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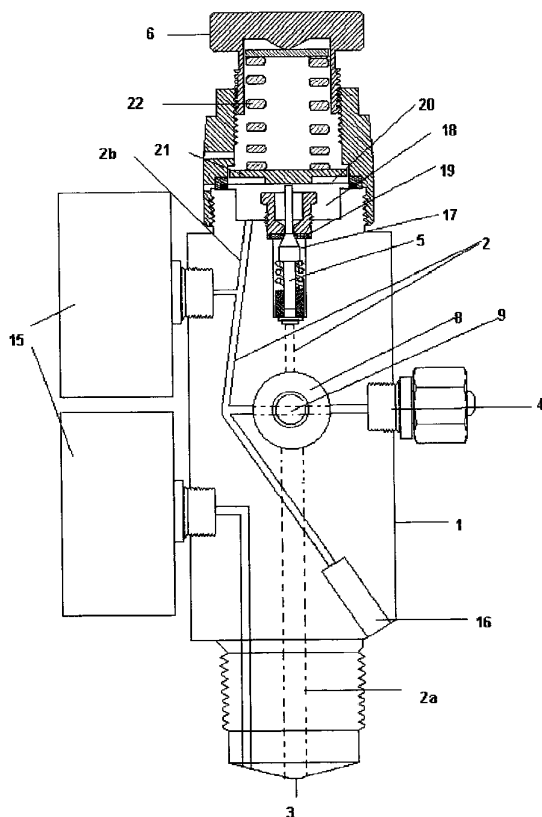
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(54) Title: EXPANSION VALVE BLOCK WITH CO-ORDINATED HIGH- AND LOW-PRESSURE CIRCUIT CONTROL  
MEANS

(54) Titre : BLOC ROBINET-DETENDEUR A COMMANDES DE CIRCUITS HAUTE ET BASSE PRESSION COORDON-  
NEES



(57) Abstract: The invention relates to an expansion valve block which is equipped with co-ordinated means (8) for isolating the high-pressure circuit (3) and the low-pressure circuit (4) such that, when the gas delivery inlet is opened and closed, the two circuits are automatically controlled using the sequence that best guarantees the immunity of the installation.

(57) Abrégé : L'invention concerne un bloc robinet-détendeur doté de moyens d'isolation coordonnés (8) du circuit haute pression (3) et du circuit basse pression (4) pour qu'à l'ouverture de la délivrance du gaz, comme à la fermeture, les deux circuits soient systématiquement commandés selon la séquence qui garantit la meilleure immunité à l'installation.

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## EXPANSION VALVE BLOCK WITH COORDINATED HIGH- AND LOW PRESSURE CIRCUIT CONTROL MEANS

The present invention relates to an expansion valve block allowing the pressure or  
5 flow rate of a fluid to be controlled or adjusted.

A reference herein to a patent document or other matter which is given as prior art is  
not to be taken as an admission that that document or matter was, in Australia,  
known or that the information it contains was part of the common general knowledge  
10 as at the priority date of any of the claims.

Expansion valves are used for bringing a gas from its transport or storage pressure  
to its service pressure. Control over the impact that expansion valves have on the  
chemical composition of the gases they deliver is important because expansion  
15 valves can have an impact on the composition of the gases passing through them.  
This impact is a detrimental impact when using gases or mixtures of gases the  
composition of which needs to be known precisely, or the purity of which needs to  
be strictly preserved, such as gases in laboratories and analysis gases and the  
gases used in electronics. It may also have an impact on gases that may present a  
20 danger when mixed with other gases or with the ambient air: it is necessary to  
control their delivery in order to avoid any dangerous mixture. This is the case, for  
example, with fuel gases such as hydrogen or acetylene which may form explosive  
mixtures with ambient air. Contamination of the delivered gas also occurs when the  
delivery of the gas by the expansion valve is interrupted: the high-pressure  
25 upstream circuit of the expansion valve is closed, the low-pressure downstream  
circuit ceases to be supplied, and ambient air or other substances can enter the low-  
pressure circuit and the measurement and safety accessories.

