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# (54) VALVE TIMING SYSTEM

VENTILSTEUERUNGSEINRICHTUNG

SYSTEME DE COMANDE DE SOUPAPES

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(56) References cited:
**WO-A1-97/06355**
**US-A- 5 404 851**
**US-A1- 2011 277 712**
**US-A1- 2013 112 160**



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## Description

### Field of the Invention

**[0001]** The present invention relates to adjustable engine valves operated by a hydraulic system.

### Background of the Invention

**[0002]** In conventional valve timing systems the rocker arm pivots around a fixed rocker shaft. These systems enable opening and closing of only one valve controlled by a profile on a cam. Recently, various systems which enable different valve actuation by varying the timing and/or the valve lift have been developed. One example of these systems is the "Multi Air" system developed by Fiat. Detailed description of the said system is given in the International patent document no. WO9834014A1. Jacobs Manufacturing Company also has hydraulically actuated variable valve actuation and engine brake systems. Furthermore, Ostfalia University also has a similar variable valve actuation system. This system employs a piezo actuator and a stroke ratio. These systems are very expensive due to the massive, numerous and complex components they have.

**[0003]** International patent document no. WO9706355, an application in the state of the art, discloses an engine valve structure actuated by a hydraulic system. The engine cylinder valve (30) and the engine cam (40) are connected to each other via an electrically controlled hydraulic system. Lost motion is permitted by deactivating the hydraulic fluid. The electrical control system optimizes engine performance by changing the amount of fluid in the hydraulic channels which helps to adjust duration and extent of valve openings. The method disclosed in the patent document no. WO9706355 is a system which determines the portion of the cam profile which is desired to be eliminated. Therefore, it is in fact a "variable lost motion" system. Its major advantage is that the amount of lost motion can be increased as much as desired. With this method, it is not possible to open the valve to an extent more than the amount determined by the cam profile or to open the valve before the time determined by the cam profile. Thus it is not a fully variable valve actuation system.

**[0004]** International patent document no. WO2007142724, an application known in the art, discloses an exhaust valve actuated by a hydraulic system. This system also includes a braking control valve. This invention adjusts operation of the valve actuator according to the extent of the valve opening. There are two cam mechanisms in this invention. While one of these cam mechanisms (172) adjusts the valve opening, the other cam mechanism (126) adjusts the timing of fuel supply to the engine cylinder. By means of the patent document no. WO2007142724, in addition to a cam profile which is always active, another cam profile (126), which is already present for adjusting the injection timing in the engine, is enabled to be actuated when desired. In this method, the cam 172 is always in interaction with the valve. Thus, the main difference of this system from the mentioned system present in this invention application is that the second cam profile does not deactivate the main cam profile when it is activated. Since this makes a two-stroke engine braking impossible, the braking power obtained in this patent will be lower than the method of the present application. In other words, since the exhaust valve is opened in the main exhaust event with the cam 172, it will not be able to allow compression of the gas in the cylinder and therefore braking power will be lower.

**[0005]** The international patent document no. WO200400567, an application in the state of the art, discloses a system controlling cylinder inlet and outlet valves. The system enables actuation of the valve by using a cam mechanism. A control mechanism (21-25, 26) controls movement of the inlet and outlet valves. When the valves are coming to the closed position (when passing from the cam lobe nose to base circle), openings of the valves are adjusted independent from the cam profile. In certain cases, closing times of the valves can be delayed by a counteracting force provided by the hydraulic system by pre-adjusting this control mechanism. The system disclosed in the patent document no. WO200400567 is not a fully variable valve actuation system. It only slows down the closing of the valve or enables to fix it at a certain extent of opening when desired. This system also cannot enable the valve to be opened earlier or at a longer duration. The system presented in this application provides solutions for both problems. Since the suggested system is a fully variable valve actuation system, a new profile completely independent from the current valve opening profile can be activated.

**[0006]** Document US5404851discloses a device for switching an engine from a propelling mode to a braking mode through a control slide.

**[0007]** The variable valve timing systems used in the above mentioned applications reach very high costs either by increasing the number of valve train components that are currently used (for example, power density engine brake system of Jacobs Vehicle Systems company requires 2 times more components) or by using high speed electrical actuators (as in the Multi Air system developed by Fiat Power Train company).

When the power density engine brake system of Jacobs Vehicle Systems is examined, since the cam designed for braking requires 2 times more valve train components, it is significantly restricted with the geometry and layout of the current system. In such systems, large design areas are required on the engine.

Additionally, another disadvantage thereof is that the alternative cam profile can only drive one of the intake or exhaust valves. On the other hand, it is known that this system makes loud noise during operation.

The system developed by Ostfalia University is excessively complex since it requires a closed loop control system and special piezo actuators for every 2 valves. More-

over, when the engine is stopped and oil leaks from the clearances, the valves will fall over the piston since no valve spring is being used. Therefore, it is understood that this system is developed only for research purposes.

**Summary of the Invention**

**[0008]** An objective of the present invention is to provide a valve timing system which does not require lost motion.

**[0009]** Another objective of the present invention is to make multiple independent cam designs for intake valves and similarly for exhaust valves, thereby providing a valve timing system that enables cams to be activated alternately.

**[0010]** A further objective of the present invention is to provide a variable valve timing system which is low cost and lightweight.

**[0011]** Another objective of the present invention is to provide a variable valve timing system which eliminates the requirement of valve lash adjustment.

**[0012]** Another objective of the present invention is to provide a variable valve timing system which eliminates use of valve train components which are subjective wear in time.

**Detailed Description of the Invention**

**[0013]** "A valve timing system" developed to fulfill the objective of the present invention is illustrated in the accompanying figures, in which:

Figure 1 is the schematic view of the active state of the second cam in the valve timing system (engine brake on).

Figure 2 is the schematic view of the active state of the first cam in the valve timing system (normal cycle).

Figure 3 is the schematic view of the hydraulic line of the first cam when the second cam is being activated in the valve timing system.

Figure 4 is the schematic view of the hydraulic line of the second cam when the second cam is being activated in the valve timing system.

