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(54) **ADJUSTABLE GAS REGULATOR.**

(57) The invention is directed to a gas regulator (2) comprising a body (4) with an inlet (6), an outlet (8) and a passage (10) therebetween; a passage regulating device (12) comprising a seal (16) mounted in an adjustable manner in the body (4); a movable member (14) delimiting in the body (4) a regulating chamber (18) downstream of the seal (16), said movable member comprising an upstream portion (14.4) surrounded by said regulating chamber (18) and engaging with the body (4) in a slidable and gas tight fashion, so as to form the passage (10), and a seat (14.1); and a spindle (22) with a longitudinal channel (22.1) forming the passage (10), threadably engaged with the body (4), carrying, at a proximal end, the seal (16) and provided, at a distal end, with an engagement surface (22.7) configured for engaging in rotation with an adjustment tool.

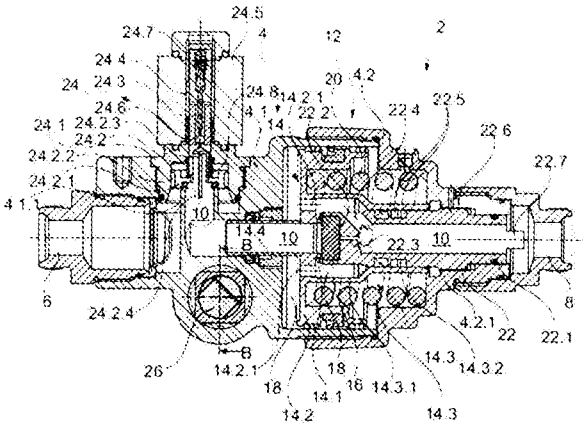

Fig. 1

Description

ADJUSTABLE GAS REGULATOR

Technical field

[0001] The invention is directed to the field of regulators for compressed gas like, in a non-limiting manner, compressed natural gas (CNG).

Background art

[0002] Prior art patent document published WO 2009/046714 A2 discloses a pressure reduction valve where the position of a seal cooperating with a movable seat is manually adjustable. The pressure reduction valve comprises a movable member forming a piston or supporting a membrane delimiting in the body a regulating chamber downstream of the seat. The movable member comprises also an upstream tubular portion surrounded by said regulating chamber and engaging in a bore formed in the body, in a slidable and gas tight fashion, so as to form an inlet passage. A seat is formed around that passage in the tubular portion and is configured for cooperating with the seal. The seal is housed at a proximal end of a spindle that is threadably engaged with the body, for adjustment purposes of the pressure reduction valve. The outlet is formed by a bore in the body parallel to the bore at the inlet receiving the tubular portion of the movable member. However, in some applications, it is desirable to have the outlet aligned with the inlet or at least located on the body at the opposite of the inlet. The spindle and the hand wheel provided at the distal end of the spindle prevent from positioning the outlet at the opposite of the inlet.

[0003] Prior art patent document published US 2004/0007269 A1 discloses a gas regulator of a similar construction to the pressure reduction valve of the above document, i.e. with a fixed seal and a movable seat. The gas regulator comprises a movable member forming a piston delimiting in the body a regulating chamber downstream of the seat and an upstream portion surrounded by said regulating chamber, with a bore engaging in a slidable and gas tight fashion with a tube formed in the body, so as to form an inlet passage. The seat is formed on the movable member directly downstream of that engagement with the tube. The seal is supported by a proximal end of a tubular portion formed on a bonnet top portion of the body. The outlet

is formed on that portion of the body, in alignment with the tubular portion and the inlet. The bonnet top portion of the body is threadably engaged with the lower portion of the body in an adjustable manner, so as to vary the preload of the main spring acting on the movable member and the position of the seal. These combined variations act in the same direction, *i.e.* unscrewing the bonnet top portion will cause the movable member to move upwardly and also the seal to move upwardly, so that the adjustment range or amplitude is limited. Also, adjusting the gas regulator implies a rotation of the outlet which is not practical for adjustment in operation, when the gas regulator outputs a flow of gas. More over any external action on the outlet is likely to modify the adjustment, which is not desirable.

[0004] Prior art patent document published WO 2007/106374 A2 discloses a gas regulator of a similar construction to the pressure reduction valve of the preceding document, i.e. with a fixed seal and a movable seat, and being adjustable. However contrary to the preceding document, the position of the seal is not adjustable, only the preloading of the spring is adjustable by a gear mechanism. That gear mechanism has however for drawback that it generates important frictional forces between the spring and the gear wheel against which the spring rests. Indeed, during rotation of the adjustment tool meshing with the gear wheel, the latter is rotated causing, by virtue of friction with the preloaded spring, torsional forces on said spring. These forces are not favourable for an accurate and smooth adjustment. For example, they can be relaxed after adjustment by rotating back the gear wheel and thereby change the adjustment.

Summary of invention

Technical Problem

[0005] The invention has for technical problem to overcome at least one of the drawbacks of the above cited prior art. More particularly, the invention has for technical problem to provide an adjustable gas regulator with the possibility to provide the outlet at the opposite of the inlet and with an accurate and efficient adjustment.