Expansion valves are complex pieces of equipment comprising a high-pressure  
30 circuit and a low-pressure circuit which circuits consist of chambers and ducts,  
regulators (shutters, diaphragms, bellows or pistons), pressure gauges, safety  
means (valves, rupture disks, etc.). Techniques for controlling  
the purity of the delivered gas include, for example:

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- the choice of sealing techniques, of materials used for the body of the expansion valve, seals, regulators (elastomeric diaphragms or metal bellows),
  - control of the quality of the surfaces, of the rinsing and passivation procedures and of the assembly conditions,
  - reduction of dead volumes,
  - the type of cleaning.

In order to avoid the risks of contamination it is also possible to employ special gas delivery procedures (purging, rinsing by compression and expansion, operating procedure), but these are lengthy and painstaking and operational errors are possible.

Finally, a gas nonreturn device may be installed at the exit from the expansion valve in order to avoid contamination of the low-pressure circuit by undesirable ingress, but this solution introduces a pressure drop in the delivery circuit and the sealing solutions used in such devices do not guarantee against microingresses of gas ( $10^7$  mbar.1/s).

It would be desirable to provide an expansion valve block which overcomes or alleviates one or more disadvantages of the prior art.

According to the present invention, there is provided an expansion valve block for controlling or adjusting pressure or flow rate of a fluid, including

a main body within which at least one internal fluid passage between at least one fluid inlet orifice and at least one fluid outlet orifice is formed,

- at least one fluid-pressure control means arranged on at least part of said internal fluid passage, the internal fluid passage between said pressure control means and the fluid inlet orifice forming an upstream circuit and the internal fluid passage between said pressure control means and the fluid outlet orifice forming a

downstream circuit,

- at least one first fluid flow rate control means arranged on at least part of the downstream circuit,

- at least one second fluid flow rate control means arranged on at least part of the upstream circuit,

- at least one command means for causing a fluid to flow in the passage, wherein the command means interacts with the first and second fluid flow rate control means in such a way that, when an operator commands delivery of a fluid in the passage, opening of the upstream circuit by the second control means occurs before opening of the downstream circuit by the first control means and, when the operator commands the stopping of the delivery of a fluid in the passage, closure of the downstream circuit by the first control means occurs before closure of the upstream circuit by the second control means.

To this end, the invention consists in providing the expansion valve with coordinated means for isolating the high-pressure circuit and the low-pressure circuit so that, upon opening the delivery of gas, and on closing it, the two circuits are systematically commanded in a sequence that guarantees the installation the best possible immunity.

Moreover, the present invention is particularly well suited to the delivery of gas of a precise composition.

The flow rate control means allow the internal passage to be open and closed either on the upstream circuit or on the downstream circuit. The second fluid flow rate control means arranged on at least part of the upstream circuit may be a valve with an axially moving shutter. This type of flow rate control means allows the cross section of the internal fluid passage in the upstream circuit to be plugged or uncovered according to its movement.

For preference, the first fluid flow rate control means arranged on at least part of the downstream circuit is a cylinder right through which a duct is radially pierced, said cylinder being placed in a bore in the body of the expansion valve block. The cylinder, according to its axial orientation, makes it possible: either to place the downstream circuit in communication with the fluid outlet orifice when one end of the duct is collaborating with the downstream circuit and the other end of the duct is collaborating with the outlet orifice of the expansion valve block, or to close the communication between the downstream circuit and the outlet orifice of the expansion valve block.

According to the preferred embodiment of the invention, one of the bases of the cylinder is the axially moving shutter of the second fluid control means arranged on at least part of the upstream circuit. In this preferred embodiment, the first and second fluid flow rate control means are combined within the cylinder:

- the first means corresponding to the part of the cylinder that is pierced radially right through by a duct,
- the second means corresponding to the base of the cylinder.