**[0014]** The components given in the figures are assigned reference numbers as follows:

1. Valve timing system
2. Solenoid valve
3. Main oil line
4. Outlet channel
5. Upper channel
6. Inlet channel
7. First piston
8. First spring
9. Safety valve
10. Second channel
11. Second piston
12. Second spring
13. Body
14. Cavity
15. Opening
16. Third channel
17. First main piston
18. First cam
19. Fourth channel
20. Second main piston
21. Second cam
22. Fifth channel
23. Sixth channel
24. Check valve
25. Valve mechanism
26. Cylinder
27. Pushing piston
28. Valve assembly
29. Pin
30. Valve
31. Valve spring

**[0015]** The valve timing system (1) of the present invention used in compression brakes in internal combustion engines basically comprises

- at least one solenoid valve (2),
- at least one main oil line (3) through which oil is pumped,
- at least one outlet channel (4),
- at least one upper channel (5),
- at least one inlet channel (6) to which the solenoid valve (2) is mounted and to which oil is delivered from the main oil line (3),
- at least one first piston (7) located within the inlet channel (6),
- at least one first spring (8) which is located within the inlet channel (6) and to which the first piston (5) exerts pressure,
- at least one safety valve (9) which is located at the end of the inlet channel (6),
- at least one second channel (10) to which the open end of the safety valve (9) is connected,
- at least one second piston (11) which moves within the second channel (10),
- at least one second spring (12) to which the second piston (11) exerts pressure,
- at least one body (13) into which the second channel (10) fits and in which the second piston (11) and the second spring (12) are located,
- at least one cavity (14) located on the body (13) surfaces,
- an opening (15) in the structure of the second piston (11),
- at least one third channel (16), by which the cavity (14) located on the body (13) surface opens outwards from the body (13),
- at least one first main piston (17) to which the end

of the third channel (16) that does not fit into the cavity (14) opens out,
- at least one first cam (18) which operates in connection with the first main piston (17),
- at least one fourth channel (19), by which the other cavity (14) located on the body (13) surface opens outwards from the body (13),
- at least one second main piston (20) to which the end of the fourth channel (19) that does not fit into the cavity (14) opens out,
- at least one second cam (21) which operates in connection with the second main piston (20),
- at least one fifth channel (22) which opens outwards from the surface of the body (13),
- at least one sixth channel (23) which branches out from the fifth channel (22),
- at least one check valve (24) which is located on the sixth channel (23),
- at least one valve mechanism (25) which is located after the check valve (24) and to which the sixth channel (23) opens out,
- at least one cylinder (26) which is located at the end of the fifth channel (22) that is not connected to the body (13),
- at least one pushing piston (27) which is located in the cylinder (26),
- at least one valve assembly (28) to which the end of the pushing piston (27) opens out,
- at least one pin (29) which is located between the valve assembly (28) and the valve mechanism (25),
- valves constituting the valve assembly (28),
- valve springs (31) which enable opening and closing of the valves (30).

**[0016]** In the valve timing system (1) of the present invention, upon being activated, the solenoid valve (2) enables the oil flow coming from the main oil line (3) to open out to the inlet channel (6) and push the first piston (7) located in the inlet channel (6) against the first spring (8). This allows flow of oil from the safety valve (9) to the second channel (10). The oil pressure in the second channel (10) pushes the second piston (11) against the second spring (12). At this position, the second piston (11) cannot move in the second channel (10), since flow is prohibited by the safety valve (9) and the first piston (7). In this case, the valves (30) are opened against high in-cylinder (30) pressure, thereby realizing compression release braking. The resulting hydraulic lock will prevent movement of the second piston (11) regardless of how high the pressure in the chamber is. In this (stationary) position of the first piston (11), the second cam (21) is activated, and by pushing the second main piston (20), pumps the oil from the cylinder (26) to the fifth channel (22) and pushes the pushing piston (27) thereby moving the valves (30). A valve spring (31) is provided to maintain the continuous contact between the second main piston (20) and the second cam (21) and to enable closing of the valves (30). Therefore the valve (30) opening action provided by the second cam (21) takes place against the valve spring (31). The second cam (21) is configured to perform engine brake cycle, therefore it works under higher pressures compared to the main cycle. At this position of the second piston (11), the first cam (18) will not be activated unless the third channel (16) is completely filled with oil. The movement of the first cam (18) is disabled thanks to the alignment of the cavity (14) with the opening (15) located on the second piston (11) and to the clearance between the third channel (16) and the cavity (14), which opens to the crankcase.

**[0017]** In order to activate the first cam (18), the solenoid valve (22) is deactivated lowering the pressure in the inlet channel (6). The first piston (7) moves downwards under the action of the first spring (8) thereby discharging the pressurized oil in the second channel (10) by aligning the upper channel (5) with the outlet channel (4). The second piston (11) starts to move upwards as the compressed spring force of the second spring (12) starts to overcome the oil pressure in the second channel (10). At this position, the third channel (16) and the fifth channel (22) are connected to each other; and the second piston (11) starts to pump the oil into the cylinder (26) with the movement it receives from the first cam (18). This way, the first cam (18) is activated. The first cam (18) performs the main cycle, and as it is also described above, valves require much lower valve opening pressures during the main cycle compared to the engine brake cycle. The oil pressure, which is created by the hydraulic lock that enables the valves (30) to open upon being combined from the third channel (16) and the fifth channel (22), exerts an equal pressure at the channels and clearances within the first piston (7) and this way there is no net force in the first piston (7) and the first piston (7) is enabled to keep its position by means of the force exerted by the first spring (8).

**[0018]** The sizes of the second piston (11) and the body (13), on which the second piston (11) is located, are adjusted such that the third channel (16) will start to open when the cavity (14) starts to be closed by the second piston (11) and the third channel (16) will be in interaction with the cavity (14) in order to prevent hydraulic lock within the fourth channel (19) when switching from the second cam (21) to the first cam (18) (seen in Figure 3). Likewise, the size of the cavity (14) located on the surface of the body (13) is such that it will provide interaction with the opening (15) before being closed by the second piston (11) (seen in Figure 4).

**[0019]** The valve mechanism (25) is utilized so as to enable renewing of the decreasing oil when the valves (30) are in closed position. When the valves (30) are in open position, the check valve (24) prevents backflow of oil in the cylinder (26) to the main oil line. When the valves (30) are close to the closed position, the pin (29) pushes the valve in the valve mechanism (25) and thus the oil within the engine main line is enabled to supply the oil within the valve timing system (1).

