

Description**Shut-off valve with integrated pressure releaser****Technical characteristic**

[0001] The invention device relates to a device for regulating gas under pressure, such as, for example, hydrogen.

Technical status

[0002] A device for releasing or regulating gas under pressure is known from the document **EP1031900 A** (SMC CORPORATION) 30.08.2000. The latter discloses a releasing device comprising a gas passageway closing element comprising sealing means cooperating with a seat. This element is actuated by a piston subjected, on one of its sides, to a first adjustable spring, and on the opposite side, to the pressure of the gas passing between the closing element and the seat. This pressure is applied by a sealing membrane surrounding the low pressure chamber below the closing element.

[0003] The pressure applied by the spring may be adjusted by actuating the pre-compression knob of the first spring. In practice, this allows for adjusting the operating pressure of the device. Closing the device is done by turning the knob to the maximum in the direction of decompression of the spring. A second spring working in the opposite direction pushes the piston upward. Decompressing the first spring allows the second spring to lift the piston and, thus, to shut off the device.

[0004] In case of a deterioration of the seal between the closing element and its seat, the complete closure of the device is no longer ensured.

[0005] The document **GB 2 267 950 A** (JULIAN STEWARD TAYLOR) 22.12.1993 also

discloses a gas release device similar in its principle to the one presented in the previous document and comprises a safety system in case of deterioration of the seal from the seat of the releaser. Indeed, an additional closing element is placed above the releaser, that is, under high pressure, and is maintained opened by a compression rod sized to burn in case of excessive pressure at the outlet of the device. Indeed, the additional closing element is connected to a membrane subjected to the outlet pressure of the pressure releaser, which applies a compressing force on the rod. In case of clogging or icing of the pressure releaser, the pressure at the outlet of the device may increase beyond an acceptable threshold, which, as a result, would make the rod burn and would shut off the additional closing element under the effect of a spring applying pressure on it in the direction of closure.

[0006] The solution to the possible malfunctioning problem of the closing element of the pressure releaser as proposed in **GB 2 267 950 A** (JULIAN STEWARD TAYLOR) 22.12.1993 is not satisfactory for reasons of size and complexity. Additionally, this safety system works only when the outlet pressure of the device reaches a certain threshold. This means that the system does not work when no apparatus is connected to the device. Thus, it does not operate as a safety valve but rather as a protection system aiming to limit the pressure on the user's side of the releaser.

Aims of the invention

[0007] The invention aims to bring a simple and compact solution to the previously mentioned problems, namely, to present a release device comprising a secured shut-off system.

- [0008] According to the invention, a gas releasing and/or regulating device is proposed, comprising: a body with a passage, a gas inlet and outlet, the inlet and outlet being connected to the passage; means for blocking the passage; movable means which, associated to the body of the device, define a low pressure chamber downstream of the blocking means, the movable means operating the blocking means as a function of the pressure within the low pressure chamber; the blocking means comprise a first valve and a second valve mounted downstream of the first in the passage; and the first and second valve are mechanically connected so that the first valve closes before the second one.
- [0009] The first and second valves may each be equipped with a movable blocking element cooperating with a respective seat affixed to the body of the device.
- [0010] Preferably, the first valve is configured so that a spring pushes it toward its seat in the normal direction of gas flow in order to close the passage, and is mechanically connected to the second valve by a simple mechanical abutment so that the second valve pushes the first one during an opening movement and so that there is a slight give in the mechanical connection between the two valves when both valves are closed.
- [0011] Preferably, the second valve closes the gas passage when its movable blocking element is supported by its seat in the normal direction of gas flow.
- [0012] The second valve may be coupled to the movable means.
- [0013] Preferably, the movable element of the second valve is pushed towards its seat by a spring supported on the body of the device and, preferably, is connected to the movable means by a mechanical abutment.

[0014] The movable element of the first valve may comprise a conical part cooperating with the seat of the first valve, and an elongated part extending through the seat downstream of the conical part.

[0015] The movable element of the second valve may comprise a conical part cooperating with the seat of the second valve, and with an elongated part extending through the seat downstream of the conical part.

[0016] Release device according to the previous claim, characterized in that the elongated part of the movable element of the first valve cooperates with the conical part of the movable element of the second valve.

[0017] The conical part of the movable element of the second valve may comprise a cavity receiving in abutment the elongated part of the movable element of the first valve such as to transmit an opening movement of the second valve caused by the movable means to the movable element of the first valve.