Technical solution

[0006] The invention is directed to a gas regulator comprising a body with an inlet, an outlet and a passage fluidly interconnecting said inlet and outlet; a passage regulating device comprising: a seal located in the passage and mounted in an adjustable manner in the body; a movable member delimiting in the body a regulating chamber downstream of the seat, said movable member comprising an upstream portion surrounded by said regulating chamber and engaging with the body in a slidable and gas tight fashion, so as to form the passage, and a seat around said passage configured for cooperating with the seal; wherein the passage regulating device further comprises a spindle with a longitudinal channel forming the passage, threadably engaged with the body, carrying, at a proximal end, the seal and provided, at a distal end, with an engagement surface configured for engaging in rotation with an adjustment tool.

[0007] Advantageously, the body comprises a first part forming an open cavity that receives the movable member and delimits the regulating chamber, and a second part that engages with the first part and closes the cavity. The second part advantageously is the body part that threadably engages with the spindle. Advantageously, the inlet is on the first part and the outlet is on the second part.

[0008] According to a preferred embodiment, the engagement surface on the distal end of the spindle is located on a front face of said distal end in order to engage with the adjustment tool by insertion of said adjustment tool through the body.

[0009] According to a preferred embodiment, the engagement surface of the spindle comprises at least one prong and/or at least one indent.

[0010] According to a preferred embodiment, the outlet is aligned with the spindle so as to receive the adjustment tool. Alternatively, the engagement surface of the spindle can be accessed by the adjustment tool via a specific port on the body.

[0011] According to a preferred embodiment, the gas regulator further comprises a gasket between the spindle and the body so as form a gas tight barrier between said spindle and said body.

[0012] According to a preferred embodiment, the thread engagement is formed by an outer thread on the spindle engaging with an inner thread on the body.

[0013] According to a preferred embodiment, the spindle comprises radially inclined holes adjacent the seal and fluidly connecting with the longitudinal channel.

[0014] According to a preferred embodiment, the radially inclined holes are located on a proximal cylindrical outer surface of the spindle.

[0015] According to a preferred embodiment, the seal is a disk of non-metallic material housed in a cavity on a front face of the proximal end of the spindle.

[0016] According to a preferred embodiment, the cavity on the front face of the proximal end of the spindle is surrounded by the proximal cylindrical outer surface of the spindle.

[0017] According to a preferred embodiment, the movable member comprises an inner circular surface engaging in a slidable and gas tight fashion with the spindle.

[0018] According to a preferred embodiment, the movable member comprises a cylindrical wall with a proximal portion radially distant from the proximal end of the spindle so as to form the passage in an annular fashion, and a distal portion with a reduced diameter compared with the proximal portion and forming the inner circular surface engaging with the spindle.

[0019] According to a preferred embodiment, the passage formed in an annular fashion is around the proximal cylindrical outer surface of the spindle with the radially inclined holes.

[0020] According to a preferred embodiment, the gas regulator further comprises a spring surrounding the cylindrical wall and resting on the body and the movable member so as to bias the seat off the seal.

[0021] According to a preferred embodiment, the upstream portion of the movable member comprises a tube engaging with a bore of the body, forming the passage, or comprises a bore engaging with a tube of the body.

[0022] Advantageously, the gas regulator comprises a shut-off valve arranged upstream of the passage regulating device.

[0023] The shut-off valve advantageously comprises a main closure element configured for cooperating with a corresponding seat in the passage. The corresponding seat can be formed in the body, in particular the first part thereof. The main closure member can be slidable in a body part of the shut-off valve and show an auxiliary gas passage. That auxiliary gas passage

can be normally closed by a pilot seal cooperating with a pilot seat on the main closure element. The pilot seal can be operated by an electromagnetic system. The slidable engagement of the main closure element with the body part forms a reduced gas passage with a cross-section area that is less than a cross-section area of the auxiliary gas passage in the main closure element, preferably less than 60% of said cross-sectional area of said auxiliary gas passage in said main closure element. The main closure element can comprise an open sliding ring housed in a radially outer groove and contacting an inner surface of a bore formed in the body part of the shut-off valve. The main closure element can comprise on a face downstream of the corresponding seat a tubular portion forming an extension of the auxiliary gas passage. That tubular portion extends over a length that is comprised between 20% and 60% of a diameter of the passage directly downstream of the corresponding seat.

[0024] The invention can also be directed to the above shut-off valve as such.

Advantages of the invention

[0025] The invention is particularly interesting in that it provides an adjustable gas regulator whose adjustment can be made in an accurate manner and cannot be easily modified by an unauthorized operator. Also, the outlet can be aligned with the inlet or at least on an opposite side with regard to the inlet, thereby providing a layout favourable for many applications.

Brief description of the drawings

[0026] Figure 1 is a sectional view of a gas regulator according to the invention.

[0027] Figure 2 is a sectional view the gas regulator of figure 1, equipped with an adjustment tool.

Description of an embodiment

[0028] Figure 1 is a sectional view of a gas regulator according to the invention. The gas regulator 2 comprises a body 4 with an inlet 6, an outlet 8 and a passage 10 fluidly interconnecting said inlet and outlet. The body 4 is for instance made of a first part 4.1 and a second 4.2 part, assembled to each other. Some sections of the passage 10 are formed directly in the body 4 whereas others are formed in element mounted into said body 4, as this will be explained hereafter.

