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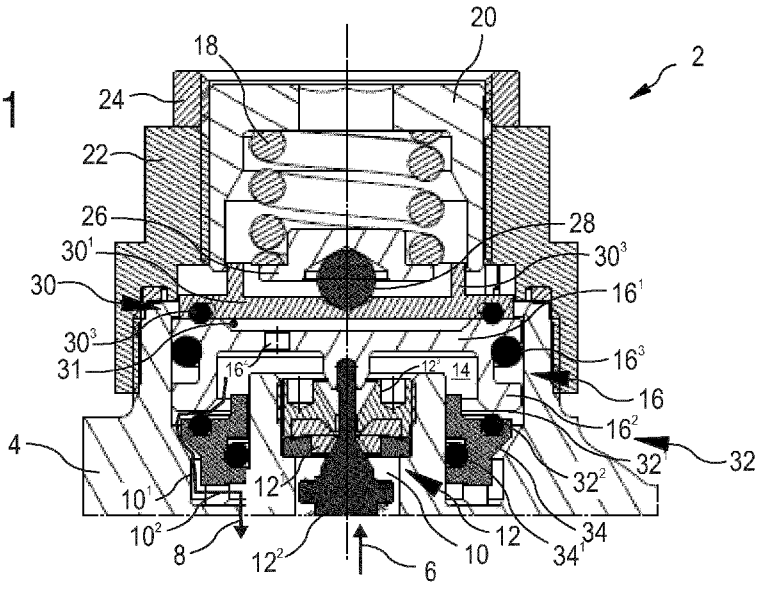
(54) Title: COMPRESSED GAS REGULATOR WITH INTEGRATED RESIDUAL PRESSURE VALVE

FIG 1



(57) Abstract: The invention is directed to Regulator (2) for compressed gas, comprising a body (4) with an inlet (6), an outlet (8) and a channel (10) between said inlet (6) and outlet (8); a regulating valve (12) with a seat (12^1) in the channel (10) and a movable closure member (12^2) upstream of said seat (12^1); a piston (16) housed in the body (4) and mechanically linked with the closure member (12^2), said piston (16) delimiting with said body (4) a regulating chamber (14) downstream of the regulating valve (12) and controlling said valve (12); a resilient member (18) able to exert a biasing force on the piston (16) towards the regulating valve (12); a residual pressure valve (32) with a first annular contact surface (32^1) on the piston (16) and a second annular contact surface (32^2) on the body (4). The first and second annular contact surfaces (32^1, 32^2) are located at the periphery of the piston (16) and the chamber (14), respectively.

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Description

COMPRESSED GAS REGULATOR WITH INTEGRATED RESIDUAL PRESSURE VALVE

Technical field

[0001] The invention is directed to a regulator for compressed gas with a residual pressure valve.

Background art

[0002] Prior art patent document published WO 2014/009279 A1 discloses a pressure reducing device for compressed gas. The device comprises a two-stages regulating valve with two closure members arranged in series and cooperating each with a corresponding seat. The second and downstream closure member is attached to a piston that delimits a regulating chamber directly downstream of the regulating valve. A main spring can be pre-set to a position where it exerts on the piston a biasing force that tends to move it against the biasing force of a secondary spring so as to open the regulating valve. As soon as the pressure in the regulating chamber increases, the piston moves away from the regulating valve progressively closes the valve or at least reduces the passage through said valve. The face of the piston delimiting the regulating chamber comprises a conical protrusion with a groove housing a seal. That seal is configured to contact a corresponding conical recess or cavity formed in a central protruding portion of the body housing the regulating valve. This forms a residual pressure valve. Indeed, when the pressure in the regulating chamber drops down below a predetermined threshold, the piston urged by the main spring moves towards the central protruding portion of the body to a point where the seal on the conical protrusion contacts the conical recess formed in said portion and thereby closes the passage for the gas. In other words, a residual pressure is kept in the container connected to the regulator, thereby avoiding a contamination where the valve is kept open without any gas flow. This teaching shows however shortcomings, including the fact that the threshold closing pressure of the residual pressure valve is high due to the reduced active

surface on which the gas pressure acts for keeping the valve open. That threshold can be also varied with the stiffness of the spring. This latter has however a direct influence on the regulation of the device. Another shortcoming is that this construction requires the central protruding portion to extend over an additional distance for forming the conical recess.