**[0020]** The valve timing system (1) of the present in-

vention can be integrated in exactly the same way to the intake valve system side. This way, two-stroke engine braking can be achieved and an engine brake power which is much higher than those of the current engine brake systems can be achieved. In this case, the solenoid valve (2) and the valve mechanism (25) are added to the valve timing system (1) exactly the same way for the intake valve (30) systems side. Likewise, by actuating a single solenoid valve (2), two second pistons (11) provided for the intake and exhaust sides can be actuated at the same time.

**[0021]** Since a completely new cam profile which is independent from the other profile can be activated in the valve timing system (1), it is possible both to increase the valve (30) opening more than it is provided by the first cam (18) profile and to open it earlier.

**[0022]** Thanks to the valve timing system (1) of the present invention, lost motion is not required, preferably two independent cam designs separate for each intake and exhaust valve which are independent from each other can be made and arranged in the current design area, variable valve (30) timing actuators can be provided as much more inexpensive and lightweight, and the requirement of valve (30) lash adjustment is eliminated. Use of valve train components which are critical in terms of wear is eliminated. Thus the excessive wear problem in the valve (30) system is significantly reduced.

**[0023]** With the developed valve timing system (1), opening closing height and timing of the valves (30) can be changed by means of the cams (first cam (18) and second cam (21)) which are designed to be two or more according to need for each cylinder (26). One of the designed cams (first cam (18) and second cam (21)) has the standard opening closing profile of the valve (30) while the other cam (or cams) (first cam (18) and second cam (21)) has/have the profile necessary for the engine braking system. If the system is developed separately for the intake and exhaust valves, high engine brake powers can be attained by means of the two-stroke compression release engine brake (shown in Figure 1).

## Claims

**1.** A valve timing system (1), which is used in compression release brakes in internal combustion engines, basically **comprising**

- at least one solenoid valve (2),
- at least one main oil line (3) through which oil is pumped,
- at least one outlet channel (4),
- at least one upper channel (5),
- at least one inlet channel (6) to which the solenoid valve (2) is mounted and to which oil is delivered from the main oil line (3),
- at least one first piston (7) located within the inlet channel (6),
- at least one first spring (8) which is located within the inlet channel (6) and to which the first piston (5) exerts pressure,
- at least one safety valve (9) which is located at the end of the inlet channel (6); and
- at least one second channel (10) to which the open end of the safety valve (9) is connected,
- at least one second piston (11) which moves within the second channel (10),
- at least one second spring (12) to which the second piston (11) exerts pressure,
- at least one body (13) into which the second channel (10) fits and in which the second piston (11) and the second spring (12) are located,
- at least one cavity (14) located on the body (13) surfaces,
- an opening (15) in the structure of the second piston (11),
- at least one third channel (16), by which the cavity (14) located on the body (13) surface opens outwards from the body (13),
- at least one first main piston (17) to which the end of the third channel (16) that does not fit into the cavity (14) opens out,
- at least one first cam (18) which operates in connection with the first main piston (17),
- at least one fourth channel (19), by which the other cavity (14) located on the body (13) surface opens outwards from the body (13),
- at least one second main piston (20) to which the end of the fourth channel (19) that does not fit into the cavity (14) opens out,
- at least one second cam (21) which operates in connection with the second main piston (20),
- at least one fifth channel (22) which opens outwards from the surface of the body (13),
- at least one sixth channel (23) which branches out from the fifth channel (22),
- at least one check valve (24) which is located on the sixth channel (23),
- at least one valve mechanism (25) which is located after the check valve (24) and to which the sixth channel (23) opens out,
- at least one cylinder (26) which is located at the end of the fifth channel (22) that is not connected to the body (13),
- at least one pushing piston (27) which is located in the cylinder (26),
- at least one valve assembly (28) to which the end of the pushing piston (27) opens out,
- at least one pin (29) which is located between the valve assembly (28) and the valve mechanism (25),
- valves constituting the valve assembly (28),
- valve springs (31) which enable opening and closing of the valves (30).

**2.** The valve timing system (1) according to Claim 1,

**characterized by** the solenoid valve (2), which, upon being activated, enables the oil flow coming from the main oil line (3) to open out to the inlet channel (6) and push the first piston (7) located in the inlet channel (6) against the first spring (8).

**3.** The valve timing system (1) according to Claim 1 or Claim 2, **characterized by** the second channel (10), the oil pressure in which pushes the second piston (11) against the second spring (12).

**4.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the valve spring (31) which is provided to maintain the continuous contact between the second main piston (20) and the second cam (21) and to enable closing of the valves (30).

**5.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the valves (30) which enable compression release brake by being opened against high in-cylinder (30) pressure.

**6.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the second channel (10) in which the second piston (11) cannot move since flow is prohibited by the safety valve (9) and the first piston (7).

**7.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the second cam (21), which, when activated, pushes the second main piston (20) and thus pumps the oil from the cylinder (26) to the fifth channel (22) and pushes the pushing piston (27) thereby starting to move the valves (30).

**8.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the first cam (18), for which, in order to be activated, the pressure in the inlet channel (6) is lowered by deactivating the solenoid valve (2).

**9.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the first piston (7) which moves downwards under the action of the first spring (8) thereby discharging the pressurized oil in the second channel (10) by aligning the upper channel (5) with the outlet channel (4).

**10.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the second piston (11) which starts to move upwards as the compressed spring force of the second spring (12) starts to overcome the oil pressure in the second channel (10).

**11.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the second piston (11), which, when the third channel (16) and the fifth channel (22) are connected to each other, starts to pump the oil into the cylinder (26) with the movement it receives from the first cam (18) and thus enables to activate the first cam (18).

**12.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the valve mechanism (25) which is utilized so as to enable renewing of the decreasing oil when the valves (30) are in closed position.

**13.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the check valve (24), which, when the valves (30) are in open position, prevents backflow of oil in the cylinder (26) to the main oil line.

**14.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the pin (29), which, when the valves (30) are close to the closed position, pushes the valve in the valve mechanism (25) and thus enables the oil within the engine main line to supply the oil within the valve timing system (1).

**15.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the cams (first cam (18) and second cam (21)) which enable opening closing height and timing of the valves (30) to be changed and which are designed to be two or more for each cylinder (26) according to need.

