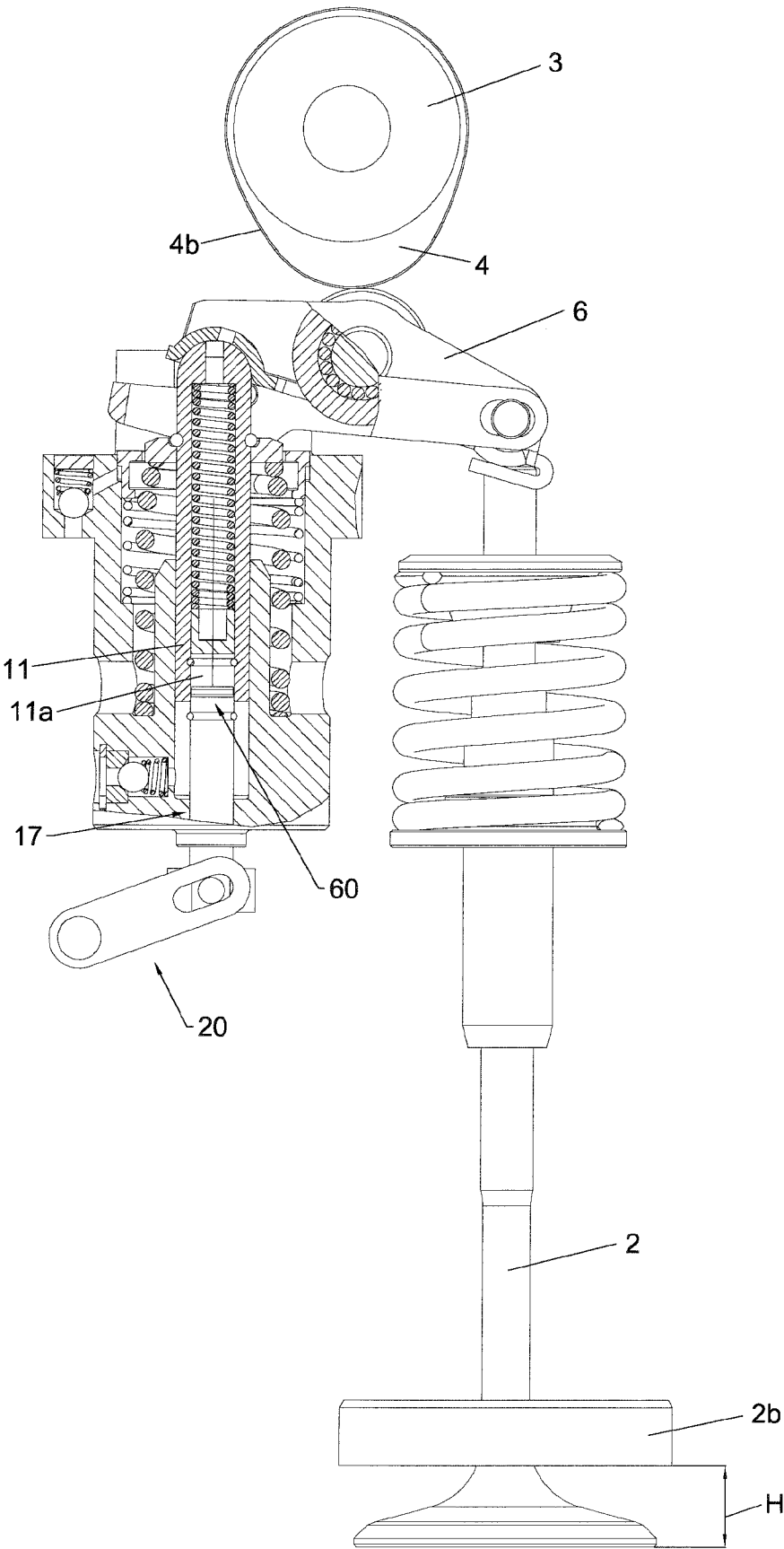


Fig.13

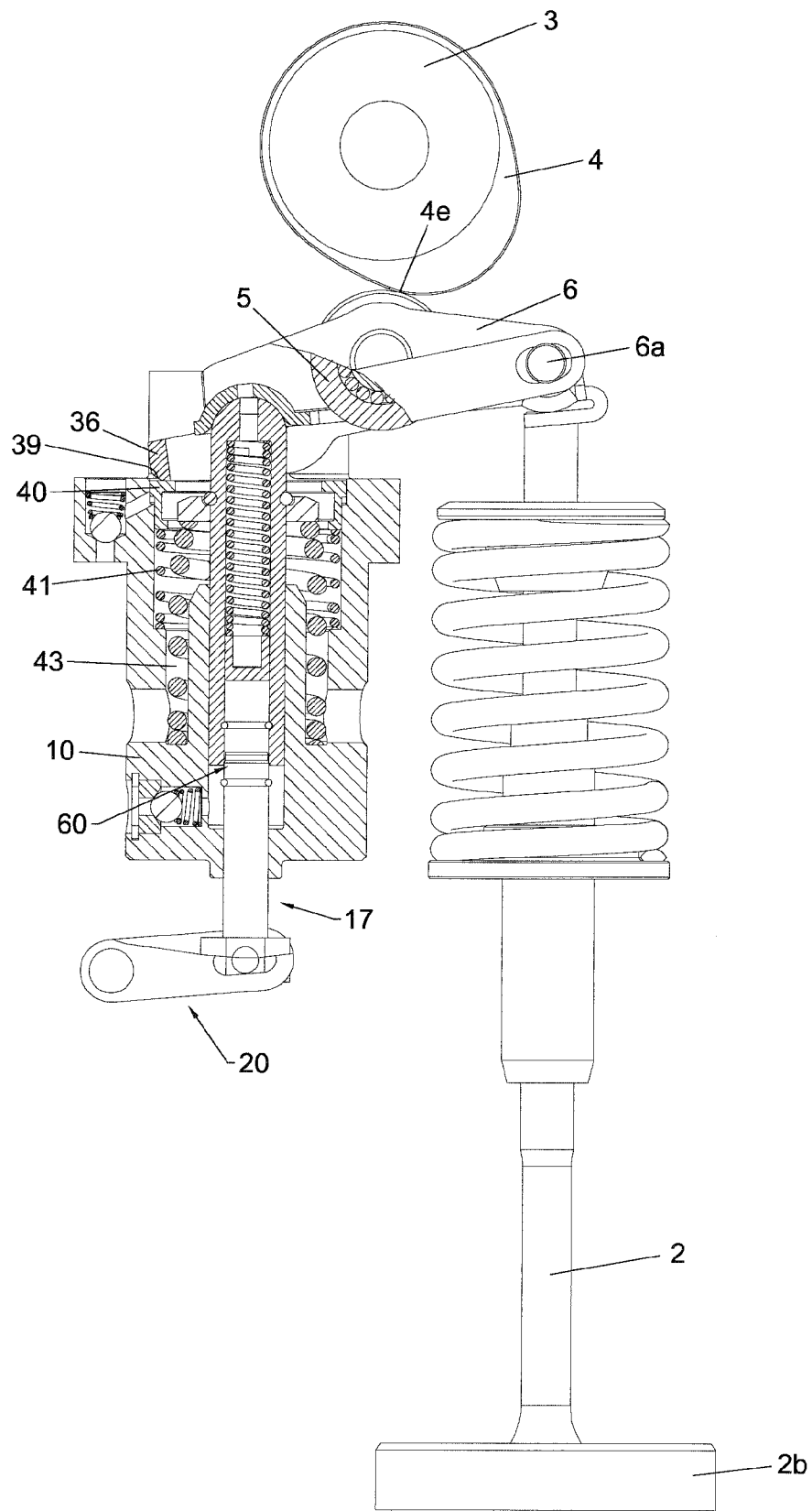


Fig.14

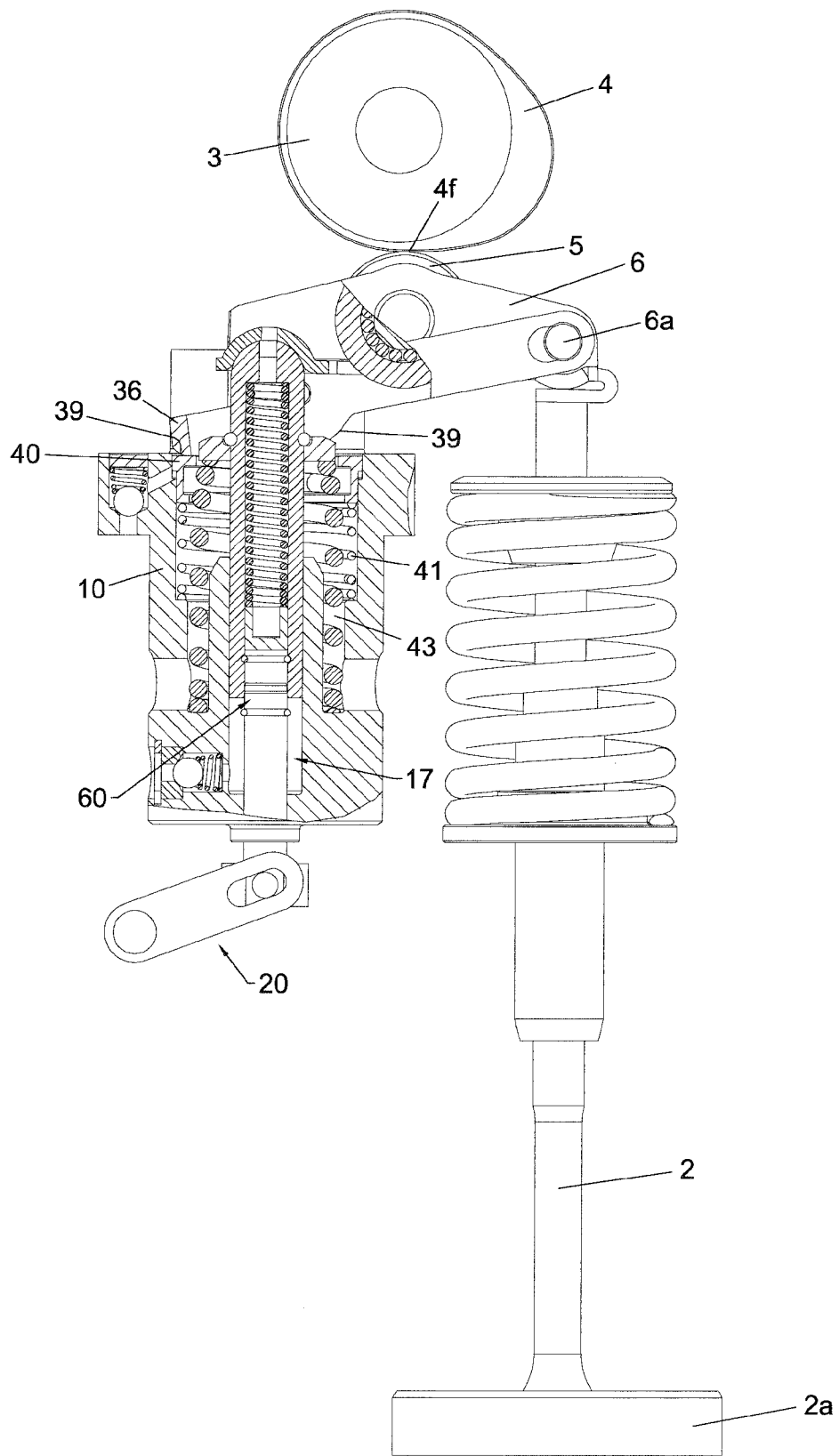


Fig.15

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/057974

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01L1/24 F01L13/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 862 784 A (BLOWERS BRYAN K [US]) 26 January 1999 (1999-01-26) abstract; figure 1 -----	1-11
A	DE 10 2008 054011 A1 (SCHAEFFLER KG [DE]) 6 May 2010 (2010-05-06) abstract; figures 1,2 -----	1-11
A	US 4 615 307 A (KODAMA HISASHI [JP] ET AL) 7 October 1986 (1986-10-07) abstract; figures -----	1-11
A	US 4 546 734 A (KODAMA HISASHI [JP]) 15 October 1985 (1985-10-15) abstract; figures ----- -/--	1-11

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

16 March 2017

Date of mailing of the international search report

06/04/2017