[0018] The elongated part of the movable element of the first valve may be placed away from the cavity abutment of the second valve receiving it when both valves are closed.

Brief description of the drawings

[0019] Figure 1 shows a cross view of a gas releasing and/or regulating device according to the invention.

[0020] Figure 2 shows the cross view of the line B-B of the device in Figure 1.

Best implementation of the invention

[0021] The device comprises a body 1 comprising a gas inlet 2, an outlet 3 and a passage connecting the inlet to the outlet. This passage is blocked by two valves placed in series and aligned according to the principal axis of the body of the device. The first valve comprises a movable element 5 having a conical shape cooperating with a seat 6 in a sealing manner. The seat may be attached to or directly machined with the body. A spring 4 applies pressure on the movable element 5 in the closing direction of the first valve. The movable element 5 comprises an elongated part extending from the conical part and through the orifice of the seat 6. When closed, the first valve defines two zones: downstream of it, the high pressure zone corresponding to the pressure in the bottle or the pipe to which the device is connected to, and downstream of the first valve, a low pressure zone, where the gas has already partially been released. The second valve is placed in series with the first one and downstream of it. It is equipped with a movable element 7 having a conical shape cooperating with seat 8 in a sealing manner. As the first valve, the seat may be attached to or directly machined with the body. When they are closed, both valves as well as the passage in the body of the device define an intermediate chamber 20. In this intermediate chamber, the conical part of the movable element 7 of the second valve comprises a cavity receiving the end of the elongated part of the movable element 5 in a sliding manner. The movable element 7 further comprises an elongated part extending from the conical part and through the orifice of the seat 8. The end of this elongated part cooperates with a movable element 9. The latter defines with the body of the device and the second valve, a chamber referred to as a low pressure chamber that communicates with the outlet 3 of the device.

[0022] A membrane 12 affixed to the movable element 9 divides up the upper part of the low pressure chamber in a sealing manner. The movable element 9 is subjected to pressure of an elastic means such as a spring 10 resting on the body of the device. In the case of the example of Figures 1 and 2, the spring 10 applies a vertical force towards the top. Thus, it tends to lift the element 9. The latter is in contact via the membrane 12 with a piston 13 adapted to slide in the top part of body of the device, the piston 13 being itself subjected to a vertical force of an elastic means such as a spring 14. The latter rests on a ball bearing abutment whose position, dependent on the principal axis of the device (and of the spring), may be adjusted by a knob 15. The latter allows for adjusting the releasing pressure of the device as well as for closing the device.

[0023] A manometer 16 is provided in direct connection with the high pressure. A connection coupling 17 for the user is provided on the side of the device. Figure 2 also shows a pressure release valve 18 connected directly to the low pressure chamber and thus to the outlet of the device. A filling device 19 for the bottle is provided in the side of the device in direct connection with the high pressure.

[0024] While operating, the knob 15 is actuated so as to subject the spring 14 to a pressure that is sufficient to counter the counter force of the springs 4 and 10 and the counter force resulting from the pressure of the gas under high pressure working on a section of the movable element 5 of the first valve corresponding to the passage section. The movable element 9 thus moves slightly downwards. This movement is transmitted directly to the movable element 7 of the second valve as well as to the movable element 5 of the first valve via the mechanical abutment. Once both valves are opened, pressure builds up in the intermediary chamber 20 as well as in the low pressure chamber 11. As the pressure

building up in the low pressure chamber, the membrane 12 is biased upwards and slightly moves the piston 13 upwards by compressing the spring 14. The movable element 9 may then move upwards in order to move the two movable elements 7 and 5 of the valves and to regulate the gas flow and thus regulate the operating pressure in the low pressure chamber.

[0025] The engagement of both movable elements 5 and 7 is such that the first valve 5, 6 closes a little before the second valve 7, 8 when the movable element moves upwards in order to close the device. This indicates that the movable element 7 does not yet touch its seat 8 when the movable element 5 has just come to rest in its seat 6. When the second valve is closed, there is a slight give between the end of the elongated rod of the movable element 5 of the first valve and the bottom of the abutment cavity of the movable element 7 receiving the latter.