[0029] As this is apparent, the inlet 6 and the outlet 8 are in alignment along a longitudinal axis of the gas regulator 2. Such a construction is however not mandatory in that the inlet and/or the outlet can be offset relative to said longitudinal axis or oriented differently. Fact is however that the passage 10 for the gas through the gas regulator extends generally longitudinally, thereby allowing the outlet to be arranged at the opposite of the inlet.

[0030] The gas regulator 2 houses a passage regulating device 12 that comprises essentially a movable member 14 provided with a seat 14.1, and a seal 16 in vis-à-vis of the seat 14.1 for cooperating with said seat for regulating the gas pressure and/or flow. In a normal state, i.e. in the absence of pressure at the inlet 6 and the outlet 8, the passage regulating device 12 is normally open, meaning that the seat 14.1 is distant from the seal 16. The gas can then flow longitudinally through the seat 14.1 and thereafter radially between said seat 14.1 and the seal 16 to a regulating chamber 18 and further to the outlet 8. The regulating chamber 18 is delimited by a cavity of the body 4 and the movable member 14 slidably housed in said cavity. The pressure in the regulating chamber 18 exerts a force on the movable member 14 that is opposed to the elastic force exerted by the spring 20 on said movable member 14. The spring 20 tends to move the movable member 14, for instance the seat 14.1, away from the seal 16, whereas the force exerted by the gas pressure in the regulating chamber 18 tends to move the movable member 14, for instance the seat 14.1, towards the seal 16. This means that as soon as gas under pressure at the inlet 6 flows through the cross-section between the seat 14.1 and the seal, the gas pressure in the regulating chamber 18 increases up to a level that the resulting force is greater than the opposed force exerted by the spring 20 and moves the movable member 14 towards the seal 16, thereby reducing the cross-section between said seal 16 and seat 14.1, resulting in a reduction of the flow and thereby outlet pressure. This principle is as such well known and therefore does not need to be further detailed.

[0031] The movable member 14 is hereby further detailed. It comprises a piston 14.2 that is received in a corresponding bore in the cavity of the body 4, in a slidable and gas tight fashion, for instance by means of at least one gasket housed in a circular outer groove and contacting the bore. The piston shows

a first main face (left side according to the orientation in figure 1) delimiting the regulating chamber 18 and a second main face (right side according to the orientation in figure 1) opposed to the first one, showing a reduced diameter and delimiting an extension of the regulating chamber 18 around the seat 14.1 and the seal 16. The regulating chamber 18 extends indeed to the opposite side of the piston 14.2 via the apertures 14.2.1 formed in said piston. That extension of the regulating chamber 18 is limited radially by the cylindrical wall 14.3 showing a proximal portion 14.3.1 adjacent the piston 14.2 and a distal portion 14.3.2 axially distant from the piston 14.2 and showing a reduced diameter compared with the first portion 14.3.1. The distal portion 14.3.2 engages in a slidable and gas tight fashion with an outer surface of the spindle 22 supporting the seal 16. The effective sectional surface onto which the gas pressure in the regulating chamber 18 exerts a resulting force on the movable member 14 is an annular section surface extending radially from the outer surface of the spindle 22 to the inner surface of the cavity housing the piston 14.2.

[0032] The movable member 14 comprises also a tube 14.4 engaging in a slidably and gas tight fashion with a bore of the body, forming the passage 10 upstream of the seat 14.1 and seal 16. The tube 14.4 forms the inlet of the passage regulating device 12, meaning that in operating conditions, the gas in said tube 14.4 is at high pressure compared with the pressure downstream in the regulating chamber 18 and at the outlet 8. The seat 14.1 shows a wedge-shaped cross-section resulting in an annular front surface with a reduced width. Advantageously, that annular surface shows a mean diameter that is the same as the outer diameter of the tube 14.4 in gas tight contact with the bore in the body 4, so that the gas regulator is compensated, i.e. not dependent on the inlet pressure.

[0033] As mentioned above, the seal 16 is supported by the spindle 22. The latter is hollow by showing a longitudinal channel 22.1 forming the passage 10. It is also threadably engaged with the body so as to be adjustable in position axially. More specifically, the spindle 22 comprises at a proximal end a cavity 22.2 housing the seal 16. The latter is for instance disk-shaped and the cavity 22.2 forms a bore with corresponding dimensions. A through-hole 22.3 is formed from the bottom of the cavity 22.2 to the longitudinal channel

22.1 in order to form a vent allowing gas under pressure that could accumulate between the seal 16 and the bottom of the cavity 22.1 to escape and prevent the seal 16 from being expelled from said cavity. The seal 16 is advantageously non-metallic, in any case of a material that is softer then the material of the seat 14.1.