The means for commanding the circulation of a fluid in the internal passage of the main body may be a screw collaborating with the cylinder/cylinder and the shutter in such a way that turning it simultaneously causes axial translational movement of the shutter and axial rotation of the cylinder.

The surface of the cylinder/cylinder may be covered with a material which provides sealing between the plug/cylinder and the main body of the expansion valve block.

The base of the cylinder may be hollowed out around its annular periphery and a seal may be positioned in this annulus.

The pressure control means may comprise at least one shutter and/or at least one spring, or the pressure control means may comprise a pressure relieving screw or a cam acting on at least one shutter.

The block may comprise a moving lever that can be manipulated by the operator between at least one fluid flow rate open and at least one fluid flow rate closed position, said lever acting on the command means.

The invention also relates to a pressurized-fluid vessel, particularly a gas cylinder, equipped with an expansion valve block as defined hereinabove.

The invention also relates to a method for delivering a fluid from an expansion valve block, said expansion valve block including an upstream circuit and a downstream circuit, whereby travel of fluid through the valve block is from the upstream circuit to the downstream circuit and the pressure of the fluid in the downstream circuit is less than the pressure in the upstream circuit, the method including the step of opening

the upstream circuit before the downstream circuit to deliver the fluid from the valve block.

The invention finally relates to a method for stopping delivery of a fluid from an expansion valve block, said expansion valve block including an upstream circuit and a downstream circuit, whereby travel of fluid through the valve block is from the upstream circuit to the downstream circuit and the pressure of the fluid in the downstream circuit is less than the pressure in the upstream circuit, the method including the step of closing the downstream circuit before the upstream circuit to stop the delivery of the fluid from the valve block.

One advantage of the present invention is the provision of an expansion valve allowing a gas to be delivered without alteration to the composition of this gas.

Another advantage of the present invention is provision of an expansion valve allowing a gas to be delivered without alteration to the composition of this gas even at the time of closing or opening the expansion valve.

Another advantage of the present invention is the provision of an expansion valve that allows a gas to be delivered without alteration to the composition of this gas and the use of which does not permit any operational error.

#### Brief Description of the Drawings

- figure 1 is a view in cross section of the expansion valve block according to the invention;

- figure 2 is a partial sectional view of the expansion valve block according to the invention.

#### Detailed Description of the Drawings

The expansion valve comprises a main body 1 within which at least one internal passage 2 is formed. This passage 2 has an inlet orifice 3 which generally collaborates with that side of the vessel to which the expansion valve block is fixed, and an outlet orifice 4 which generally collaborates with a gas dispensing means.

The expansion valve comprises a means 5 for controlling the pressure of the fluid



flowing through the internal passage 2. In the upstream circuit 2a situated between this pressure control means 5 and the inlet orifice 3, the fluid has a high pressure. In the downstream circuit 2b situated between this pressure control means 5 and the outlet orifice 4 the fluid has a pressure that is lower than it is upstream, the pressure control means 5 allowing the pressure of the fluid from the orifice 3 to be lowered. The pressure control means here is an expansion valve shutter 5 moved by a screw 6. Behind the expansion valve

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shutter there is the high pressure chamber 17 of the expansion valve, which opens onto the low-pressure chamber 18 of the expansion valve. The valve shutter 15 rests on a