[0026] During the closing of the device, the knob is actuated by the operator so as to release to the maximum the force of the spring 14, that is, to elevate the stopper of the spring 14 up to its top abutment. Thus the pressure of the springs 4 and 10 is sufficient to counter the spring 14 in order to elevate the movable element 9 and the piston 13. Since the movable element 7 of the second valve is attached to the movable element, elevating the latter results in elevating it as well. In turn, elevating the movable element 7 allows the movable element 5 to rise until closure under the effect of the spring 4. Once the first valve closed, the downstream pressure, and thus the pressure in the intermediate chamber 20 drops since the second valve is not yet completely closed. When the operator continues to release the pre-constraint of the spring 14 until it reaches a mechanical abutment for example, the movable element 9 is able to rise further and thus close the

second valve. From that point, the device is doubly closed by the first and second valves. The second valve theoretically always operates under low pressures, whereas the first valve is constantly under the high pressure of the bottle. The second valve may then fully operate as a safety valve insofar as it is theoretically not biased much at all, if only when the first valve leaks.

[0027] It is noted that the second valve should not necessarily be attached to the movable element 9 of the pressure releaser. In fact, the movable element 7 may be subjected to the force of a spring resting on the body of the device in a similar fashion as the movable element of the first valve. A simple engagement of the “abutment” type would thus suffice in this case between the movable element 9 and the end of the elongated part of the movable element 7.

[0028] The movable elements 5 and 7 should not necessarily have a conical shaped cooperating with the respective seat. In fact, it is possible to consider that one or both movable elements would comprise, for example, a flat and circular element cooperating with a planar seat. Inversely, it is also possible for the seat, and not the blocking element, to be movable.

[0029] The movable element 9 cooperating with the membrane may be replaced by a completely different yet equivalent release command device. In fact, one could replace it for example with a similar movable element connected to a metal bellows in a sealing manner in order to form therein low pressure chamber. This would eliminate the use of the membrane 12 since the metal bellows would ensure the sealing of the chamber.

Claims

1. Gas releasing and/or regulating device comprising:

A body (1) with a passage, a gas inlet (2) and outlet (3), both the inlet and outlet are connected to the passage;

means for blocking (5, 6, 7, 8) the passage;

movable means (9, 12) defining with the body (1) of the device a low pressure chamber (11) downstream of the blocking means (5, 6, 7, 8), the movable means (9, 11) operating the blocking means (5, 6, 7, 8) as a function of the pressure within the low pressure chamber (11); wherein

the blocking means (5, 6, 7, 8) comprise a first valve (5, 6) and a second valve (7, 8) mounted downstream of the first one in the passage; and the first and second valves (5, 6, 7, 8) are mechanically connected so that the first valve (5, 6) closes before the second one (7, 8).

2. Release device according to the previous claim, characterized in that the first and second valves each comprise a movable blocking means (5, 7) cooperating with a respective seat (6, 8) affixed to the body (1) of the device.

3. Release device according to the previous claim, characterized in that the first valve (5, 6) is configured so that a spring (4) pushes it towards its seat (6) in the normal direction of gas flow in order to close the passage, and is mechanically connected to the second valve (7, 8) by a simple mechanical abutment so that the second valve (7, 8) pushes the first one during the opening movement and there is a slight give in the mechanical connection between the two valves when both valves are closed.

4. Release device according to the previous claim, characterized in that the second valve (7, 8) closes the passage of gas when its movable blocking element (7) rests in its seat (8) in the normal direction of gas flow.
5. Release device according to the previous claim, characterized in that the second valve (7, 8) is coupled with the movable means (9).
6. Release device according to claim 4, characterized in that the movable element (7) of the second valve (7, 8) is pushed towards its seat (8) by a spring taking support on the body (1) of the device and, preferably, is connected to the movable means (9, 11) by a mechanical abutment.
7. Release device according to one of claims 2-6, characterized in that the movable element (5) of the first valve (5, 6) comprises a conical part cooperating with the seat (6) of the first valve, and an elongated part extending across the seat (6) downstream of the conical part.
8. Release device according to the previous claim, characterized in that the movable element (7) of the second valve (7, 8) comprises a conical part cooperating with the seat (8) of the second valve, and an elongated part extending across the seat (8) downstream of the conical part.
9. Release device according to the previous claim, characterized in that the elongated part of the movable element (5) of the first valve (5, 6) cooperates with the conical part of the movable element (7) of the second valve (7, 8).
10. Release device according to the previous claim, characterized in that the conical part of the movable element (7) of the second valve (7, 8) comprises a cavity receiving the abutment of the movable element (5) of the first valve (5, 6) in order to transmit an opening movement from the second valve triggered by the movable means (9, 11) to the movable element (5) of the first valve (5, 6).

11. Release device according to the previous claim, characterized in that the elongated part of the movable element (5) of the first valve (5, 6) is mounted away from the cavity abutment of the second valve receiving it when both valves are closed.