A PRESSURE REGULATOR

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Title: A PRESSURE REGULATOR

Abstract: A pressure regulator (1) comprises a high pressure chamber (2) accommodated in a high pressure housing (3) and a low pressure chamber (4) accommodated in a low pressure housing (5). The chambers (2, 4) can communicate with each other via a controllable valve (6). The maximum pressure level in the high pressure chamber (2) against which the high pressure housing (3) is resistant is higher than the maximum pressure level in the low pressure chamber (4) against which the low pressure housing (5) is resistant. The low pressure chamber (4) is provided with a release valve (3, 18; 19-21) which opens to the outside at a predetermined pressure level in the low pressure chamber (4). The high pressure housing (3) is resiliently connected to and movable with respect to the low pressure housing (5) such that the high pressure housing (3) displaces with respect to the low pressure housing (5) upon a pressure change in the low pressure chamber (4).
OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG). Published: — with international search report (Art. 21(3))
A pressure regulator

The present invention relates to a pressure regulator comprising a high pressure chamber accommodated in a high pressure housing and a low pressure chamber accommodated in a low pressure housing, wherein the chambers can communicate with each other via a controllable valve.

Such a pressure regulator is known from DE 1 809 509. The known pressure regulator comprises a valve which is controlled by a membrane which is in contact with the low pressure chamber. When fluid flows through the valve from the high pressure chamber to the low pressure chamber the membrane will be pressed outwardly due to increasing pressure in the low pressure chamber. Since the valve is fixed to the membrane it will be displaced towards its seat and at a certain pressure level in the low pressure chamber the valve will rest on its seat and close the valve between the low pressure chamber and the high pressure chamber. As a consequence, the fluid flow from the high pressure chamber to the low pressure chamber stops. A disadvantage of the known pressure regulator is that it is relatively expensive.

The object of the invention is to provide a low cost pressure regulator.

This is achieved by the pressure regulator according to the invention which is characterized in that the maximum pressure level in the high pressure chamber against which the high pressure housing is resistant is higher than the maximum pressure level in the low pressure chamber against which the low pressure housing is resistant, and wherein the low pressure chamber is provided with a release valve which opens to the outside at a predetermined pressure level in the low pressure chamber.

The high pressure housing has a higher strength than the low pressure housing. Assuming that the ambient pressure outside the entire pressure regulator is equal the allowable pressure difference over the high pressure chamber and the ambient is higher than the allowable pressure difference over
the low pressure chamber and the ambient. Due to the relatively low strength of the low pressure housing it can be made of a low-cost material, for example a plastic, whereas the high pressure housing can be made of conventional housing materials of pressure regulators such as brass or the like. Since the maximum pressure in the low pressure chamber is not allowed to be as high as in the high pressure chamber the release valve is present for safety reasons. In case of overpressure in the low pressure chamber the low pressure housing does not explode because of the low strength material thereof since the release valve will open to reduce the pressure level in an emergency.

The high pressure housing and low pressure housing may have numerous configurations. Each of the housings may be made of different materials; for example, the low pressure housing may be partly made of a material having a relatively low strength whereas an other part may be made of a material having a relatively high strength. Each of the housings can be defined as accommodating a low or high pressure chamber, respectively, and the pressure in a chamber exerts a force on the inside of the corresponding housing.

The high pressure housing may be made of a material which has a higher tensile strength than the material of which the low pressure housing is made. This means that if the pressure in both the low and high pressure chambers increased above a certain pressure level the low pressure housing would burst whereas the high pressure housing would not be damaged.

The high pressure housing may be made of brass and the low pressure housing may be made of a plastic. Brass is a strong but relatively expensive material and is often used for both low and high pressure housings of conventional pressure regulators.

The release valve may be a ball spring valve, but alternative release valves are conceivable.

The high pressure housing and the low pressure housing may be separate parts which are assembled.

In a preferred embodiment the high pressure housing is resiliently connected to and movable with respect to the low pressure housing and partly in contact with the low pressure chamber such that the high pressure housing displaces with respect to the low pressure housing upon a pressure change in
the low pressure chamber, wherein the controllable valve fits to an opening in the high pressure housing and is movable with respect to at least the high pressure housing and is controlled such that it releases the opening upon a predetermined pressure decrease in the low pressure chamber and closes the opening upon a predetermined pressure increase in the low pressure chamber. This appears to be a surprising alternative embodiment with respect to conventional pressure regulators including a membrane.