packing 19 such that the combined effect of the shutter 5 and of the packing 19 provides sealing between the high-pressure chamber 17 and the low-pressure chamber 18 of the expansion valve. The downstream end of the valve shutter 5 rests on a diaphragm 20, itself pushed by a plate 21 under the effect of a spring 22 compressed by the screw 6. When the pressure of the gas in the low-pressure chamber 18 is below the setpoint value, the combination of the spring 22 and of the plate 21 pushes the shutter 5 back; the latter therefore moves away from the packing 19 and allows the gas to pass from the high-pressure chamber 17 to the low-pressure chamber 18, so the pressure in the chamber 18 rises. As soon as the pressure in the low-pressure chamber 18 reaches the setpoint value, the diaphragm 20 pushes the plunger 21 back and the shutter 5 returns into contact with the packing 19 so as to close off the gas passage. The screw 6 is adjusted in such a way as to set the setpoint value and therefore the desired pressure for the delivered gas, control being possible by reading the pressure off the pressure gauge 15 of the downstream circuit 2b. A filter 7 may be placed in contact with the expansion valve shutter 5. The cylinder 8 combines the functions of controlling the flow rate of the fluid flowing in the upstream circuit 2a and in the downstream circuit 2b. In fact it is radially pierced right through by a duct 9 so that when one of the ends of this duct 9 is in communication with the upstream circuit 2b, the other end of this duct is in communication with the outlet orifice 4. In addition, this cylinder 8 may undergo a translational movement along its axis in such a way that its end situated at the same end as the upstream circuit 2a either does or does not close this upstream circuit. The command means for operating the plug is a screw 11 which:

- by being turned, positions the duct 9 in such a way as to either allow or prevent communication between the orifice 4 and the circuit 2b,

- through its translational movement, closes or opens the upstream circuit 2a.

The pitch of the screw needs to be fixed in such a way that, when the operator begins to command delivery of fluid into the passage 2, he unscrews the screw 11 in such a way that:

- first, the translational movement of the screw axially moves the cylinder 8 enough to allow the base 10 of the cylinder 8 to move and allow fluid to pass in the circuit 2a towards the expansion valve shutter 6, without the turning of the screw at the same time causing the cylinder to rotate through enough of an angle to allow communication between the orifice 4 and the circuit 2b,

- second, the translational movement of the screw continues to move the cylinder 8 axially in order to continue to allow fluid to pass in the circuit 2a toward the expansion valve shutter 6 and, at the same time, the turning of the screw allows the cylinder to be turned through enough of an angle to allow communication between the orifice 4 and the circuit 2b.

In consequence, first of all, the gas to be delivered circulates in the upstream circuit 2a and in the downstream circuit 2b as far as the cylinder 8, then the gas can flow in the duct 9 of the cylinder 8 and be delivered out of the expansion valve.

Likewise, when the operator begins to command closure of the delivery of fluid in the passage 2, he turns the screw 11 in such a way that:

- first, the turning of the screw causes the cylinder to turn through enough of an angle in order no longer to allow communication between the orifice 4 and the circuit 2b without, at the same time, the translational movement of the screw moving the base 10 of the cylinder 8 axially far enough to block the passage of the fluid in the circuit 2a toward the

expansion valve shutter 6,

- second, the turning of the screw continues to cause the cylinder to turn without allowing communication between the orifice 4 and the circuit 2b, and at the same time, the translational movement of the screw 11 continues to move the base 10 of the cylinder 8 axially until it is able to plug the passage of the fluid in the circuit 2a toward the expansion valve shutter 6.

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A packing 12 is placed in the downstream circuit 2a to collaborate with the base 10 of the cylinder 8 when this base 10 closes the upstream circuit 2a. A seal 13 is placed in the hollowed-out peripheral annulus of the base 10 of the cylinder 8.

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The screw 11 collaborates with the cylinder 8 by way of a toric seal 14 which allows the screw to be incorporated into the expansion valve; nonetheless, it is possible also to screw the screw directly into the block 1 of the expansion valve. A sealing ring 15 is positioned around the cylinder 8 between the body 1 of the block and the toric seal 14. Two pressure gauges 15 allow the pressure within the upstream and downstream circuits 2a, 2b to be checked. A safety valve (or relief valve) 16 is provided in case the pressure within the internal passage 2 reaches too high a level. It may for example consist of a ball pressed firmly against a seat by a spring. The ball bears against the seat along a contact circle. The ball is subjected to the actions of the spring which tends to press it firmly against the seat and of the gas which tends to lift it off the seat. When the pressure exerted on the cross-sectional area of the circle of contact produces a force higher than the force of the spring, the gas escapes. As an alternative, use could be made of a metal diaphragm which tears under the effect of pressure.