[0003] Prior art patent document published US 6,026,850 discloses a pressure regulating device for interconnecting between a pressurized liquid supply and a spray nozzle. The device is designed for keeping the pressure in the spray nozzle at an almost constant level and to shut-off the flow when the supply pressure falls below a lower limit. The device comprises a piston and a membrane for delimiting a regulating chamber downstream of the regulating valve. The bottom of the regulating chamber comprises a circular raised portion forming a seat that cooperates with the membranes for achieving a residual pressure valve function. Similarly to the above teaching, the threshold or cut-off pressure is set rather high. Also, that device is not designed for gas compressed at high pressure like industrial gases at more than 100 bar.

Summary of invention

Technical Problem

[0004] The invention has for technical problem to provide a regulator for compressed gas that overcome at least one of the drawbacks of the above cited prior art. More particularly, the invention has for technical problem to provide a regulator with a residual pressure valve that achieves a broader range of threshold pressure, and with a more compact construction and reliable functioning.

Technical solution

[0005] The invention is directed to a regulator for compressed gas, comprising: a body with an inlet, an outlet and a channel for guiding a flow of gas from said inlet to said outlet; a regulating valve with a seat in the channel and a movable closure member upstream of said seat; a piston housed in the body and mechanically linked with the closure member, said piston delimiting with said body a regulating chamber downstream of the

regulating valve and controlling said valve; a resilient member able to exert a biasing force on the piston towards the regulating valve in order to open the regulating valve; a residual pressure valve with a first annular contact surface on the piston and a second annular contact surface on the body, both first and second surfaces being in the regulating chamber and configured to be brought in mutual contact by the resilient member for closing said valve; wherein the first and second annular contact surfaces are located at the periphery of the piston and the chamber, respectively.

[0006] The periphery of the piston or the chamber means an outer annular portion that comprises the periphery of said piston or chamber. By outer annular portion it is meant that this portion is distant from a central portion that can correspond to 50% of the diameter of the piston or chamber.

[0007] The regulator can be a pressure reducer, e.g. from an inlet pressure of up to 300 bar to an outlet pressure comprised between 1 and 20 bar. The regulator can be integrated in a device to be screwed to a gas cylinder. The device can for example comprise a flow selector downstream of the regulator.

[0008] The regulator can comprise an additional resilient member located in the regulating chamber, said additional resilient member only partially compensating the biasing force of the resilient member on the opposite side of the piston.

[0009] The regulating chamber is advantageously delimited by a face of the piston in vis-à-vis of the regulating valve.

[0010] According to a preferred embodiment, the body comprises in the regulating chamber a central portion that protrudes towards the piston and houses the seat of the regulating valve, the second annular contact surface of the residual pressure valve surrounding said central portion.

[0011] According to a preferred embodiment, the second annular contact surface of the residual pressure valve is set back relative to a distal end of the central protruding portion of the body, preferably at a distance of more than 3mm, more preferably at a distance of more than 6mm.

[0012] According to a preferred embodiment, the second annular contact surface of the residual pressure valve is formed on a ring that is slip on the central

protruding portion of the body. The ring can be attached to the body by various fastening means.

[0013] According to a preferred embodiment, said regulator comprises a seal between the ring and the central protruding portion of the body, said seal being housed in a groove on an inner surface of said ring or on an outer surface of said portion.

[0014] According to a preferred embodiment, the inner surface of the ring and the outer surface of the central protruding portion of the body are cylindrical and contact each other.

[0015] According to a preferred embodiment, the regulating chamber forms an annular cavity around the central protruding portion of the body, the ring being located in said cavity and providing a passage for the gas between an external surface of said ring and an internal surface of said cavity.

[0016] According to a preferred embodiment, a bottom surface of the ring and/or a bottom surface of the cavity of the regulating chamber comprises at least one passage for the gas towards the central protruding portion of the body.

[0017] According to a preferred embodiment, the second annular contact surface of the residual pressure valve is on a portion of the body that is integral and forms the regulating chamber.

[0018] According to a preferred embodiment, the first annular contact surface of the residual pressure valve is on an annular shoulder portion of the piston, said portion being toward a bottom of the regulating chamber.

[0019] According to a preferred embodiment, the piston comprises a central disk-shaped portion, the annular shoulder portion extending from the central disk-shaped portion and forming a groove that opens radially outwardly, said groove housing a seal that is configured for sliding along an inner cylindrical surface of the body and delimit the regulating chamber.