**16.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the second piston (11) and the body (13), on which the second piston (11) is located, whose sizes are adjusted such that the third channel (16) will start to be opened when the cavity (14) starts to be closed by the second piston (11) and the third channel (16) will be in communication with the cavity (14) in order to prevent hydraulic lock within the fourth channel (19) when switching from the second cam (21) to the first cam (18).

**17.** The valve timing system (1) according to any one of the preceding claims, **characterized by** the cavity (14), whose size is such that it will provide communication with the opening (15) before being closed by the second piston (11), and which is located on the surface of the body (13).

## Patentansprüche

**1.** Ventiltriebsystem (1), das in Dekompressionsmotorbremsen in Brennkraftmaschinen verwendet wird,

im Wesentlichen **umfassend**

- mindestens ein Magnetventil (2),
- mindestens eine Hauptölleitung (3), durch die Öl gepumpt wird,
- mindestens einen Auslasskanal (4),
- mindestens einen oberen Kanal (5)
- mindestens einen Einlasskanal (6), an dem das Magnetventil (2) montiert ist und zu dem Öl von der Hauptölleitung (3) geliefert wird,
- mindestens einen ersten Kolben (7), der innerhalb des Einlasskanals (6) angeordnet ist,
- mindestens eine erste Feder (8), die innerhalb des Einlasskanals (6) angeordnet ist und auf den der erste Kolben (5) Druck ausübt,
- mindestens ein Sicherheitsventil (9), das am Ende des Einlasskanals (6) angeordnet ist; und
- mindestens einen zweiten Kanal (10), mit dem offenen Ende des Sicherheitsventils (9) verbunden ist,
- mindestens einen zweiten Kolben (11), der sich innerhalb des zweiten Kanals (10) bewegt,
- mindestens eine zweite Feder (12), auf die der zweite Kolben (11) Druck ausübt,
- mindestens einen Körper (13), in den der zweite Kanal (10) passt und in dem der zweite Kolben (11) und die zweite Feder (12) angeordnet sind,
- mindestens einen an der Oberfläche des Körpers (13) angeordneten Hohlraum (14),
- eine Öffnung (15) im Aufbau des zweiten Kolbens (11),
- mindestens einen dritten Kanal (16), durch den der auf der Oberfläche des Körpers (13) angeordneten Hohlraum (14) aus dem Körper (13) nach außen mündet,
- mindestens einen ersten Hauptkolben (17), zu dem das Ende des dritten Kanals (16) mündet, der nicht in den Hohlraum (14) passt,
- mindestens einen Nocken (18) der in Verbindung mit dem ersten Hauptkolben (17) arbeitet,
- mindestens einen vierten Kanal (19), durch den der andere auf der Oberfläche des Körpers (13) angeordneten Hohlraum (14) aus dem Körper (13) nach außen mündet,
- mindestens einen zweiten Hauptkolben (20), zu dem das Ende des vierten Kanals (19) mündet, der nicht in den Hohlraum (14) passt,
- mindestens einen zweiten Nocken (21) der in Verbindung mit dem zweiten Hauptkolben (20) arbeitet,
- mindestens einen fünften Kanal (22), der aus der Oberfläche des Körpers (13) nach außen mündet,
- mindestens einen sechsten Kanal (23), der sich aus dem fünften Kanal (22) verzweigt,
- mindestens ein Rückschlagventil (24), das an dem sechsten Kanal (23) angeordnet ist,
- mindestens einen Ventilmechanismus (25), der nach dem Rückschlagventil (24) angeordnet ist und zu dem der sechste Kanal (23) mündet,
- mindestens einen Zylinder (26), der am Ende des fünften Kanals (22) angeordnet ist, der nicht mit dem Körper (13) verbunden ist,
- mindestens einen Druckkolben (27), der im Zylinder (26) angeordnet ist,
- mindestens eine Ventilanordnung (28), zu der das Ende des Druckkolbens (27) mündet,
- mindestens einen Stift (29), der zwischen der Ventilanordnung (28) und dem Ventilmechanismus (25) angeordnet ist,
- Ventile, die die Ventilanordnung (28) bilden,
- Ventilfedern (31), die ein Öffnen und Schließen der Ventile (30) ermöglichen.

**2.** Ventiltriebsystem (1) nach Anspruch 1, **gekennzeichnet durch** das Magnetventil (2), das bei der Aktivierung es ermöglicht, dass der von der Hauptölleitung (3) kommende Ölströmung zum Einlasskanal (6) mündet und den ersten Kolben (7), der im Einlasskanal (6) angeordnet ist, gegen die erste Feder (8), drückt.

**3.** Ventiltriebsystem (1) nach Anspruch 1 oder Anspruch 2, **gekennzeichnet durch** den zweiten Kanal (10), in dem der Öldruck den zweiten Kolben (11) gegen die zweite Feder (12) drückt.

**4.** Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** die Ventilfeder (31), die vorgesehen ist, um den kontinuierlichen Kontakt zwischen dem zweiten Hauptkolben (20) und dem zweiten Nocken (21) aufrechtzuerhalten und das Schließen der Ventile (30) zu ermöglichen.

**5.** Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** die Ventile (30), die die Dekompressionsmotorbremse aktivieren, indem sie gegen einen hohen Zylinderinnendruck (30) geöffnet werden.

**6.** Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den zweiten Kanal (10), in dem der zweite Kolben (11) sich nicht bewegt, da die Strömung durch das Sicherheitsventil (9) und den ersten Kolben (7) verhindert wird.

**7.** Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den zweiten Nocken (21), der, bei der Aktivierung, den zweiten Hauptkolben (20) drückt und somit das Öl aus dem Zylinder (26) in den fünften Kanal (22) pumpt und den Druckkolben (27) drückt, wodurch er beginnt, die Ventile (30) zu bewegen.

8. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den ersten Nocken (18), bei dem zur Aktivierung, der Druck im Einlasskanal (6) durch Deaktivierung des Magnetventils (2) gesenkt wird.

9. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den ersten Kolben (7), der sich nach unten unter der Wirkung der ersten Feder (8) bewegt, wodurch das Drucköl im zweiten Kanal (10) durch Ausrichten des oberen Kanals (5) mit dem Auslasskanal (4) entfüllt wird.

10. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den zweiten Kolben (11), der beginnt, sich nach oben zu bewegen, wenn die komprimierte Federkraft der zweiten Feder (12) beginnt, den Öldruck in dem zweiten Kanal (10) zu überwinden.

11. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den zweiten Kolben (11), der, wenn der dritte Kanal (16) und der fünfte Kanal (22) miteinander verbunden sind, beginnt, das Öl mit der Bewegung, die es von der ersten Nocken (18) empfängt, in den Zylinder (26) zu pumpen und ermöglicht somit die Aktivierung des ersten Nockens (18).

12. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** einen Ventilmechanismus (25), der verwendet wird, um eine Erneuerung des abnehmenden Öls zu ermöglichen, wenn sich die Ventile (30) in der geschlossenen Position befinden.

13. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** das Rückschlagventil (24), das, wenn die Ventile (30) in offener Position sind, einen Rückfluss von Öl in dem Zylinder (26) zur Hauptölleitung verhindert.

14. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den Stift (29), der, wenn die Ventile (30) zu nahe der geschlossenen Position sind, das Ventil in dem Ventilmechanismus (25) drückt und somit ermöglicht, dass das Öl innerhalb der Motorhauptleitung das Öl innerhalb des Ventiltriebsystems (1) liefert.

15. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** die Nocken (erste Nocke (18) und zweite Nocke (21)), die die Veränderung der Höhe des Öffnen und Schließens und des Zeitrahmens der Ventile (30) ermöglichen und die je nach Bedarf für jeden Zylinder (26) zwei oder mehr sein können.

16. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den zweiten Kolben (11) und der Körper (13) auf dem der zweite Kolben (11) angeordnet ist, dessen Größe so eingestellt ist, dass der dritte Kanal (16) beginnt, geöffnet zu werden, wenn der Hohlraum (14) beginnt, durch den zweiten Kolben (11) geschlossen zu werden, und der dritte Kanal (16) mit dem Hohlraum in Verbindung steht (14) um eine hydraulische Blockierung innerhalb des vierten Kanals (19) beim Umschalten von der zweiten Nocke (21) auf die erste Nocke (18) zu verhindern.

17. Ventiltriebsystem (1) nach einem der vorangehenden Ansprüche, **gekennzeichnet durch** den Hohlraum (14), dessen Größe derart ist, dass er mit der Öffnung (15) in Verbindung steht, bevor er durch den zweiten Kolben (11) geschlossen wird, und der an der Oberfläche des Körpers (13) angeordnet ist.

**Revendications**

1. Système de réglage de soupapes (1), qui est utilisé dans des freins à décompression dans des moteurs à combustion interne, **comprenant** essentiellement

- au moins une électrovanne (2).
- au moins une conduite d'huile principale (3) à travers laquelle l'huile est pompée,
- au moins un canal de sortie (4),
- au moins un canal supérieur (5),
- au moins un canal d'entrée (6) sur lequel est montée l'électrovanne (2) et à laquelle de l'huile est délivrée par la conduite d'huile principale (3),
- au moins un premier piston (7) situé à l'intérieur du canal d'entrée (6),
- au moins un premier ressort (8) situé à l'intérieur du canal d'entrée (6) et auquel le premier piston (5) exerce une pression,
- au moins une soupape de sécurité (9) située à l'extrémité du canal d'entrée (6); et
- au moins un deuxième canal (10) à laquelle est raccordée l'extrémité ouverte de la soupape de sécurité (9),
- au moins un deuxième piston (11) qui se déplace dans le deuxième canal (10),
- au moins un deuxième ressort (12) auquel le deuxième piston (11) exerce une pression,
- au moins un corps (13) dans lequel s'adapte le deuxième canal (10) et dans lequel sont situés le deuxième piston (11) et le deuxième ressort (12),
- au moins une cavité (14) située sur les surfaces du corps (13), une ouverture (15) dans la structure du deuxième piston (11),
- au moins un troisième canal (16), par lequel la cavité (14) située sur la surface du corps (13)

s'ouvre vers l'extérieur du corps (13),
- au moins un premier piston principal (17) sur lequel débouche l'extrémité du troisième canal (16) qui ne rentre pas dans la cavité (14),
- au moins une première came (18) qui coopère avec le premier piston principal (17),
- au moins un quatrième canal (19), par lequel l'autre cavité (14) située sur la surface du corps (13) s'ouvre vers l'extérieur du corps (13),
- au moins un deuxième piston principal (20) vers lequel débouche l'extrémité du quatrième canal (19) qui ne rentre pas dans la cavité (14),
- au moins une deuxième came (21) qui coopère avec le deuxième piston principal (20),
- au moins un cinquième canal (22) qui s'ouvre vers l'extérieur de la surface du corps (13),
- au moins un sixième canal (23) qui se détache du cinquième canal (22),
- au moins un clapet anti-retour (24) situé sur le sixième canal (23),
- au moins un mécanisme de soupape (25) qui est situé après le clapet anti-retour (24) et auquel le sixième canal (23) débouche,
- au moins un cylindre (26) situé à l'extrémité du cinquième canal (22) non relié au corps (13),
- au moins un piston de poussée (27) qui est situé dans le cylindre (26),
- au moins un ensemble de soupape (28) sur lequel débouche l'extrémité du piston de poussée (27),
- au moins une tige (29) qui est située entre l'ensemble de soupape (28) et le mécanisme de soupape (25),
- des soupapes constituant l'ensemble de soupape (28),
- des ressorts de soupape (31) qui permettent l'ouverture et la fermeture des soupapes (30).

**2.** Système de réglage de soupapes (1) selon la revendication 1, **caractérisé par** l'électrovanne (2), qui, lors de son activation, permet au flux d'huile provenant de la conduite d'huile principale (3) de s'ouvrir vers le canal d'entrée (6) et de pousser le premier piston (7) situé dans le canal d'entrée (6) contre le premier ressort (8).

**3.** Système de réglage de soupapes (1) selon la revendication 1 ou la revendication 2, **caractérisé par** le deuxième canal (10), la pression d'huile dans laquelle pousse le deuxième piston (11) contre le deuxième ressort (12).

**4.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** le ressort de soupape (31) qui est prévu pour maintenir le contact continu entre le deuxième piston principal (20) et la deuxième came (21) et pour permettre fermeture des soupapes (30).

