

Description

Title of Invention: VALVE ASSEMBLY FOR A DIFFERENTIAL PRESSURE SENSOR WITH SAFETY VALVE

Technical Field

- [1] Present invention relates to a valve assembly for a differential pressure sensor for measuring of pressures in a fluid system, for instance in a heating or cooling system and where the assembly is mounted via measuring hoses on a measuring nipple to, as an example, a valve or a measuring nipple direct on a container or a piping and where the assembly protects the differential pressure sensor against not allowed differential pressure levels.

Background Art

- [2] By measuring pressure in fluid systems differential pressure sensors often is used combined with some sort of valve assembly which principally is aimed to protect the differential pressure sensor against to high continuous pressures or pressure shocks, higher than the sensor can handle. Those assemblies often also has functions for flushing through the assembly to get rid of enclosed air in cavities and functions to calibrate the differential pressure sensor, so called zero point calibration, where a calibration procedure is aimed to foresee that both measuring sides of the pressure sensor has the same pressure, before measuring has to begin.
- [3] There are several constructions solving the problem to protect a differential pressure sensor against not allowed differential pressure levels. Example of such solutions is evident from DE 19503488 that describes a device with two safety valves (4, 5) that protects the differential pressure sensor against not allowed differential pressure levels and also GB 2091883 A that also describes a device with safety valves (46, 48) for protect against not allowed differential pressure levels.
- [4] Moreover there is a solution, GB 2 410 332 A, which includes the functions zero point calibration and flushing through a valve assembly where the same solution additionally includes two safety valves (36, 38) to protect the differential pressure sensor (26) against not allowed differential pressure levels. The safety valves (36, 38) in this device are two in number, and they are designed as non return valves, which protects a connection side each at the differential pressure sensor. Depending on which side of connection that is connected to the highest pressure, the respective safety valve protects one side/direction each.

Disclosure of Invention

Technical Problem

- [5] The problem with earlier solutions, for instance the solution that is described above

in GB 2 410 332 A, is that at least two safety valves are required, and to them arranged ducts, to protect the complete valve assembly against to high differential pressures, which consequently makes the manufacturing of the device more expensive and more difficult.

Technical Solution

- [6] The object of the present invention is to solve the problem of protecting the differential pressure sensor with only one detail and in that way simplify the manufacturing of the complete valve assembly and hence obtain lower costs of manufacturing.
- [7] In the known solutions valve assemblies exists with protection against not allowed differential pressure levels by two safety valves. The reason why two safety valves is used is that by connection of valve assemblies to measuring nipples of a fluid system you can't in advance know which one of the measuring sides that will receive the highest pressure. The two safety valves therefore protect the differential pressure sensor against to high pressures independent of from which direction the high pressure comes. In the present invention this is solved by one detail, a cone, named safety valve cone, which by that is advantageous, among other things, from the point of view of function, manufacturing and costs. The safety valve cone is arranged displaceable in a cavity, so that by a differential pressure higher than a dimensioned value, the safety valve cone is displaced in the cavity in the direction from that side that constitutes the high pressure side towards the low pressure side, whereby a passage is opened between both the connections, high and low pressure side, so that a pressure equalization occurs. The complete valve assembly, in addition to the present invention, also includes other advantages, which are protected by the initial application to this divisional application, for instance a calibration cone, which provides two positions by the complete valve assembly. Those positions are the measuring position and also it's combined position of zero point calibration and flushing through. In the latter position the differential pressure sensor is separated from the fluid flow by that the two measuring sides of the differential pressure sensor are arranged in a way that they are not in contact with the flowing fluid at the zero point calibration, while a calibration cone by means of seals separates the measuring sides of the differential pressure sensor from the fluid. This position constitutes the initial position of the valve assembly. The advantage with the present invention, compared to the known solutions, is that the differential pressure sensor is protected against to high differential pressures with only one safety valve cone, instead of several valve or protection devices.
- [8] In a preferred embodiment of the invention the safety valve cone is in its initial position, arranged between both the orifices of the connections towards or to the cavity, where the safety valve cone is arranged. Accordingly, the advantage is obtained

that for instance by connection of a valve assembly against measuring nipples of a construction, it doesn't matter which one of the connections that is coming to be the high pressure or the low pressure side, respective, since the safety valve cone can "be triggered", i.e. be moved to either side, that constitutes that side that will be the low pressure side. The valve assembly will therefore be free reversible, regarding to the connections.