The controllable valve may comprise a first contact portion which fits to a valve seat on the high pressure housing for closing the opening, and a second contact portion spaced from the first contact portion which second contact portion abuts against a stop portion being present on the low pressure housing. When the pressure in the low pressure chamber decreases the valve will be lifted from its seat such that fluid may flow from the high pressure chamber to the low pressure chamber. In an alternative embodiment the controllable valve may be fixed to the low pressure housing, for example the second portion is fixed to the stop portion. This means that in fact the high pressure housing is movable with respect to the low pressure housing including the controllable valve.

Preferably, the controllable valve is resiliently connected to the high pressure housing since this effects a quickly closing of the valve.

The stop portion may be made of a material having a higher hardness than the material of the low pressure housing. This avoids damage of the stop portion due to many repetitive contacts of the second contact portion of the controllable valve onto the stop portion during operation of the pressure regulator.

The controllable valve may also be movable with respect to the low pressure housing, and the low pressure housing and the high pressure housing may be shaped such that upon a predetermined pressure increase in the low pressure chamber the high pressure housing displaces beyond a pressure release opening in the low pressure housing, through which the low pressure chamber can communicate with the outside of the pressure regulator. In fact this feature forms a pressure
release valve of the low pressure chamber. It may replace the ball valve or be present in addition to the ball valve, for example.

The pressure regulator may be provided with adjusting means for adjusting the mutual position of the low pressure housing and the high pressure housing in a rest condition of the pressure regulator. This affects the resiliency between the high pressure housing and the low pressure housing and provides the opportunity to adjust the controlled pressure level in the low pressure chamber.

The invention is also related to a pressure regulator comprising a high pressure chamber accommodated in a high pressure housing and a low pressure chamber accommodated in a low pressure housing, wherein the chambers can communicate with each other via a controllable valve, wherein the high pressure housing is resiliently connected to and movable with respect to the low pressure housing and partly in contact with the low pressure chamber such that the high pressure housing displaces with respect to the low pressure housing upon a pressure change in the low pressure chamber, wherein the controllable valve fits to an opening in the high pressure housing and is movable with respect to at least the high pressure housing and is controlled such that it releases the opening upon a predetermined pressure decrease in the low pressure chamber and closes the opening upon a predetermined pressure increase in the low pressure chamber.

The controllable valve may comprise a first contact portion which fits to a valve seat on the high pressure housing for closing the opening, and a second contact portion spaced from the first contact portion which second contact portion abuts against a stop portion on the low pressure housing.

The invention will hereafter be elucidated with reference to the schematic drawings showing embodiments of the invention by way of example.

Fig. 1 is a cross-sectional view of an embodiment of a pressure regulator according to the invention in assembled condition.

Fig. 2 is an exploded view of the embodiment of Fig. 1.
Figs. 3 and 4 are similar views as Fig. 1, but showing two different conditions: an open valve (Fig. 3) and a closed valve (Fig. 4).

Fig. 5 is a similar view as Fig. 4, but showing a condition in which the pressure regulator is adjusted to a higher pressure level in the low pressure chamber.

Fig. 6 is a similar view as Fig. 5, but showing a condition in which the pressure regulator releases overpressure from the low pressure chamber.

Fig. 7 is a perspective cut-away view of an alternative embodiment of the pressure regulator according to the invention.

Fig. 8 is a cross-sectional view of the embodiment of Fig. 7 in more detail and on a larger scale.

Fig. 1 shows an embodiment of a pressure regulator 1 according to the invention in cross section. The pressure regulator 1 is shown in assembled condition. In Fig. 2 the pressure regulator 1 is shown in disassembled condition. The pressure regulator 1 comprises a high pressure chamber 2 which is accommodated in a high pressure housing 3, and a low pressure chamber 4 which is accommodated in a low pressure housing 5. Both chambers 2, 4 can communicate with each other via a controllable valve 6.