[0020] According to a preferred embodiment, the annular shoulder portion of the piston extends along the central protruding portion of the body.

[0021] According to a preferred embodiment, the second annular contact surface of the residual pressure valve is formed by a seal, preferably of the O-ring type, housed in a groove.

[0022] According to a preferred embodiment, the residual pressure valve is configured to close when the pressure at the inlet is below a threshold that is comprised between 1 and 10 bar, preferably between 2 and 5 bar.

[0023] According to a preferred embodiment, the closure member of the regulating valve comprises a rod that extends through the seat and rigidly attached to the piston.

[0024] According to a further preferred embodiment, the regulator comprises a pressure relief valve for the channel downstream of the regulating valve; wherein the pressure relief valve comprises a movable element interposed between the resilient member and the piston, said element forming a gas tight closure of the channel and being able to move by virtue of the pressure of the gas in said channel and against the biasing force of the resilient member so as to allow said gas to leak.

[0025] According to a preferred embodiment, the pressure relief valve is in fluid connection with the regulating chamber.

[0026] According to a preferred embodiment, the piston comprises at least one passage interconnecting the regulating chamber with the movable closure element.

[0027] According to a preferred embodiment, the movable closure element is disk-shaped.

[0028] According to a preferred embodiment, the movable closure element comprises at least one lateral guiding surface, said surface preferably being a cylindrical surface formed by a wall extending longitudinally.

[0029] According to a preferred embodiment, the movable closure element is urged against the piston by the biasing force of the resilient member.

[0030] According to a preferred embodiment, the pressure relief valve forms a chamber with a height of at least 0.5mm, preferably at least 1mm.

[0031] According to a preferred embodiment, the chamber is delimited by the movable closure element and the piston.

[0032] According to a preferred embodiment, at least one of the movable closure element and the piston is recessed for forming the chamber.

[0033] According to a preferred embodiment, at least one of the piston and the movable closure element comprises a circular groove housing a seal for a gas tight mutual contact of said piston and element.

[0034] According to a preferred embodiment, the seal shows an outer diameter that is larger than 80%, preferably 90%, of a diameter of the piston.

[0035] According to a preferred embodiment, said regulator further comprises a thrust bearing interposed between the resilient member and the movable closure element.

[0036] According to a preferred embodiment, the thrust bearing comprises a pressure plate resting on the resilient member and a ball resting in a recess on said pressure plate and an opposed recess on the movable closure element.

[0037] According to a preferred embodiment, said regulator comprises a screw for adjusting a compression of the resilient member.

[0038] According to a preferred embodiment, the piston comprises a first face oriented in front of the regulating valve and delimiting the regulating chamber, and a second face opposed to the first one, said second face being in contact with the movable closure element.

Advantages of the invention

[0039] The invention is particularly interesting in that providing the first and second annular contact surfaces at the periphery of the piston and of the chamber results in a larger active surface on which the pressure of the gas results in an opening force of the valve. The residual pressure can therefore be lower. Also the fact of providing these first and second annular contact surfaces at the periphery of the piston and of the chamber avoids the conical engagement of the prior art (WO 2014/009279 A1, cited above) which is bulky (longitudinally) and which can remain stuck under certain circumstances. Compared to the design of the above prior art, the invention provides the advantage that the central protruding portion can be designed with more freedom, e.g. the seat of the regulating valve can be mounted from the top of said portion. The invention makes profit of free space at the periphery of the piston and chamber that is anyway available, resulting in a more compact design. In addition, the use of a ring attached

to the body for forming the second annular surface is interesting in that it provides more freedom for the passage of gas downstream of the residual pressure valve.

[0040] The invention is further particularly interesting with regard to the pressure relief valve in that it provides a regulator with a regulating valve where the closure member is upstream of the seat, i.e. in the high pressure of the inlet, and with an integrated pressure relief valve. The latter can present a larger active surface and thereby be more sensitive by opening at a lower pressure. The compression of the resilient member can be adjusted for adjusting the outlet pressure. The adjustment of the outlet pressure via the compression of the resilient member automatically adjusts the threshold of the pressure relief valve. Indeed, upon increase of the compression of the resilient member, the outlet pressure and automatically also the relief pressure are increased. The presence of a chamber in the pressure relief valve guarantees that the gas pressure is applied to the whole active surface of the valve.

Brief description of the drawings

[0041] Figure 1 is a sectional view of a regulator according the invention in an open state.

[0042] Figure 2 corresponds to figure 1 where the regulator is in a closed state.