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/057974

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 509 467 A (ARAI FUMINAO [JP] ET AL) 9 April 1985 (1985-04-09) abstract; figure 1 -----	1-11
A	DE 198 18 146 A1 (SCHAEFFLER WAEZLAGER OHG [DE]) 28 October 1999 (1999-10-28) abstract; figures -----	1-11
A	US 4 442 806 A (MATSUURA MASAOKI [JP] ET AL) 17 April 1984 (1984-04-17) abstract; figures 3,4 -----	1-11
A	EP 1 493 902 A1 (FORD GLOBAL TECH LLC [US]) 5 January 2005 (2005-01-05) abstract; figure 1 -----	1-11
A	EP 0 814 240 A1 (RICARDO CONSULTING ENG [GB]) 29 December 1997 (1997-12-29) abstract; figure 1 -----	1-11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2016/057974

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5862784 A	26-01-1999	DE 69908857 D1 DE 69908857 T2 EP 0953734 A1 US 5862784 A	24-07-2003 06-05-2004 03-11-1999 26-01-1999
DE 102008054011 A1	06-05-2010	DE 102008054011 A1 WO 2010049324 A1	06-05-2010 06-05-2010
US 4615307 A	07-10-1986	JP H0247564 B2 JP S60204912 A US 4615307 A	22-10-1990 16-10-1985 07-10-1986
US 4546734 A	15-10-1985	JP S6350404 Y2 JP S59175615 U US 4546734 A	26-12-1988 24-11-1984 15-10-1985
US 4509467 A	09-04-1985	JP H0368209 B2 JP S5987218 A US 4509467 A	25-10-1991 19-05-1984 09-04-1985
DE 19818146 A1	28-10-1999	DE 19818146 A1 DE 19980751 D2 JP 2002513113 A US 6318322 B1 WO 9956006 A1	28-10-1999 18-01-2001 08-05-2002 20-11-2001 04-11-1999
US 4442806 A	17-04-1984	FR 2517740 A1 GB 2112456 A JP H0257205 B2 JP S5896134 A US 4442806 A	10-06-1983 20-07-1983 04-12-1990 08-06-1983 17-04-1984
EP 1493902 A1	05-01-2005	NONE	
EP 0814240 A1	29-12-1997	DE 69708757 D1 DE 69708757 T2 EP 0814240 A1 ES 2169321 T3 JP H1054213 A US 5749340 A	17-01-2002 18-07-2002 29-12-1997 01-07-2002 24-02-1998 12-05-1998