[0034] The spindle 22 further comprises a series of radially inclined holes 22.4 adjacent the seal 16 and fluidly connecting with the longitudinal channel 22.1. The number of the radially inclined holes 22.4 can be at least 3, preferably at least 4, and/or not more than 8, preferably not more than 6. Each of the radially inclined holes22.4 shows an inclination angle relative to a radial direction, i.e. a direction perpendicular to the longitudinal axis of the spindle 22 that is at least 30° and/or not more than 55°. The radially inclined holes 22.4 are advantageously angularly distributed around the spindle 22. As this is apparent, the radially inclined holes 22.4 open out on a proximal cylindrical outer surface of the spindle. They are positioned and oriented so as to form an aerodynamically optimized flow path for the gas flowing from the annular extension of the regulating chamber 18 towards the longitudinal channel 22.1. As this is apparent, the annular extension of the regulating chamber 18 completely surrounds the radially inclined holes 22.4. The connection between the proximal and distal portions 14.3.1 and 14.3.2 of the cylindrical wall 14.3 of the movable member 14 shows an inclination that is about the same as the inclination of the radially inclined holes 22.4 so as to form an optimized guiding surface for the flow of gas.

[0035] The spindle 22 shows on its outer surface at least one groove housing a gasket 22.5 contacting the inner surface of the proximal portion 14.3.2 of the cylindrical wall 14.3 of the movable member 14. That at least one groove and gasket 22.5 are adjacent the radially inclined holes 22.4.

[0036] The spindle 22 shows further in a downstream direction an outer thread 22.6 engaging with an inner thread 4.2.1 formed on the body 4, for instance on the second part 4.2 thereof, thereby forming the threaded engagement mentioned above.

[0037] The spindle 22 shows at its distal end, i.e. in the downstream direction, an engagement surface 22.7 configured for engaging in rotation with an adjustment tool. That surface is for instance formed by two prongs

extending distally from the end face of the distal end, these two prongs being diametrically opposed. An adjustment tool (not represented in figure 1 but well in figure 2) can be inserted longitudinally through the outlet 8 so as to engage in rotation with the surface 22.7 and allow the spindle 22 to be adjusted in position by rotation of the adjustment tool. The adjustment in position of the spindle is advantageously carried out while the gas regulator is in operation, i.e. outputting a flow gas. To that end a specific tool is coupled to the outlet as this will be detailed below in connection with figure 2.

[0038] Still with reference to figure 1, the gas regulator 2 can comprises a shut-off valve 24 arranged fluidly upstream of the passage regulating device 12. The shut-off valve 24 comprises a body part 24.1 that is mechanically engaged with the body 4 of the gas regulator 2, more particularly with the first part 4.1 thereof.

[0039] The body part 24.1 comprises for instance a main portion engaging in the body 4 and forming a cavity housing a main closure element 24.2 that cooperates with a corresponding seat 4.1.1 formed in the body 4, for instance the first part 4.1 thereof. The engagement is for instance by an outer thread on the main portion engaging with an inner thread on the first part 4.1 of the body 4, being however understood that other configurations can be considered. The main closure element 24.2 is slidable in the cavity of the body part 24.1 and shows a front face with sealing means, for instance a gasket 24.2.1, designed for contacting the corresponding seat 4.1.1. The main closure element 24.2 shows also a sliding ring 24.2.2 contacting in a slidable fashion a bore forming the cavity of the body part 24.1. Although not visible, that sliding ring 24.2.2 does not form a gas tight barrier with the bore but rather shows at least one axial groove for allowing a gas passage as this will be described here after. For instance, the sliding ring 24.2.2 can be an open ring where the groove is formed at the two opposed and adjacent ends of the open ring.

[0040] The body part 24.1 of the shut-off valve 24 comprises also a cylindrical sleeve extending out of the main portion and housing a first plunger 24.3 and a second plunger 24.4 both made of ferromagnetic material and that can be moved longitudinally along said sleeve by means of a coil 24.5

mounted around said sleeve. The first plunger 24.3 carries, by means of a shoulder at its proximal end, a pilot seal 24.6 cooperating with a pilot seat of an auxiliary gas passage 24.2.3 through the main closure element 24.2. The pilot seal 24.6 is elastically biased towards the pilot seat by a rod and a pilot spring 24.7 so that in the absence of energy supplied to the coil 24.5, the pilot seal 24.6 contacts the pilot seat and closes the auxiliary gas passage 24.2.3. A main spring 24.8 surrounding the main closure element 24.2 and acting against the body part 24.1 and said main closure element 24.2 urges said main closure element 24.2 towards the corresponding seat 4.1.1.

[0041] A non-visible pin extends freely through a corresponding axially offset through-hole formed in the first plunger 24.3 so that it shows a first end contacting the main closure element 24.2 and a second end contacting the second plunger 24.4 in order to maintain a minimum distance between said second plunger 24.4 and said main closure element 24.2, that distance being slightly greater than the corresponding dimension (for instance the height) of the first plunger 24.3. Once the coil 24.5 is energized, a magnetic field is produced in the first plunger 24.3 and the second plunger 24.4, in particular in the air gap there between causing a magnetic attraction force that moves said first and second plungers towards each other so as to contact each other and cancel the air gap. This movement causes, by virtue of the above-described pin, to move the first plunger 24.3 away from the main closure element 24.2 causing the pilot seal 24.6 to move away from the pilot seat and thereby opening the auxiliary gas passage 24.2.3.

[0042] The construction of the above described shut-off valve is similar to the one disclosed in the patent application published EP 1 327 809 A1 of the same applicant and whose content is incorporated by reference.