Description of an embodiment

[0043] Figures 1 and 2 are sectional view of a regulator with a residual pressure valve in accordance with the invention. In figure 1, the residual pressure valve is in an open state whereas in figure 2 said valve is a closed state.

[0044] The regulator 2 is a pressure reducer for compressed gas. It comprises a body 4 with an inlet 6 and an outlet 8 which are only schematically represented. The regulator can indeed by integrated into a device with additional functions like a shut-off valve, a flow selector, an anti-refill device, a pressure indicator and/or a remaining usage time indicator. The inlet and outlet of such an integrated device can therefore be distant from but anyway in connection with the schematic inlet and outlet represented in figure 1. The body 4 comprises a channel 10 interconnecting the inlet 6 with the outlet 8. The normal gas flow is from the inlet 6 to the outlet 8.

[0045] The regulator 2 comprises also a regulating valve 12 arranged in the channel 10. The regulating valve 12 comprises a seat 12^1 located in the channel 10 and a closure member 12^2 designed for cooperating with said seat 12^1. More particularly, the closure member 12^2 is located on the upstream side of the seat, i.e. is located in the high pressure of the inlet 6. The seat 12^1 is attached to the body 4 by means of a blocking screw 12^3 and preferably by means of one or several centring washers. The regulating valve 12 is housed in a central portion 4^1 of the body 4 that protrudes in a regulating chamber 14 towards a piston 16. The regulating chamber 14 is directly downstream of the regulating valve 12 and is delimited by the body 4 and the body 4. The piston comprises a central disk-shaped portion 16^1. It can also comprise on the face delimiting the regulating chamber 14 an annular shoulder portion 16^2 extending axially away from the disk-shaped portion 16^1. That annular shoulder portion 16^2 forms a groove on the external peripheral surface of the piston 16, said groove housing a seal 16^3 that is configured for sliding along a cylindrical surface of the body 4.

[0046] The closure member 12^2 of the regulating valve 12 is advantageously rigidly attached to the piston. The piston 12 is urged towards the valve 12 by means of the spring 18. This spring 18 located on the side of the piston 12 that is opposite to the regulating valve 12. The spring 18 is held by an adjusting screw 20 engaged in a cap 22 that is attached to the body 4. The adjusting screw 20 is held in position by means of a counter-nut 24. The spring 18 contacts the piston 12 via a pressure plate 26, a ball 28 and a closure element 30 that contacts the piston in a gas tight manner by means of a seal. The piston 16 comprises in its central portion 16^1 at least one communication hole 16^4 for communication the pressure in the regulating chamber 14 and the outlet 8 to the opposite side of the piston and therefore to the pressure relief plate 30. In the case of an increased pressure at the outlet of the regulator, the closure element 30 can move slightly away from the piston 16 and allow gas to escape and limit the outlet pressure.

[0047] The closure element 30 and the piston 16 form a pressure relief valve. The piston 16 comprises in its central portion 16^1 at least one communication hole 16^4 for communication the pressure in the regulating chamber 14 and the outlet 8 to the opposite side of the piston and therefore to the closure element 30. In the case of an increased pressure at the outlet of the regulator, the closure element 30 can move slightly away from the piston 16 and allows gas to escape and limit the outlet pressure. This situation is illustrated in figure 2 where the flow of gas escaping radially and outwardly between the piston 16 and the closure element 30 is illustrated by two arrows.

[0048] More specifically, the pressure relief valve can form a chamber 31 between the closure element 30 and the piston 16. To that end, at least one of the faces of the element 30 and of the piston 16 that are in vis-à-vis is recessed. The height of the chamber can be of at least 0.5mm or 1mm.

[0049] The movable closure element 30 can comprise a disk-shaped central portion 30^1. That central portion can be generally flat. The movable closure element 30 can also comprise a cylindrical wall 30^2 extending axially from the central portion 30^1 towards the spring 18. The external surface of that wall 30^2 forms a guiding surface along a fixed cylindrical surface of the body 4. For instance that surface is the inner surface of the screw 20. The central portion 30^1 of the movable closure element 30 can also comprise a groove housing a seal 30^3 for contacting the piston 16 and delimiting in a gas tight manner the chamber 31.