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The device has the advantage of providing dual closure: the upstream circuit and the downstream circuit are both closed. By employing a device as described hereinabove, the upstream valve of the device is opened  
5 before the downstream valve, and this allows the high-pressure and low-pressure circuits of the expansion valve to be pressurized before the valve begins to deliver gas to the user circuit. On closure, the downstream circuit is isolated first to prevent any  
10 ingress of contamination, then the upstream circuit is closed to interrupt the supply and prevent the risk of a rise in pressure in the low-pressure circuit in the event of leakage of the expansion valve shutter. This operation allows the circuits of the expansion valve  
15 block to be balanced and avoids any contamination of said circuits.

Thanks to the implementation of the device according to the invention, ambient air or the gas present in the  
20 distribution circuit downstream of the expansion valve does not suck back into the circuits of the expansion valve block.

The invention has the advantage of allowing the high-  
25 pressure and low-pressure circuits of the expansion valve block to be shut off in a single action.

By virtue of the invention, there is no longer any need to purge the circuits of the expansion valve using gas  
30 present in the cylinder between two uses; this gas is not wasted.

The invention makes it possible to avoid microingresses of ambient gas into the expansion valve.  
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The invention finally relates to a method for predicting the change in the composition of a gas or of a gaseous mixture contained in a vessel, in which method the following steps are repeated:

1 - the technical characteristics of the vessel are established;

2 - the vessel is filled with said gas or gaseous mixture and a prediction of the change in the composition of the gas or gaseous mixture is established on the basis of the technical characteristics of the vessel;

3 - some of the gas or gaseous mixture contained in the vessel is used;

4 - the gas or gaseous mixture contained in the vessel and which has not yet been used is analyzed;

5 - the analysis of the gas or gaseous mixture contained in the vessel and which has not yet been used is compared against the prediction of the change in composition established during step 2;

6 - the comparison at step 4 is used to establish a new prediction of the change in the composition of the gas or gaseous mixture for step 2.

During step 1, the technical characteristics of the vessel include the nature of the vessel, the nature and the method of internal surface treatment thereof.

The prediction of the change in the composition of the gas or gaseous mixture used during step 2 is established initially by introducing gas or gaseous mixture into the vessel then analyzing the composition delivered by the vessel and measuring the deviation with respect to the initial composition as a function of time. All the data relating to a vessel are stored in a database on the basis of which the prediction of the change in the composition of the gas or gaseous mixture can be refined each time the vessel is used again. During step 4, if there is a significant deviation between the analysis of the gas or gaseous mixture contained in the vessel and which has not yet been used, and the prediction of the change in the composition established during step 2, use of the vessel may be halted and the user who used it last may

be informed of the drift in the composition of the gas or gaseous mixture against the prediction of step 2.

Advantageously, during step 3, the operator uses the gas or gaseous mixture contained in the vessel while at the same time taking account of the prediction of the change in the composition established during step 2. This procedure of predicting the change in the composition of a gaseous mixture contained in a vessel is particularly advantageous in the case of the gaseous mixtures used for calibrating the analyser or in the case of gaseous mixtures the use of which requires knowledge of their precise composition, something which is the case, for example, with applications for inerting sensitive packages of products, the manufacture of electronic components, the filling of fluorescent tubes, the supply of gas to gas laser cavities, the verification of the operation of sensors or detectors (explosimeter alarm level for example).

The invention described herein is susceptible to variations, modifications and/or additions other than those specifically described and it is to be understood that the invention includes all such variations, modifications and/or additions which fall within the spirit and scope of the present disclosure.