- [9] According to a further preferred embodiment of the invention the safety valve cone is arranged before both the cavity, which includes the calibration cone, and also before the differential pressure sensor, seen in the flowing direction, i.e. the safety valve cone is arranged closest to the connections towards the fluid system. Accordingly, the protection is always active, independent of the position of the calibration cone, the measuring position or the combined position for zero point calibration and flushing through.
- [10] According to a further preferred embodiment of the invention the safety valve cone is arranged always to return to its initial position, between the orifice of the two connections towards the cavity, in which the safety valve cone is arranged, in those cases when the differential pressure between the connections are lower than the dimensioned value. This is going to be possible by that the cavity includes return springs on both sides of the safety valve, which return springs are dimensioned to be pressed together by the safety valve cone, when this is moved towards the low pressure side, at differential pressures higher than the value that the springs are dimensioned for. When the differential pressure again is lower than the dimensioned value, the clamped spring expands, whereby the safety valve cone returns to its neutral initial position, and as a result the safety function is by that back in the "readiness position".
- [11] According to another preferred embodiment of the invention the safety valve cone is protected against to high differential pressures by double functions of protect, in the initial position of the valve assembly. This by that the protection of the safety valve cone in the initial position, i.e. the position for zero point calibration and flushing through, is combined with the advantage, according to the initial application, that the calibration cone in this position moreover protects the differential pressure sensor against fluid contact. Thus the advantage is obtained, compared to known solutions, that the risk that the differential pressure sensor is exposed for to high pressures, is minimal, by connection of the valve assembly to a fluid system.
- [12] According to a further preferred embodiment of the invention the design of the safety valve cone is such that it is symmetrical regarding both of its possible moving directions and further the form is preferable cylindrical. The symmetric form makes it impossible to mount the safety valve wrong by mounting of the complete valve assembly. In addition the cavity, in which the safety cone is mounted, is by dimensions

coordinated with the exterior dimensions of the safety valve cone, which in addition foresees that the function is secured while the detail, by mounting, always lands in a way that the intended function is obtained, independently of which end of the safety valve cone lands in respective direction/moving direction.

Advantageous Effects

- [13] To sum up some advantages that is obtained with the present invention related to existing constructions in connection with that the measuring has to be done:
- [14] - the valve assembly protects the differential pressure sensor against to high differential pressures with only one detail, a safety valve cone, instead of several valve or protection devices
- [15] - the valve assembly protects the differential pressure sensor against to high differential pressures, where this function of protection functions independently of which connection side that connects to the high pressure side
- [16] - the protection is always active, independent of the position of the calibration cone, the measuring position or the combined position for zero point calibration and flushing through
- [17] - the safety valve cone always returns to its initial position, after that it is "triggered", whereupon it again is in the protection position
- [18] - the valve assembly includes double protections functions at flushing through and zero point calibration, i.e. in the initial position, whereby the risk that the differential pressure sensor is exposed for to high pressure is minimal, by connection of the valve assembly to a fluid system
- [19] - the safety valve cone is symmetrical and can as a result not be turned wrong by the mounting of the same in the intended cavity in the valve body.
- [20] The above mentioned preferred embodiments of the invention are stated in the dependent claims. The constructive design of the present invention is in detail described by the following description of an example of embodiment of the invention with reference to the accompanying drawings showing a preferred, but not limited, embodiment of the invention. Moreover the invention brings the prior art further in different respects. This is realized in the present invention by that an arrangement of the art described below preferable is constituted in a way that is evident from the characterizing part of claim 1.

Brief Description of Drawings

- [21] In detail represents in diametrical, partly schematic cross-sections or perspective views:
- [22] - Figure 1 shows a part of a fluid system where a differential pressure measuring system is connected.

- [23] - Figure 2 shows included details in the complete valve assembly.
- [24] - Figure 3 shows the complete valve assembly in its initial position, i.e. its position of flushing through/zero point calibration.
- [25] - Figure 4a shows a view in detail of the safety valve in normal position.
- [26] - Figure 4b shows a view in detail of the safety valve in triggered position.