[0043] The functioning principle of the shut-off valve 24 is as follows:

- In the absence of electrical energy supplied to the coil 24.5, the main spring 24.8 urges the main closure element 24.2 towards the corresponding seat 4.1.1 so as to close the passage 10. The above-mentioned groove(s) formed in the sliding ring 24.2.2 allows the inlet pressure to build up downstream of said main closure element 24.2 and

acts on a larger surface than upstream thereof, resulting in an additional force tending to close the passage 10.

- When the coil 24.5 is energized, with reference to the above explanations, the auxiliary gas passage 24.2.3 is opened, allowing gas to flow through the main closure element 24.2. The cross-sectional area resulting from the groove(s) formed in the sliding ring 24.2.2 is smaller than the cross-section area of the auxiliary gas passage 24.2.3, preferably less than 60% of said cross-section area of said auxiliary gas passage, meaning that the pressure on the main closure element 24.2 downstream of the sliding ring 24.2.2 become less than the inlet pressure upstream thereof. This pressure difference on both opposed faces of the main closure element 24.2 results in an opening force counteracting the elastic force of the main spring 24.8.

[0044] For a given inlet pressure, which can be considered to be constant during a given period of time, the pressure difference on the main closure element 24.2 depends on the reduced pressure on the downstream side caused by the pressure drop through the groove(s) of the sliding ring 24.2.2. The pressure difference and therefore the opening force is therefore directly dependent on the flow through the auxiliary gas passage 24.2.3. To that end, the main closure element 24.2 can show on its face downstream of the corresponding seat 4.1.1 a tubular portion 24.2.4 forming an extension of the auxiliary gas passage 24.2.3. This tubular portion 24.2.4 allows, when the main closure element 24.2 is in the open position of the shut-off valve 24, to keep a reduced pressure at the exit of the auxiliary gas passage 24.2.3 and thereby to keep a sufficient auxiliary flow there through helping in keeping the shut-off valve 24 wide open. In the absence of that tubular portion, the radial flow of gas between the main closure element 24.2 and the corresponding seat 4.1.1 can be decelerated at a central position of the downstream face of the main closure element 24.2 where the gas speed in converted into a static pressure at the exit of the auxiliary gas passage 24.2.3, potentially reducing the auxiliary flow there through. The length of the tubular portion 24.2.4 can be optimized to obtain a minimum pressure at the exit therefore bearing in mind that the pressure reducing effect is inverted beyond a certain length. That length can be comprised between

20% and 60% of a diameter of the passage directly downstream of the corresponding seat.

[0045] Still with reference to figure 1, the gas regulator 2 can comprise a pressure relief device 26 of the outlet pressure. The pressure relief device 26 is housed in a cavity of the body 4, for instance the first part 4.1 thereof, in direct fluidic connection (not visible in the sectional view) with the regulating chamber 18.

[0046] Figure 2 is a sectional view the gas regulator of figure 1, equipped with the adjustment tool mentioned above.

[0047] As this is apparent, the adjustment tool 28 comprises a body 28.1 with an inlet port 28.2 engaging in a gas tight fashion with the outlet port of the gas regulator 2, with an outlet port 28.3, for instance two opposed outlet ports 28.3. The adjustment tool 28 comprises also an adjustment spindle 28.3 that is rotatably housed in the body 28.1. The adjustment spindle 28.3 comprises a proximal (relative to the gas regulator) end 28.4.1 that rotatably engages with the engagement surface 22.7 at the distal end of the spindle 22. This engagement is achieved by a progressive axial displacement of the adjustment spindle 28.4 when the body 28.1 of the adjustment tool is engaged with the outlet port of the gas regulator 2. The proximal end 28.4.1 of the adjustment spindle 28.4 shows a surface that is designed for axially engaging with the engagement surface of the 22.7 of the spindle 22 and, once axially engaged, provide an engagement in rotation with said spindle 22. This means that rotation of the adjustment spindle 28. 4 will cause rotation of the spindle 22 and thereby will adjust the outlet pressure and/or flow of the gas regulator 2.

[0048] The adjustment spindle 28.4 is hollow by forming a channel 28.4.2 extending from the proximal end 28.4.1 to radial holes 28.4.3 opening out to the outlet ports 28.3. As this is apparent, the adjustment spindle 22 is rotatably mounted in the body 28.1 in a gas tight fashion so that the fluidic passage interconnecting the outlet of the gas regulator 2 with the outlet ports 28.3 of the adjustment tool is sealed from the external environment of the adjustment tool 28. A gasket 28.5 is provided between the body 28.1 and the adjustment spindle 28. 4 in order to form a gas tight barrier between the fluidic passage interconnecting the outlet of the gas regulator 2 with the

outlet ports 28.3 and the distal end 28.4.4 of adjustment spindle 28.4 extending out of the body 28.1 in order to be engaged by a tool, lever or hand wheel for adjusting the gas regulator 2.

[0049] The above adjustment tool 28 allows the gas regulator to be adjusted in operation, i.e. when outputting a flow of gas. The adjustment can be very fine in that it is operated by rotation of the spindle 22 of the gas regulator 2. In other words, the spindle 22 shows an infinity of angular and therefore also axial positions within a given range. Such an adjustment is particularly accurate and efficient. For simulating real operating conditions, the outlet ports 28.3 can be fluidly connected to an end consumer identical to the one in real operating conditions or at least showing the same or similar characteristics regarding gas flow and counter pressure. Once the gas regulator 2 is adjusted, the operating conditions can be stopped and the adjustment tool 28 is removed. The gas regulator is then deemed to be properly adjusted, e.g. for an indefinite period of time. This means that any user or operator having access to the gas regulator 2 cannot modify its settings in the absence of the above describe very specific tool 28. In other words, the above construction allows not only a fine adjustment in operation conditions but also prevents any change of its settings by unauthorized persons.