**5.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** les soupapes (30) qui permettent le relâchement par compression en étant ouvertes contre une pression élevée dans le cylindre (30).

**6.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** le deuxième canal (10) dans lequel le deuxième piston (11) ne peut pas bouger puisque le débit est interdit par la soupape de sécurité (9) et le premier piston (7).

**7.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** la deuxième came (21), qui, lorsqu'il est activé, pousse le deuxième piston principal (20) et pompe ainsi l'huile du cylindre (26) vers le cinquième canal (22) et pousse le piston de poussée (27) en commençant ainsi à déplacer les soupapes (30).

**8.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** la première came (18), pour laquelle, afin d'être activée, la pression dans le canal d'entrée (6) est abaissée en désactivant l'électrovanne (2).

**9.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** le premier piston (7) se déplace vers le bas sous l'action du premier ressort (8) déchargeant ainsi l'huile sous pression dans le deuxième canal (10) en alignant le canal supérieur (5) avec le canal de sortie (4).

**10.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** le deuxième piston (11) commence à se déplacer vers le haut lorsque la force de ressort comprimé du deuxième ressort (12) commence à dépasser la pression d'huile dans le deuxième canal (10).

**11.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** le deuxième piston (11) qui, lorsque le troisième canal (16) et le cinquième canal (22) sont reliés l'un à l'autre, commence à pomper l'huile dans le cylindre (26) avec le mouvement qu'il reçoit du premier came (18) et permet ainsi d'activer la première came (18).

**12.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** le mécanisme de soupape (25) qui est utilisé de manière à permettre le renouvellement de l'huile décroissante lorsque les soupapes (30) sont en position fermée.

**13.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** le clapet anti-retour (24) qui, lorsque les soupapes (30) sont en position ouverte, empêche le refoulement d'huile dans le cylindre (26) vers le ligne principale d'huile.

**14.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** la tige (29) qui, lorsque les soupapes (30) sont proches de la position fermée, pousse la soupape dans le mécanisme de soupape (25) et permet ainsi à l'huile à l'intérieur de la ligne principale du moteur de fournir l'huile dans le système de réglage de soupapes (1).

**15.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** les cames (première came (18) et deuxième came (21)) qui permettent de changer la hauteur de fermeture et le calage des soupapes (30) et qui sont conçus pour être deux ou plus pour chaque cylindre (26) selon le besoin.

**16.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** le deuxième piston (11) et le corps (13) sur lequel est situé le deuxième piston (11), dont les dimensions sont réglées de sorte que le troisième canal (16) commence à s'ouvrir lorsque la cavité (14) commence à être fermée par le deuxième piston (11) et que le troisième canal (16) sera en communication avec la cavité (14) afin d'empêcher le verrouillage hydraulique à l'intérieur du quatrième canal (19) lors du passage de la deuxième came (21) à la première came (18).

**17.** Système de réglage de soupapes (1) selon l'une quelconque des revendications précédentes, **caractérisé par** la cavité (14) dont la taille est telle qu'elle communiquera avec l'ouverture (15) avant d'être fermée par le deuxième piston (11), et qui est situé sur la surface du corps (13).