[0050] The regulator 2 comprises also a residual pressure device 32 comprising a first annular contact surface 32^1 on the piston 12 and a second annular contact surface 32^2 on the body 4. More particularly, the second annular contact surface 32^2 can be a seal that is housed in a groove formed in the body or on a separate ring 34 attached to the body 4. The ring 34 is slip on the central protruding portion 4^1 of the body 4 in a gas tight manner. To that end, the outer surface of the central protruding portion 4^1 and the inner surface of the ring contact each other and at least one of them can comprise a groove housing a seal 34^1.

[0051] As can be seen in both figures 1 and 2, the second annular contact surface 32^2 of the residual pressure valve 32 can be at another level than the distal end of the central protruding portion 4^1 of the body 4, for instance deeper in the annular cavity between the central protruding portion 4^1 and the chamber 14. Also the annular shoulder portion extends axially into that annular cavity. This provides a clear advantage of compactness.

[0052] The spring 18 tends to close the residual pressure valve by moving the piston 12 towards the regulating valve 12 so that the first annular contact surface 32^1 on the piston 12 contacts in a gas tight manner the second annular contact surface 32^2 on the body 4 (for instance the ring 34). This situation does not occur as long as the pressure in the regulating chamber is above a predetermined threshold that corresponds to the closing pressure of the residual pressure valve 32. This threshold is determined by the geometry of the residual pressure device and also by the characteristics and pre-constraint of the spring 18. This situation is illustrated in figure 1 where the regulating valve 12 is partially opened. As is apparent in figure 1, the gas under pressure at the inlet can flow through the regulating valve 12 to the chamber 14 and then flows from said chamber 14 radially outwardly between the first and second annular contact surfaces 32^1 and 32^2 of the residual pressure valve 32. The gas flows then along the channel section 10^1, between the outer surface of the ring 34 and the cavity housing the ring and forming the chamber. In the particular case of the embodiment of figures 1 and 2, the bottom of the cavity housing the ring 34 is raised and comprises passages (not visible) that allow the gas to flow along the channel section 10^2 radially inwardly towards the central protruding portion 4^1 of the body 4. A drilled hole (not visible) can extend from there towards the outlet or a further function that might be integrated in the regulator. For instance, this could be a flow selector (not represented).

[0053] It shall be mentioned that the gas passage does not necessarily need to circumvent the outer surface of the ring 34 as illustrated in figure 1. Indeed, one or several drilled holes can be made in the wall of the body 4

delimiting the cavity in order to guide the gas towards the next downstream function (if any) or the physical outlet.

[0054] The first annular contact surface 32^1 on the piston 12 contacts in a gas tight manner the second annular contact surface 32^2 on the body 4 when the regulator supplies gas to a consumer and, further to said supply, the pressure in the container, e.g. a gas cylinder, drops down below a predetermined threshold that corresponds to the closing pressure of the residual pressure valve 32. This pressure can be comprised between 1 and 10 bar, preferably between 2 and 5 bar. This closed state of the residual pressure valve is illustrated in figure 2.

Claims

1. Regulator (2) for compressed gas, comprising:
   - a body (4) with an inlet (6), an outlet (8) and a channel (10) for guiding a flow of gas from said inlet (6) to said outlet (8);
   - a regulating valve (12) with a seat (12^1) in the channel (10) and a movable closure member (12^2) upstream of said seat (12^1);
   - a piston (16) housed in the body (4) and mechanically linked with the closure member (12^2), said piston (16) delimiting with said body (4) a regulating chamber (14) downstream of the regulating valve (12) and controlling said valve (12);
   - a resilient member (18) able to exert a biasing force on the piston (16) towards the regulating valve (12) in order to open said valve (12);
   - a residual pressure valve (32) with a first annular contact surface (32^1) on the piston (16) and a second annular contact surface (32^2) on the body (4), both first and second surfaces (32^1, 32^2) being in the regulating chamber (14) and configured to be brought in mutual contact by the resilient member (18) for closing said valve (32);

   characterized in that

   the first and second annular contact surfaces (32^1, 32^2) are located at the periphery of the piston (16) and the chamber (14), respectively.

2. Regulator (2) according to claim 1, characterized in that the body (4) comprises in the regulating chamber (14) a central portion (4^1) that protrudes towards the piston (16) and houses the seat (12^1) of the regulating valve (12), the second annular contact surface (32^2) of the residual pressure valve (32) surrounding said central portion (4^1).

3. Regulator (2) according to claim 2, characterized in that the second annular contact surface (32^2) of the residual pressure valve (32) is set back relative to a distal end of the central protruding portion (4^1) of the body (4), preferably at a distance of more than 3mm, more preferably at a distance of more than 6mm.