Claims

1. Gas regulator (2) comprising:

   - a body (4) with an inlet (6), an outlet (8) and a passage (10) fluidly interconnecting said inlet (6) and outlet (8);

   - a passage regulating device (12) comprising:
     - a seal (16) located in the passage (10) and mounted in an adjustable manner in the body (4);
     - a movable member (14) delimiting in the body (4) a regulating chamber (18) downstream of the seal (16), said movable member comprising an upstream portion (14.4) surrounded by said regulating chamber (18) and engaging with the body (4) in a slidable and gas tight fashion, so as to form the passage (10), and a seat (14.1) around said passage (10) configured for cooperating with the seal (16);

   characterized in that the passage regulating device (12) further comprises:
     - a spindle (22) with a longitudinal channel (22.1) forming the passage (10), threadably engaged with the body (4), carrying, at a proximal end, the seal (16) and provided, at a distal end, with an engagement surface (22.7) configured for engaging in rotation with an adjustment tool (28).

2. Gas regulator (2) according to claim 1, wherein the engagement surface (22.7) on the distal end of the spindle (22) is located on a front face of said distal end in order to engage with the adjustment tool (28) by insertion of said adjustment tool through the body (4).

3. Gas regulator (2) according to claim 2, wherein the engagement surface (22.7) of the spindle (22) comprises at least one prong and/or at least one indent.

4. Gas regulator (2) according to one of claims 2 and 3, wherein outlet (8) is aligned with the spindle (22) so as to receive the adjustment tool (28).

5. Gas regulator (2) according to any one of claims 2 to 4, further comprising a gasket (22.5) between the spindle (22) and the body (4) so as form a gas tight barrier between said spindle and said body.

6. Gas regulator (2) according to one of claims 1 to 5, wherein the thread engagement is formed by an outer thread (22.6) on the spindle (22) engaging with an inner thread (4.2.1) on the body (4).

7. Gas regulator (2) according to any one of claims 1 to 6, wherein the spindle (22) comprises radially inclined holes (22.4) adjacent the seal (16) and fluidly connecting with the longitudinal channel (22.1).

8. Gas regulator (2) according to claim 7, wherein the radially inclined holes (22.4) are located on a proximal cylindrical outer surface of the spindle (22).

9. Gas regulator (2) according to any one of claims 1 to 8, wherein the seal (16) is a disk of non-metallic material housed in a cavity (22.2) on a front face of the proximal end of the spindle (22).

10. Gas regulator (2) according to claims 8 and 9, wherein the cavity (22.2) is surrounded by the proximal cylindrical outer surface of the spindle (22).

11. Gas regulator (2) according to any one of claims 1 to 10, wherein the movable member (14) comprises an inner circular surface engaging in a slidable and gas tight fashion with the spindle (22).

12. Gas regulator (2) according to claim 11, wherein the movable member (14) comprises a cylindrical wall (14.3) with a proximal portion (14.3.1) radially distant from the proximal end of the spindle (22) so as to form the passage (10) in an annular fashion, and a distal portion (14.3.2) with a reduced diameter compared with the proximal portion (14.3.1) and forming the inner circular surface engaging with the spindle (22).

13. Gas regulator (2) according to one of claims 8 and 10, and according to claim 11, wherein the passage (10) formed in an annular fashion is around the proximal cylindrical outer surface of the spindle (22) with the radially inclined holes (22.4).

14. Gas regulator (2) according to one of claims 12 and 13, further comprising a spring (20) surrounding the cylindrical wall (14.3) and resting on the body (4) and the movable member (14) so as to bias the seat (14.1) off the seal (16).

15. Gas regulator (2) according to any one of claims 1 to 14, wherein the upstream portion (14.4) of the movable member (14) comprises a tube engaging with a bore of the body (4), forming the passage (10), or comprises a bore engaging with a tube of the body.

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Revendications

1. Régulateur de gaz (2) comprenant:
   - un corps (4) avec une entrée (6), une sortie (8) et un passage (10) interconnectant fluidiquement lesdites entrée (6) et sortie (8);
   - un dispositif de régulation de passage (12) comprenant:
     - un joint (16) situé dans le passage (10) et monté de manière réglable dans le corps (4);
     - un organe mobile (14) délimitant dans le corps (4) une chambre de régulation (18) en aval du joint (16), ledit organe mobile comprenant une partie amont (14.4) entourée par ladite chambre de régulation (18) et s'engageant avec le corps (4) de manière coulissante et étanche aux gaz, de façon à former le passage (10), et un siège (14.1) autour dudit passage (10) configuré pour coopérer avec le joint (16);

   caractérisé en ce que le dispositif de régulation de passage (12) comprend en outre:
     - une broche (22) avec un canal longitudinal (22.1) formant le passage (10), en prise par filetage avec le corps (4), portant, à une extrémité proximale, le joint (16) et munie, à une extrémité distale, d'une surface d'engagement (22.7) configurée pour s'engager en rotation avec un outil de réglage (28).