The claims defining the invention are as follows:

1. An expansion valve block for controlling or adjusting pressure or flow rate of a fluid, including

- a main body within which at least one internal fluid passage between at least one fluid inlet orifice and at least one fluid outlet orifice is formed,

- at least one fluid-pressure control means arranged on at least part of said internal fluid passage, the internal fluid passage between said pressure control means and the fluid inlet orifice forming an upstream circuit and the internal fluid passage between said pressure control means and the fluid outlet orifice forming a downstream circuit,

- at least one first fluid flow rate control means arranged on at least part of the downstream circuit,

- at least one second fluid flow rate control means arranged on at least part of the upstream circuit,

- at least one command means for causing a fluid to flow in the passage, wherein the command means interacts with the first and second fluid flow rate control means in such a way that, when an operator commands delivery of a fluid in the passage, opening of the upstream circuit by the second control means occurs before opening of the downstream circuit by the first control means and, when the operator commands the stopping of the delivery of a fluid in the passage, closure of the downstream circuit by the first control means occurs before closure of the upstream circuit by the second control means.

2. The block as claimed in claim 1, wherein the second fluid flow rate control means arranged on at least part of the upstream circuit is a valve with an axially moving shutter.

3. The block as claimed in claim 1 or 2, wherein the first fluid flow rate control means arranged on at least part of the downstream circuit is a cylinder through which a duct extends radially, said cylinder having a body positioned in an opening in the main body of the expansion valve block.

4. The block as claimed in claim 2 or 3, wherein a base of the cylinder is the

axially moving shutter of the second fluid control means arranged on at least part of the upstream circuit.

5 5. The block as claimed in any one of claims 2 to 4, wherein the command means is a screw which interacts with the cylinder so that turning the screw causes axial translational movement of the shutter and axial rotation of the cylinder simultaneously.

10 6. The block as claimed in claim 2, or claim 3 or 4 when dependent on claim 2, wherein the command means is a screw which interacts with the cylinder and the shutter so that turning the screw causes axial translational movement of the shutter and axial rotation of the cylinder simultaneously.

15 7. The block as claimed in any one of claims 4 to 6, wherein the cylinder has a surface covered with a material which provides sealing between the cylinder and the main body of the expansion valve block.

20 8. The block as claimed in any one of claims 4 to 7, wherein a base of the cylinder includes a hollow annular periphery and a seal positioned in the hollow annular periphery.

9. The block as claimed in any one of the preceding claims, wherein the pressure control means includes at least one shutter and/or at least one spring.

25 10. The block as claimed in any one of claims 1 to 8, wherein the pressure control means includes a pressure relieving screw or a cam acting on at least one shutter.

30 11. The block as claimed in any one of the preceding claims, including a moving lever for manipulation by the operator between at least one fluid flow rate open and at least one fluid flow rate closed position, said lever acting on the command means.

12. A pressurized fluid vessel, particularly a gas cylinder, equipped with an expansion valve block as claimed in any one of claims 1 to 11.

13. A method for delivering a fluid from an expansion valve block, said expansion

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valve block including an upstream circuit and a downstream circuit, whereby travel of fluid through the valve block is from the upstream circuit to the downstream circuit and the pressure of the fluid in the downstream circuit is less than the pressure in the upstream circuit, the method including the step of opening the upstream circuit before the downstream circuit to deliver the fluid from the valve block.

14. A method for stopping delivery of a fluid from an expansion valve block, said expansion valve block including an upstream circuit and a downstream circuit, whereby travel of fluid through the valve block is from the upstream circuit to the downstream circuit and the pressure of the fluid in the downstream circuit is less than the pressure in the upstream circuit, the method including the step of closing the downstream circuit before the upstream circuit to stop the delivery of the fluid from the valve block.

15. An expansion valve block for controlling or adjusting the pressure or the flow rate of a fluid, substantially as herein described with reference to Figures 1 and 2 of the accompanying drawings.