4. Regulator (2) according to one of claims 2 and 3, characterized in that the second annular contact surface (32^2) of the residual pressure valve (32) is

formed on a ring (34) that is slip on the central protruding portion (4^1) of the body (4).

5. Regulator (2) according to claim 4, characterized in that said regulator (2) comprises a seal (34^1) between the ring (34) and the central protruding portion (4^1) of the body (4), said seal (34^1) being housed in a groove on an inner surface of said ring (34) or on an outer surface of said portion.

6. Regulator (2) according to claim 5, characterized in that the inner surface of the ring (34) and the outer surface of the central protruding portion (4^1) of the body (4) are cylindrical and contact each other.

7. Regulator (2) according to any one of claims 4 to 6, characterized in that the regulating chamber (14) forms an annular cavity around the central protruding portion (4^1) of the body (4), the ring (34) being located in said cavity and providing a passage for the gas between an external surface of said ring (34) and an internal surface of said cavity.

8. Regulator (2) according to claim 7, characterized in that a bottom surface of the ring (34) and/or a bottom surface of the cavity of the regulating chamber (14) comprises at least one passage for the gas towards the central protruding portion (4^1) of the body (4).

9. Regulator (2) according to any one of claims 1 to 3, characterized in that the second annular contact surface of the residual pressure valve (34) is on a portion of the body that is integral and forms the regulating chamber.

10. Regulator (2) according to any one of claims 1 to 9, characterized in that the first annular contact surface (34^1) of the residual pressure valve (34) is on an annular shoulder portion (16^2) of the piston (16), said portion (16^2) being towards a bottom of the regulating chamber (14).

11. Regulator (2) according to claim 10, characterized in that the piston (16) comprises a central disk-shaped portion (16^1), the annular shoulder portion (16^2) extending from the central disk-shaped portion (16^1) and forming a groove that opens radially outwardly, said groove housing a seal (16^3) that is configured for sliding along an inner cylindrical surface of the body (4) and delimiting the regulating chamber (14).

12. Regulator (2) according to any one of claims 2 to 8 and according to one of claims 10 and 11, characterized in that the annular shoulder portion (16^2) of the piston (16) extends along the central protruding portion (4^1) of the body (4).

13. Regulator (2) according to any one of claims 1 to 12, characterized in that the second annular contact surface (32^2) of the residual pressure valve (32) is formed by a seal, preferably of the O-ring type, housed in a groove.

14. Regulator (2) according to any one of claims 1 to 13, characterized in that the residual pressure valve (32) is configured to close when the pressure at the inlet (6) is below a threshold that is comprised between 1 and 10 bar, preferably between 2 and 5 bar.

15. Regulator (2) according to any one of claims 1 to 14, characterized in that the closure member (12^2) of the regulating valve (12) comprises a rod that extends through the seat (12^1) and is rigidly attached to the piston (16).