The controllable valve 6 comprises a valve disc 7, a valve steel 8 and a first contact portion which is formed by a valve seal 9. In a closed condition of the valve 6, the valve seal 9 rests on a valve seat 10, which is part of the high pressure housing 3 and which surrounds an opening 11 in the high pressure housing 3. The opening 11 is a through-hole in the high pressure housing 3 which ends in the low pressure chamber 4 in assembled condition. A valve spring 12 mounted to the high pressure housing 3 and exerting a force on the valve disc 7 forces the valve seal 9 on the valve seat 10 so as to avoid any leakage between the high pressure chamber 2 and the low pressure chamber 4. It is noted that the controllable valve 6 is movable with respect to both the high and low pressure housings 3, 5. An end portion of the valve steel 8 forms a second contact portion of the valve 6 which is spaced from the valve seat 10 and which abuts against a stop portion 13 on the low pressure housing 5. The valve steel 8 has a smaller diameter then the opening 11.
through which it extends so as to allow fluid to flow between
the valve steel 8 and the wall of the high pressure housing 3 at
the opening 11. The stop portion 13 is located at the inner side
of the low pressure housing 5 opposite to the opening 11 of the
high pressure housing 3. The fluid may be gaseous CO₂, for
example.

The high pressure housing 3 is resiliently connected to
the low pressure housing 5 via an activating spring 14, which is
hold by a screw-on cap 15. The screw-on cap 15 is screwed on the
low pressure housing 5 and forces the activating spring 14
against the high pressure housing 3. The high pressure housing 3
has a cylindrical portion 3a that fits in a cylindrical portion
5a of the low pressure housing 5. The cylindrical portion 3a of
the high pressure housing 3 is provided with a sealing which
seals the low pressure chamber 4. In this case the sealing
comprises an O-ring 16 disposed in an annular groove in the high
pressure housing 3, but alternative sealing means are
conceivable.

The high pressure housing 3 is movable with respect to
the low pressure housing 5. It is also partly in contact with
the low pressure chamber 4 such that the high pressure housing 3
displaces upon a pressure change in the low pressure chamber 4.
In the embodiment as shown in Fig. 1 the high pressure housing 3
will be lifted upwardly upon increasing the pressure in the low
pressure chamber 4. It is noted that the low pressure chamber 4
as shown in Figs. 1 and 2 is open to the outside only for
clarity reasons. In practice the low pressure chamber 4 will be
separated from the ambient in order to be able to build up a
pressure therein.

Figs. 3 and 4 illustrate the functioning of the
pressure regulator 1. In Fig. 3 the pressure regulator 1 is not
connected to a high pressure source and in Fig. 4 a bottle 17
containing a fluid under high pressure is connected to the high
pressure housing 3, for example by screwing the bottle 17 into
the high pressure housing 3. When fluid under high pressure
flows from the bottle 17 into the high pressure chamber 2 and
the pressure regulator is in the initial condition as shown in
Fig. 3 the fluid flows via the open valve 6 through the opening
11 along the valve steel 8 into the low pressure chamber 4. If
the flow downstream of the low pressure chamber 4 is such that the pressure level in the low pressure chamber 4 rises, the high pressure housing 3 will be lifted with respect to the low pressure housing 5. As a consequence, the valve steel 8 will move with respect to the high pressure housing 3 towards the stop portion 13 on the low pressure housing 5 due to the pressure in the high pressure chamber 2 on the valve 6, supported by a pressing force of the valve spring 12. This means that the valve seal 9 will also move towards the valve seat 10 and at a certain moment the valve 6 will be in a closed condition and the fluid flow from the high pressure chamber 2 to the low pressure chamber 4 will stop.

When the pressure level in the low pressure chamber 4 is reduced the activating spring 14 forces the high pressure housing 3 downwards together with the valve 6. As the valve steel 8 touches the stop portion 13 the valve seal 9 is lifted from the valve seat 10 and fluid starts flowing again from the high pressure chamber 2 to the low pressure chamber 4. So, the valve 6 is controlled such that it releases the opening 11 upon a predetermined pressure decrease in the low pressure chamber 4 and closes the opening 11 upon a predetermined pressure increase in the low pressure chamber 4.

The pressure level in the low pressure chamber 4 at which the valve 6 is opened mainly depends on the spring characteristics of the activating spring 14. This pressure level can be adjusted by turning the screw-on cap 15 with respect to the low pressure housing 5. This is illustrated in Fig. 5: the achievable pressure level in the low pressure chamber 4 in the condition as shown in Fig. 5 is higher than that as shown in Fig. 4 due to the increased pressing force of the activating spring 14.