Detailed Description of the Drawings

- [27] **Figure 1** shows an example of a complete valve assembly 1 provided with an actuator 2 where the valve assembly 1 is connected to a valve 3 via measuring hoses 4 to the measuring nipples 5 of the valve. The figure also includes a manual unit 6 for preferable wireless communication with the actuator 2 and, where appropriate, communication with a computer or a computer system.
- [28] **Figure 2** shows details included in the complete valve assembly. The complete valve assembly is provided with a valve body 7, a safety valve cone 8, with return springs 9a, 9b on both sides of the safety valve cone, a calibration cone 10, with an axis 11, connected to the actuator 2 and one, on the valve body 7 mounted sensor 31 with a differential pressure sensor 12. The valve body 7 has two connections 13, 14 where the measuring hoses 4 are connected, and those connections are often called inlet and outlet respective. By inlet is intended the high pressure side and by outlet is intended the low pressure side. Depending on how the connections lands related to the high/low pressure side of the fluid system, either side of the device can be either the inlet or the outlet. In addition the valve body has a cavity 15 that by dimensions is coordinated with the outer dimensions of the safety valve cone 8. In the outer end 16 of the cavity 15 there is a safety valve stop 17 provided with sealing elements 18 and in connection with this stop there is the first return spring 9a where the safety valve stop 17 constitutes the base for the return spring. Between this first return spring 9a and the second return spring 9b, placed at the bottom 19 of the cavity, is the safety valve cone 8 situated and as a result clamped between the two return springs. The safety valve cone preferably includes two interior recessed cavities 24 in axial direction relative the safety valve cone, which cavities orifice in each end of the safety valve cone 8, and where every cavity at its bottom has a communication, a recess 25 outwards to the periphery of the cone. Externally the safety valve cone 8 is provided with sealing elements 20 on the surface of the periphery, at either side of the recesses 25. From the one connection 13 a duct 21 extends, via the cavity 15, at the first return spring 9a, and further up to a cavity 22 that by dimensions is coordinated with the outer dimensions of the calibration cone 10. To the cavity 22 also a second duct 23 extends from the outlet 14, via the bottom 19 of the cavity 15. In the cavity 22 the calibration cone 10 is situated, which preferably includes an interior recessed cavity 26 in axial direction, relative the calibration cone and where the cavity extends through the whole length of

the calibration cone 10. At the exterior the calibration cone 10 is provided with preferable two sealing elements 27 at the peripheral surface of respective end. In the other end 28 of the cavity 22 there is a stop lug 29, provided with sealing elements 30, and this stop lug 29 also constitutes the attachment/holder of the actuator 2 and its axis 11 which ends up through the stop lug 29 and where the axis 11 is fastened at the calibration cone 10. Between the bottom of the cavity 22 and the calibration cone a return spring 35 is clamped. From the peripheral surface of the cavity 22 ducts 32 and 33 extends to the differential pressure sensor 12 in the sensor support 31.

[29] **Figure 3** shows the complete valve assembly in its initial position, i.e. its position for flushing through/zero point calibration. Always, except of just at the measuring the valve assembly is in its initial position, its position for flushing through/zero point calibration. The device is brought to return to the position of flushing through and zero point calibration after finished measuring sequence, either by that the actuator 2 return the device to this position or alternative another stored energy, for instance a return spring 35, looks for this. In this initial position the calibration cone 10 is between the ducts 21 and 23 and thereby both the sealing elements 27 lands on either side of the ducts 32 and 33, which results in that the ducts 32 and 33 are short circuited, and consequently get the same static pressure. Accordingly the differential pressure sensor 12 will be zero point calibrated and the calibration occurs outside the fluid flow because the ducts 32 and 33 contacts the cavity 22 at its peripheral surface, between booth the sealing elements 27 that seals between the cavity 22 and the calibration cone 10. The flushing through occurs at the same time because the construction of the calibration cone and the position permit an open flowing passage between high and low pressure side, from the one connection/the inlet 13, via the duct 21, to the cavity 22, through the cavity 26 of the calibration cone 10 and further to the cavity 22, then to the duct 23 and thereafter to the second connection/ the outlet 14. After this process the complete valve assembly 1 is flushed through and is free from enclosed air and also the valve assembly is zero point calibrated.