2. Régulateur de gaz (2) selon la revendication 1, dans lequel la surface d'engagement (22.7) sur l'extrémité distale de la broche (22) est située sur une face avant de ladite extrémité distale pour s'engager avec l'outil de réglage (28), par insertion dudit outil de réglage à travers le corps (4).

3. Régulateur de gaz (2) selon la revendication 2, dans lequel la surface d'engagement (22.7) de la broche (22) comprend au moins une dent et/ou au moins une encoche.

4. Régulateur de gaz (2) selon l'une des revendications 2 et 3, dans lequel la sortie (8) est alignée avec la broche (22) de manière à recevoir l'outil de réglage (28).

5. Régulateur de gaz (2) selon l'une quelconque des revendications 2 à 4, comprenant en outre un joint (22.5) entre la broche (22) et le corps (4) de manière à former une barrière étanche aux gaz entre ladite broche et ledit corps.

6. Régulateur de gaz (2) selon l'une des revendications 1 à 5, dans lequel l'engagement du filetage est formé par un filetage extérieur (22.6) sur la broche (22) s'engageant avec un filetage intérieur (4.2.1) sur le corps (4).

7. Régulateur de gaz (2) selon l'une quelconque des revendications 1 à 6, dans lequel la broche (22) comprend des trous radialement inclinés (22.4) adjacents au joint (16) et en liaison fluidique avec le canal longitudinal (22.1).

8. Régulateur de gaz (2) selon la revendication 7, dans lequel les trous radialement inclinés (22.4) sont situés sur une surface externe cylindrique proximale de la broche (22).

9. Régulateur de gaz (2) selon l'une quelconque des revendications 1 à 8, dans lequel le joint (16) est un disque en matériau non métallique logé dans une cavité (22.2) sur une face avant de l'extrémité proximale de la broche (22).

10. Régulateur de gaz (2) selon les revendications 8 et 9, dans lequel la cavité (22.2) est entourée par la surface extérieure cylindrique proximale de la broche (22).

11. Régulateur de gaz (2) selon l'une quelconque des revendications 1 à 10, dans lequel l'organe mobile (14) comprend une surface circulaire intérieure s'engageant de manière coulissante et étanche aux gaz avec la broche (22).

12. Régulateur de gaz (2) selon la revendication 11, dans lequel l'organe mobile (14) comprend une paroi cylindrique (14.3) avec une partie proximale (14.3.1) radialement éloignée de l'extrémité proximale de la broche (22) de manière à former le passage (10) de manière annulaire, et une partie distale (14.3.2) avec un diamètre réduit par rapport à la partie proximale (14.3.1) et formant la surface circulaire intérieure s'engageant avec la broche (22).

13. Régulateur de gaz (2) selon l'une des revendications 8 et 10, et selon la revendication 11, dans lequel le passage (10) formé de façon annulaire est autour de la surface extérieure cylindrique proximale de la broche (22) avec le passage radialement incliné trous (22,4).

14. Régulateur de gaz (2) selon l'une des revendications 12 et 13, comprenant en outre un ressort (20) entourant la paroi cylindrique (14.3) et reposant sur le corps (4) et l'organe mobile (14) de manière à solliciter le siège (14.1) du joint (16).

15. Régulateur de gaz (2) selon l'une quelconque des revendications 1 à 14, dans lequel la partie amont (14.4) de l'organe mobile (14) comprend un tube venant en prise avec un alésage du corps (4), formant le passage (10), ou comprend un alésage s'engageant avec un tube du corps.