16. A pressurized fluid vessel substantially as herein described with reference to Figures 1 and 2 of the accompanying drawings.

17. A method for delivering a fluid in an expansion valve block substantially as herein described with reference to Figures 1 and 2 of the accompanying drawings.

18. A method for stopping delivery of a fluid in an expansion valve block substantially as herein described with reference to Figures 1 and 2 of the accompanying drawings.

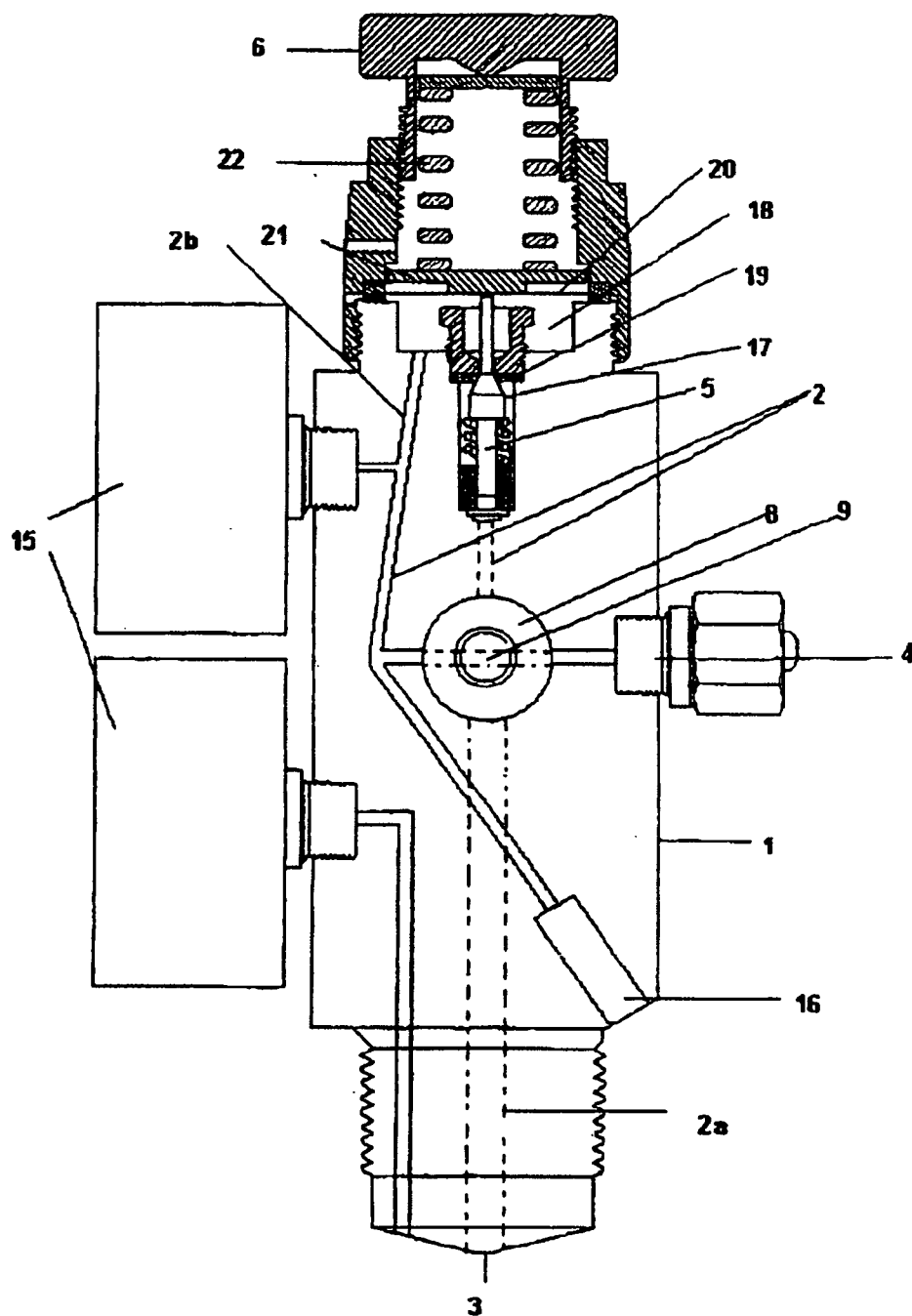


FIGURE 1

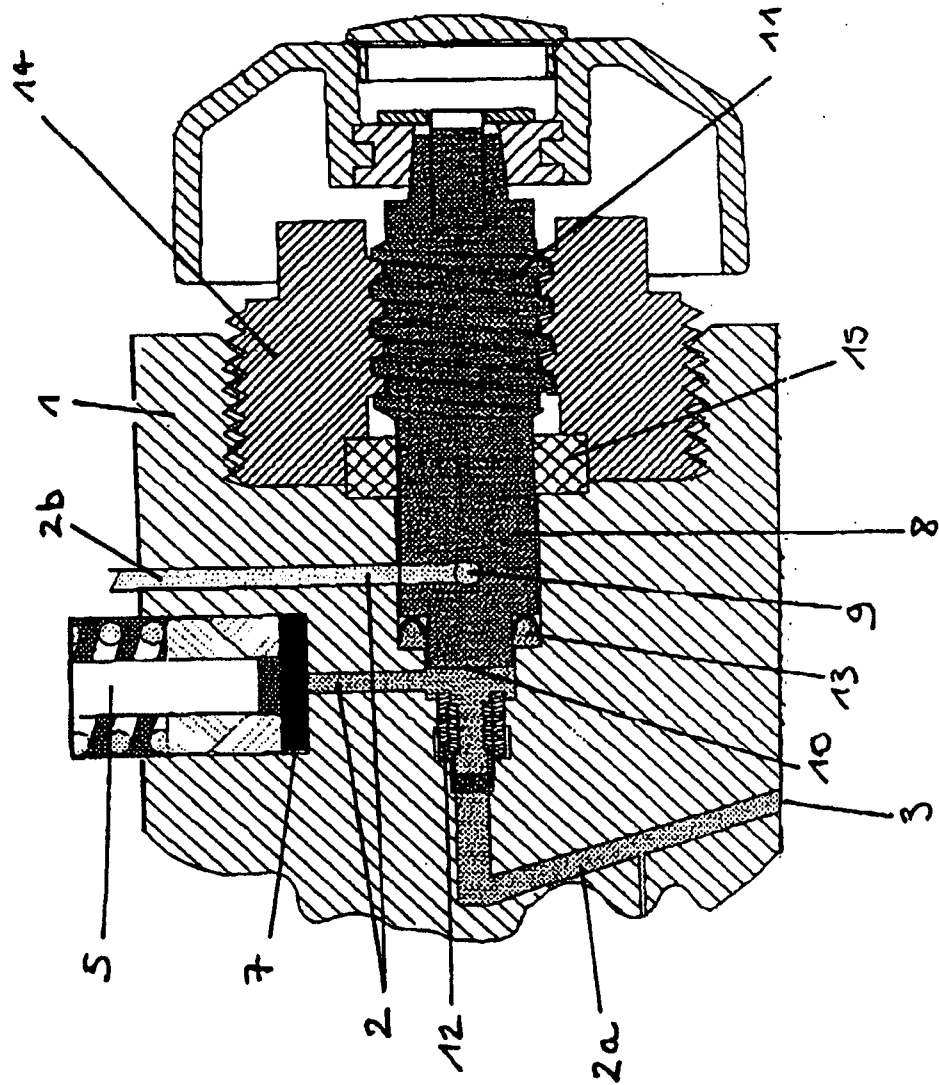


FIGURE 2