Fig. 6 shows a condition in which the high pressure housing 3 functions as a blow-off valve in case the pressure level in the low pressure chamber 4 suddenly becomes too high. Upon a predetermined pressure increase in the low pressure chamber 4 the high pressure housing 3 displaces beyond a pressure release opening 18. Via the pressure release opening 18 the low pressure chamber 4 communicates with the outside of the
pressure regulator 1 since a space between the screw-on cap 15 and the high pressure housing 3 is not sealed.

Figs. 7 and 8 show an alternative embodiment of the pressure regulator 1. The embodiment is basically similar as the embodiment described hereinbefore. Corresponding parts have the same reference sign. The embodiment as shown in Figs. 7 and 8 are provided with a pressure release valve which opens to the outside at a predetermined pressure level in the low pressure chamber 4. The pressure release valve is a ball valve 19 in combination with a ball valve spring 20. If the pressure in the low pressure chamber 4 exceeds a certain level the ball valve 19 will be opened against the spring force and fluid will be blown-off via an opening 21. The ball valve spring 20 and the activating spring 14 can be selected such that the ball valve 19 opens at a lower pressure level than the pressure release opening 18. In an alternative embodiment the release valve of the low pressure chamber 4 may comprise only one of the ball valve 19 and the high pressure housing 3 in combination with the release opening 18.

The high pressure housing 3 is made of a material which has a higher strength than the material of which the low pressure housing 5 is made. This means that the maximum pressure level in the high pressure chamber 2 against which the high pressure housing 3 is resistant is higher than the maximum pressure level in the low pressure chamber 4 against which the low pressure housing 5 is resistant. For example, the high pressure housing 3 is made of brass and the low pressure housing 5 is made of a plastic. Due to this feature the pressure regulator 1 is a relatively low cost article, whereas for safety reasons the low pressure chamber 4 is provided with pressure release valves in the form of the ball valve 19 and the high pressure housing 3 in combination with the release opening 18.

In the embodiment of the pressure regulator 1 as shown in Figs. 7 and 8 the stop portion 13 is made of steel, which has a higher hardness than the remainder of the low pressure housing 5. Of course, alternative materials are conceivable. Furthermore, in the embodiment of Fig. 8 it can be seen that the pressure regulator 1 is connected to a downstream pipe 22. The activating spring 14 rests on a ring 23 mounted to the high
pressure housing 3. In order to mount the controllable valve 6 in the high pressure housing 3 an auxiliary valve supporting part 24 is fixed into the high pressure housing 3. The auxiliary valve supporting part 24 must at least partially be made of a high strength material such as the high pressure housing 3, but this may be a different material than that of the high pressure housing 3.

From the foregoing, it will be clear that the invention provides a low cost pressure regulator.

The invention is not limited to the embodiments shown in the drawings and described hereinbefore, which may be varied in different manners within the scope of the claims and their technical equivalents. It is possible, for example, that the high pressure housing has a fixed position with respect to the low pressure housing and the controllable valve is attached to a spring supported membrane such as in conventional pressure regulators, but wherein the low pressure housing is made of a relatively weak material and the low pressure chamber is provided with a release valve.
CLAIMS

1. A pressure regulator (1) comprising a high pressure chamber (2) accommodated in a high pressure housing (3) and a low pressure chamber (4) accommodated in a low pressure housing (5), wherein the chambers (2, 4) can communicate with each other via a controllable valve (6), characterized in that: the maximum pressure level in the high pressure chamber (2) against which the high pressure housing (3) is resistant is higher than the maximum pressure level in the low pressure chamber (4) against which the low pressure housing (5) is resistant, and wherein the low pressure chamber (4) is provided with a release valve (3, 18; 19-21) which opens to the outside at a predetermined pressure level in the low pressure chamber (4).

2. A pressure regulator (1) according to claim 1, wherein the high pressure housing (3) is made of a material which has a higher tensile strength than the material of which the low pressure housing (5) is made.

3. A pressure regulator (1) according to claim 1 or 2, wherein the high pressure housing (3) is made of brass and the low pressure housing (5) is made of a plastic.