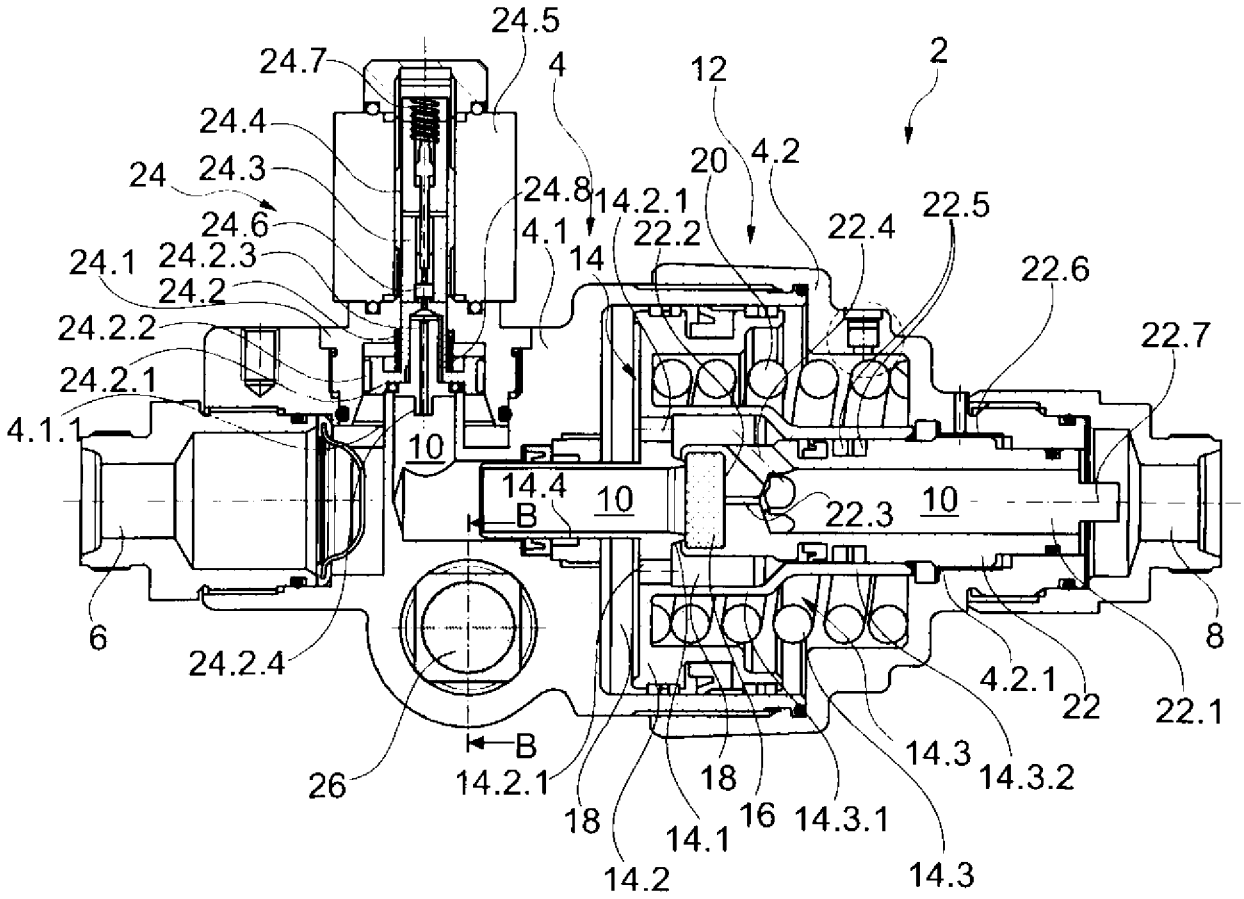
24.5
24.7
4
12
2
24.4
24
24.3
24.8
14.2.1
20
4.2
24.6
4.1
14
22.2
22.4
22.5
24.1
24.2.3
22.6
24.2
24.2.2
22.7
24.2.1
4.1.1
10
14.4
10
22.3
10
B
6
8
24.2.4
4.2.1
22
22.1
B
26
14.2.1
18
14.3
14.3.2
18
16
14.3.1
14.1
14.2
14.3

Fig. 1

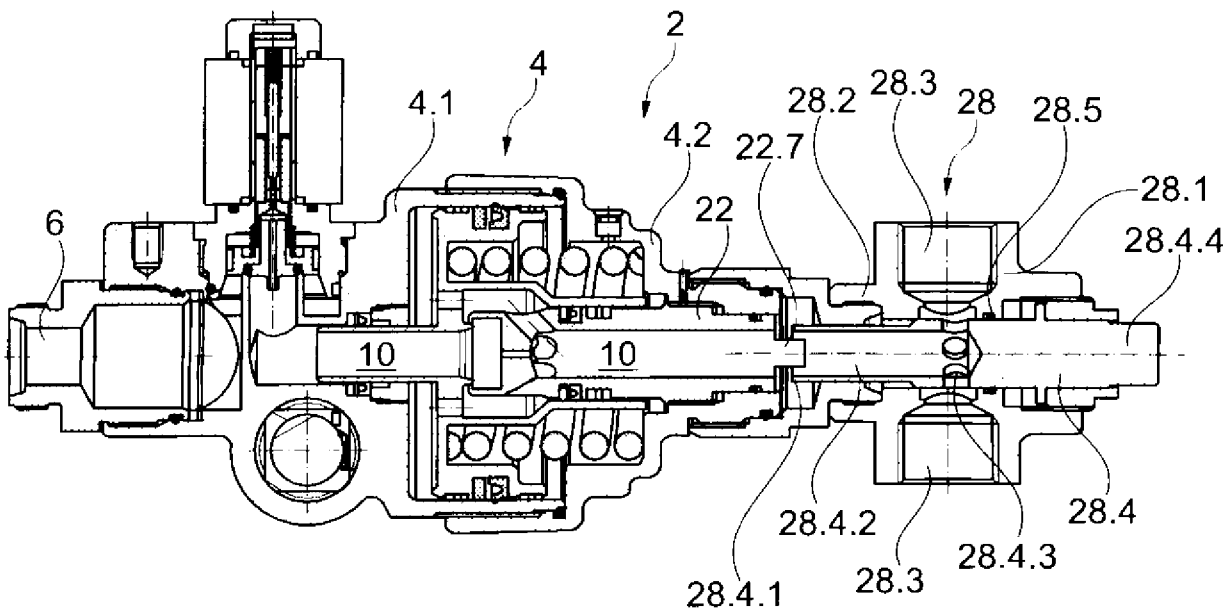
2
4
4.1
28.2
28.3
28
28.5
4.2
22.7
28.1
6
22
28.4.4
10
10
28.4.2
28.4
28.4.3
28.3
28.4.1

Fig. 2