FIG 1

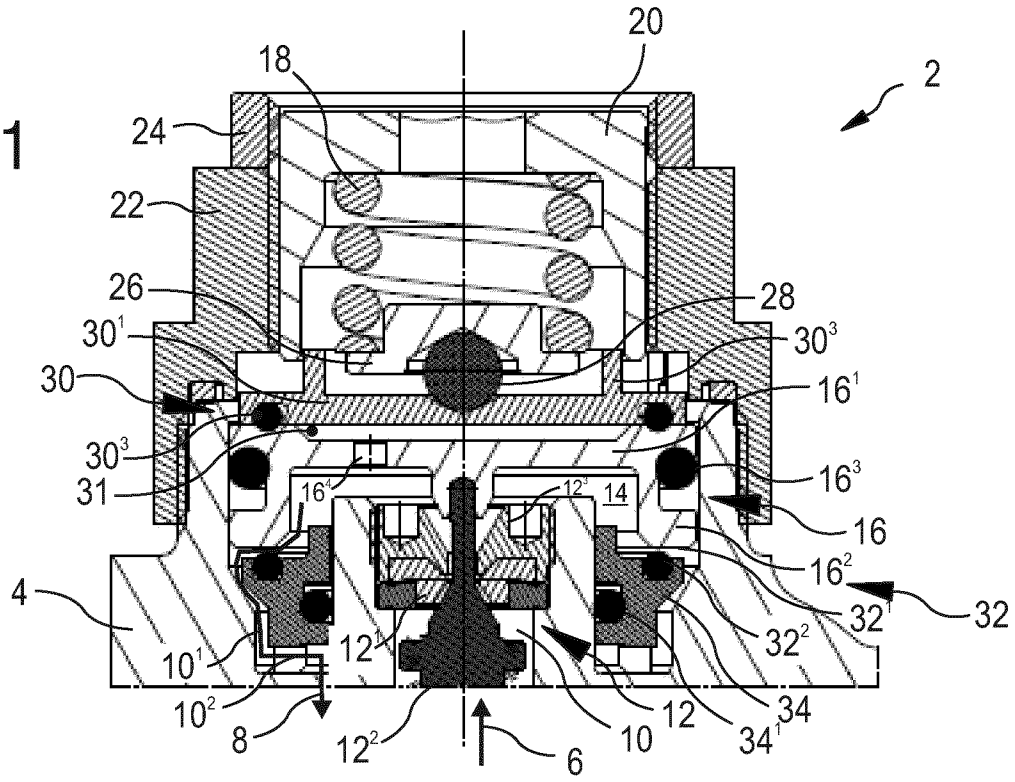
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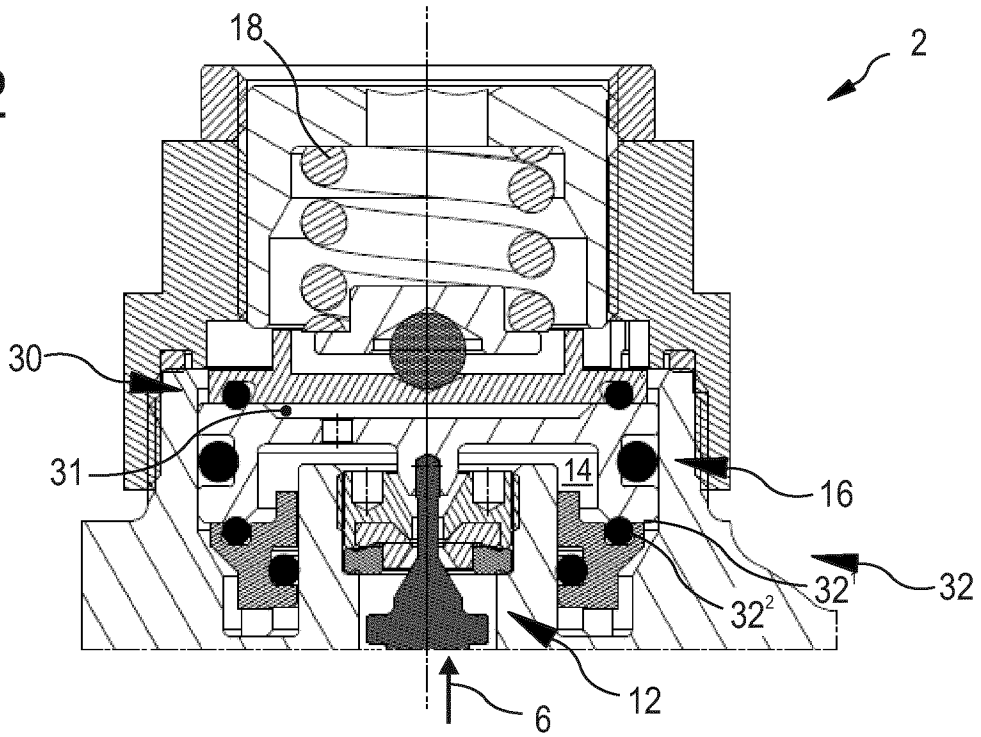
FIG 2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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/060816

A. CLASSIFICATION OF SUBJECT MATTER
INV. G05D16/10
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)
G05D

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)
EPO-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	WO 2014/009279 A1 (LUXEMBOURG PATENT CO [LU]) 16 January 2014 (2014-01-16) cited in the application the whole document	1-15
A	US 6 026 850 A (NEWTON JOHN R [US] ET AL) 22 February 2000 (2000-02-22) cited in the application the whole document	1-15
A	GB 2 349 200 A (VTI VENTIL TECHNIK GMBH [DE]) 25 October 2000 (2000-10-25) the whole document	1-15
A	EP 2 453 333 A1 (NERIKI VALVE CO LTD [JP]) 16 May 2012 (2012-05-16) the whole document	1-15

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
31 July 2017	04/08/2017

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