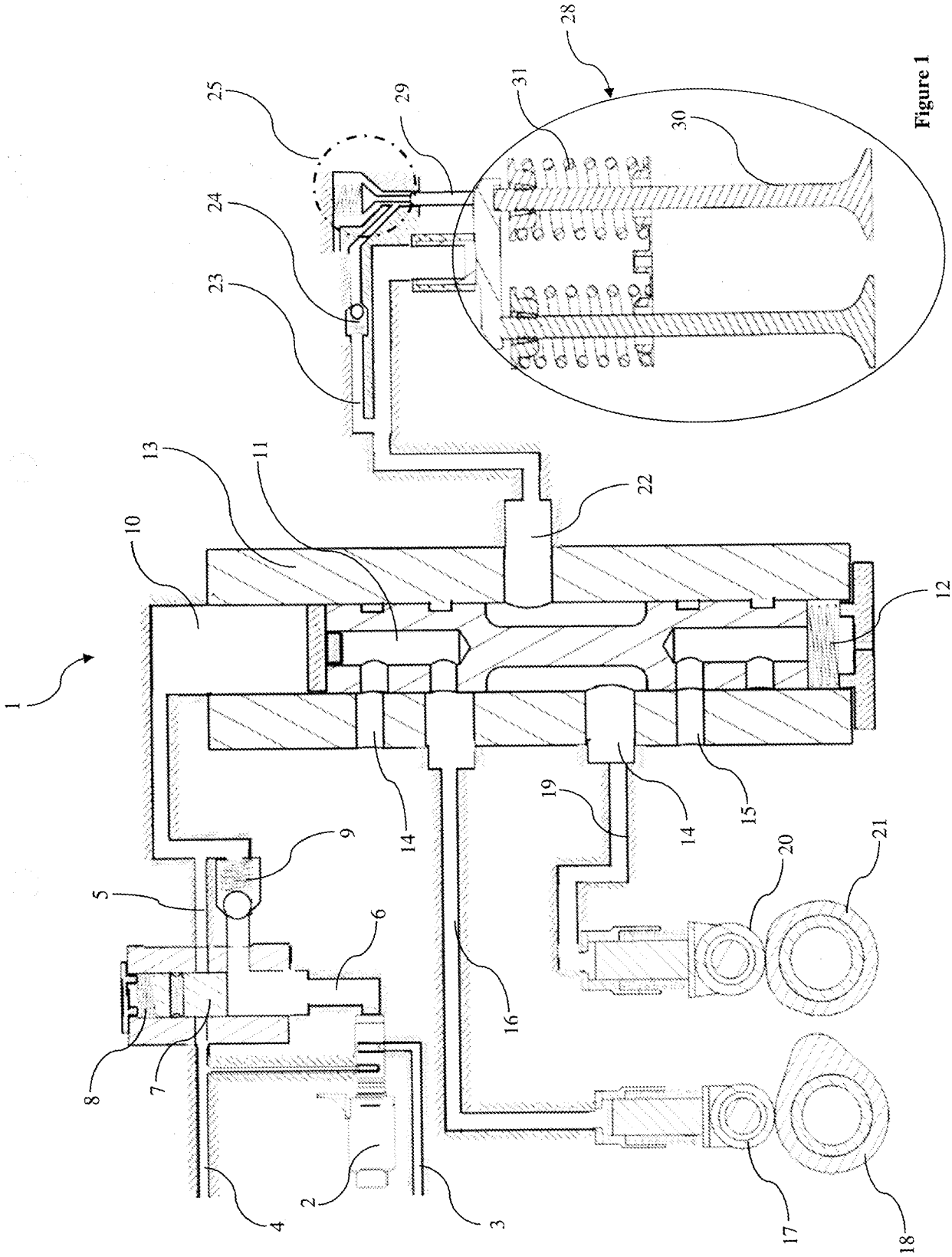


Figure 1

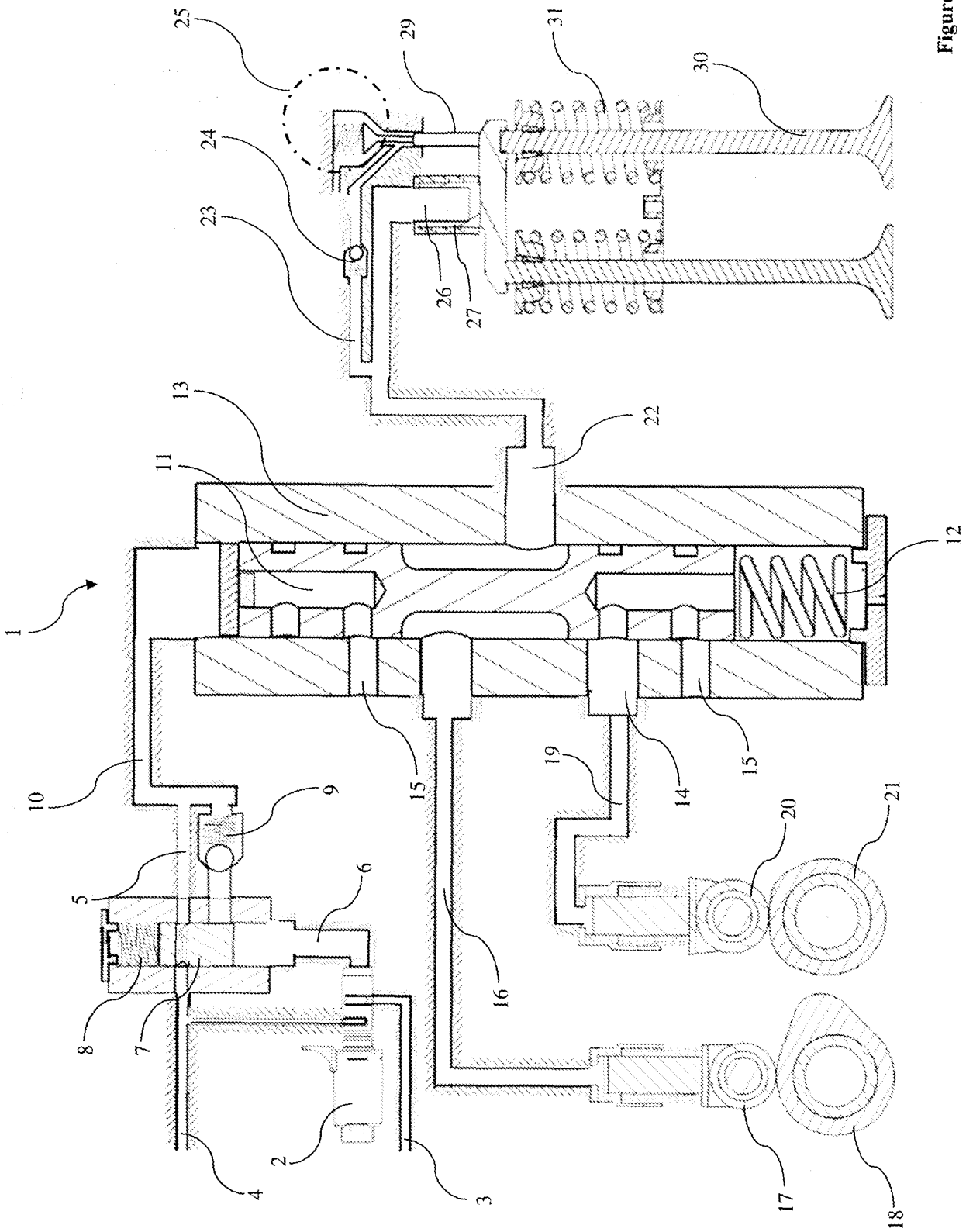
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Figure 2