4. A pressure regulator (1) according to one of the preceding claims, wherein the release valve is a ball spring valve (19-21).

5. A pressure regulator (1) according to one of the preceding claims, wherein the high pressure housing (3) and the low pressure housing (5) are separate parts which are assembled.

6. A pressure regulator (1) according to one of the preceding claims, wherein the high pressure housing (3) is resiliently connected to and movable with respect to the low pressure housing (5) and partly in contact with the low pressure chamber (4) such that the high pressure housing (3) displaces with respect to the low pressure housing (5) upon a pressure change in the low pressure chamber (4), wherein the controllable valve (6) fits to an opening (11) in the high pressure housing (3) and is movable with respect to at least the high pressure housing (3) and is controlled such that it releases the opening (11) upon a predetermined pressure decrease in the low pressure
chamber (4) and closes the opening (11) upon a predetermined pressure increase in the low pressure chamber (4).

7. A pressure regulator (1) according to claim 6, wherein the controllable valve (6) comprises a first contact portion (9) which fits to a valve seat (10) on the high pressure housing (3) for closing the opening (11), and a second contact portion (8) spaced from the first contact portion (9) which second contact portion (8) abuts against a stop portion (13) being present on the low pressure housing (5).

8. A pressure regulator (1) according to claim 7, wherein the controllable valve (6) is resiliently connected to the high pressure housing (3).

9. A pressure regulator (1) according to claim 7, wherein the stop portion (13) is made of a material having a higher hardness than the material of the low pressure housing (5).

10. A pressure regulator (1) according to one of the claims 6-9, wherein the controllable valve (6) is also movable with respect to the low pressure housing (5), wherein the low pressure housing (5) and the high pressure housing (3) are shaped such that upon a predetermined pressure increase in the low pressure chamber (4) the high pressure housing (3) displaces beyond a pressure release opening (18) in the low pressure housing (5), through which the low pressure chamber (4) can communicate with the outside of the pressure regulator (1).

11. A pressure regulator (1) according to one of the claims 6-10, wherein the pressure regulator (1) is provided with adjusting means (15) for adjusting the mutual position of the low pressure housing (5) and the high pressure housing (3) in a rest condition of the pressure regulator (1).

12. A pressure regulator (1) comprising a high pressure chamber (2) accommodated in a high pressure housing (3) and a low pressure chamber (4) accommodated in a low pressure housing (5), wherein the chambers (2, 4) can communicate with each other via a controllable valve (6), wherein the high pressure housing (3) is resiliently connected to and movable with respect to the low pressure housing (5) and partly in contact with the low pressure chamber (4) such that the high pressure housing (3) displaces with respect to the low pressure
housing (5) upon a pressure change in the low pressure chamber (4), wherein the controllable valve (6) fits to an opening (11) in the high pressure housing (3) and is movable with respect to at least the high pressure housing (3) and is controlled such that it releases the opening (11) upon a predetermined pressure decrease in the low pressure chamber (4) and closes the opening (11) upon a predetermined pressure increase in the low pressure chamber (4).

13. A pressure regulator (1) according to claim 12, wherein the controllable valve (6) comprises a first contact portion (9) which fits to a valve seat (10) on the high pressure housing (3) for closing the opening (11), and a second contact portion (8) spaced from the first contact portion (9) which second contact portion (8) abuts against a stop portion (13) on the low pressure housing (5).
### A. CLASSIFICATION OF SUBJECT MATTER

INV. G05D16/10  F17C13/04  F16K1/30

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  F17C  F16K

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 practical, search terms used)

**EPO-Internal**

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
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<td>X</td>
<td>US 3 319 829 A (SENTZ ADAM J) 16 May 1967 (1967-05-16) column 1, line 56 - column 3, line 74; figure 4</td>
<td>1-5</td>
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<td>Y</td>
<td>US 7 334 598 B1 (HOLLARS ANTHONY SCOTT [US]) 26 February 2008 (2008-02-26) column 4, line 12 - column 7, line 7; figures 1-3</td>
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Further documents are listed in the continuation of Box C

See patent family annex

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<td>A</td>
<td>EP 0 675 054 A2 (NIPPON TANSAN GAS CO LTD [JP]) 4 October 1995 (1995-10-04) column 5, line 47 - column 6, line 2; figure 1</td>
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