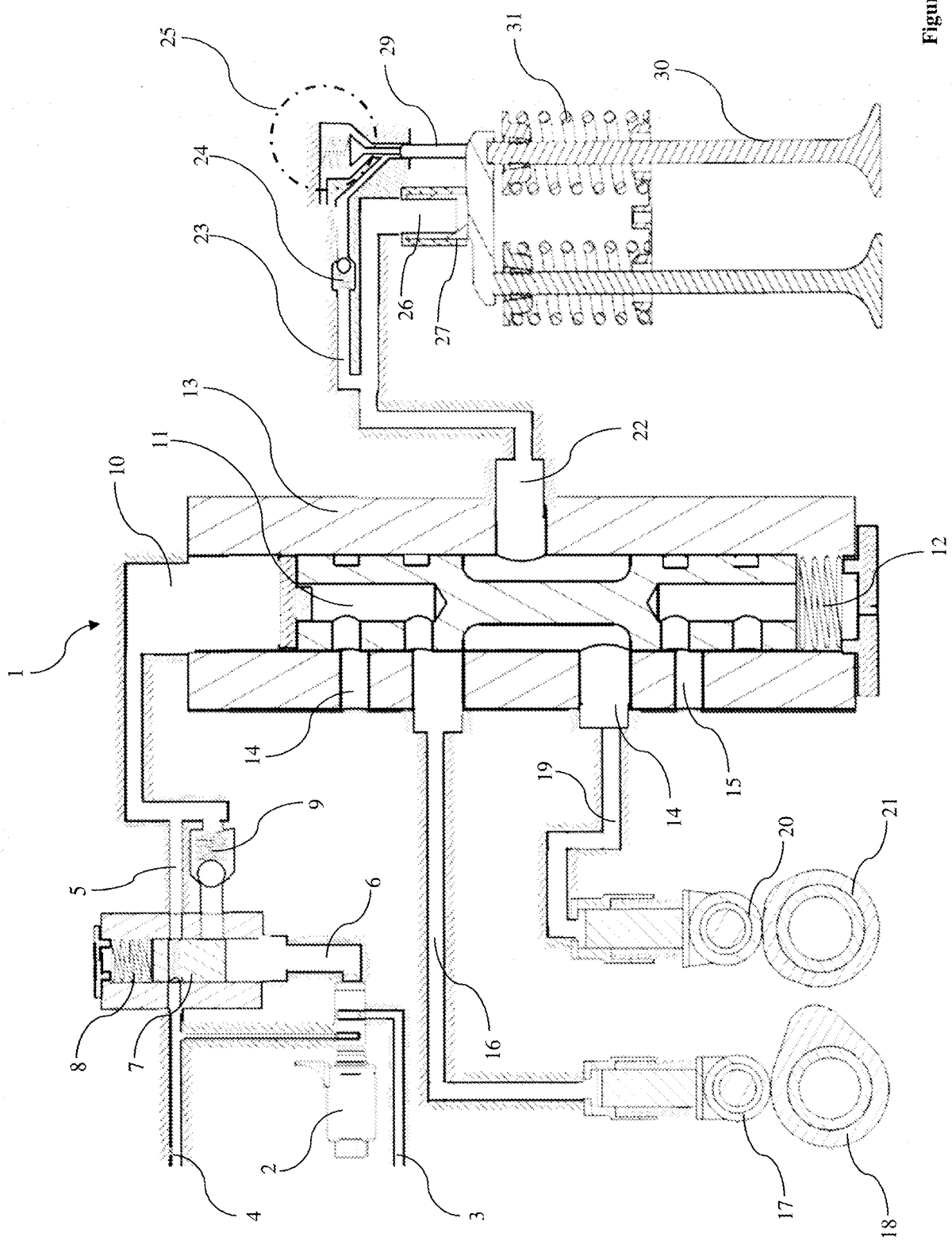
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Figure 3

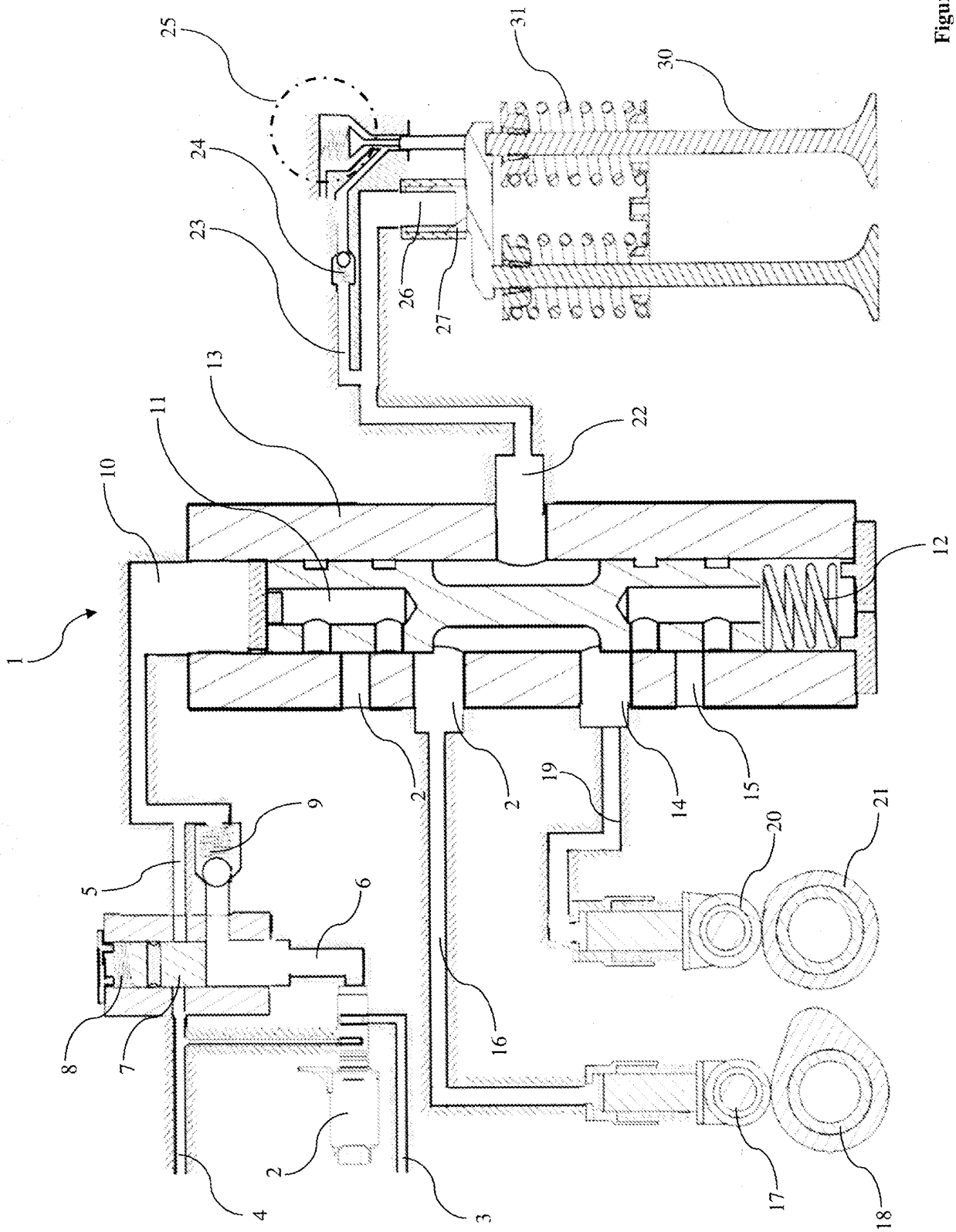
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Figure 4

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- WO 9834014 A1 **[0002]**
- WO 9706355 A **[0003]**
- WO 2007142724 A **[0004]**
- WO 200400567 A **[0005]**
- US 5404851 A **[0006]**