[30] **Figure 4a** shows the safety valve in normal position. When the complete valve assembly 1 isn't exposed to higher differential pressures than to which the entire protection function, constituted by the return springs 9a, 9b and the safety valve cone 8, is dimensioned, the safety valve cone is in a position between both the return springs 9a, 9b and the ducts 21, 23. In this position the passage through the cavity 24 of the safety valve cone 8 and the recess 25 is closed and as a result the communication between the connections 13, 14 is impossible. The passage of fluid between high and low pressure side is made impossible in this position because of that the sealing that occurs by means of the sealing elements 20 on either sides of the orifice of the recesses 25 to the wall of the cavity 15. This constitutes the normal position of the safety valve

in the valve assembly 1, when the protection function is in "readiness position", i.e. not triggered position.

- [31] **Figure 4b** shows the safety valve in triggered position. In that case when the differential pressure exceeds the value for which the safety valve cone 8 together with the return springs 9a, 9b are dimensioned, the safety valve cone 8 is pressed in a direction towards the side with the lowest pressure, whereby the return spring on this side is compressed. By that the passage between high and low pressure side is opened, and the fluid is passed from the one connection 13, i.e. the inlet, to the cavity 15, through the cavity 24 and the recess 25 of the safety valve cone 8 and further outwards to the second connection 14, i.e. the outlet. On the other hand the fluid can flow in opposite direction if the high and low pressure sides are the reversed. Accordingly, by one and the same detail/function, a protection against to let to high pressure further to the connected differential pressure sensor 12 is obtained, and this protection works in both directions.

[32] **COMPONENT LIST**

- 1 valve assembly
- 2 actuator
- 3 valve
- 4 measuring hose
- 5 measuring nipple
- 6 manual unit
- 7 valve body
- 8 safety valve cone
- 9 return spring
- 10 calibration cone
- 11 axis
- 12 differential pressure sensor
- 13 inlet
- 14 outlet
- 15 cavity
- 16 outer end
- 17 safety valve stop
- 18 sealing element
- 19 bottom
- 20 sealing element
- 21 duct
- 22 cavity
- 23 duct

- 24 cavity
- 25 recess
- 26 cavity
- 27 sealing element
- 28 outer end
- 29 stop lug
- 30 sealing element
- 31 sensor carrier
- 32 duct
- 33 duct

Claims

- [Claim 1] Device included in a system for measuring differential pressures in a fluid system and where the device is a valve assembly (1) including a valve body (7) with two connections (13, 14) for connection to the fluid system, ducts (32, 33) for communication with a differential pressure sensor (12) for registration the differential pressure, a first cavity (22) in contact with the ducts (32, 33), where the cavity (22) includes a calibration cone (10) which is displaceable in the first cavity (22) between a measure position and a position for zero point calibration/ flushing through of the valve assembly (1), and moreover the calibration cone (10) separates the differential pressure sensor (12) from the fluid system in those cases when the measuring position of the device not exists, i.e. in its initial position, by that the calibration cone (10) includes sealing elements (27), which sealing elements shields the ducts (32, 33) from the first cavity (22), **characterized** in that the valve assembly (1) includes a second cavity (15) with a safety valve cone (8), which safety valve cone (8) protects the differential pressure sensor (12) against to high differential pressure by that the safety valve cone (8) is arranged to, by differential pressures higher than a dimensioned value, be displaced in direction towards the low pressure side and as a result open a passage between high and low pressure side, from the one connection (13), i.e. the high pressure side, to the other connection (14), i.e. the low pressure side, via the second cavity (15) in the valve body (7), and via, in the safety valve cone (8) provided cavities (24) and recesses (25), whereby a pressure equalizing occurs.
- [Claim 2] Device according to claim 1, **characterized** in that the safety valve cone (8) always is displaceable towards the low pressure side independent on which connection (13, 14) constitutes the high pressure side and low the pressure side respective, by that the safety valve cone (8) in its initial position is arranged between the orifices of the two connections (13, 14) towards or to the second cavity (15).
- [Claim 3] Device according to claim 1-2, **characterized** in that the safety valve cone (8), in the flowing direction, is arranged before the first cavity (22) with its calibration cone (10), and before the differential pressure sensor (12), whereby the differential pressure sensor (12) always is protected against to high differential pressures, independent of if the calibration cone (10) is in its measuring position or in the position for

zero point calibration/flushing through of the valve assembly (1), i.e. in its initial position.

[Claim 4] Device according to claim 1-3, **characterized** in that safety valve cone (8) is arranged to return to its initial position, between the orifices of the two connections (13, 14) towards or to the second cavity (15), when the differential pressure is lower than a dimensioned value, by that the second cavity (15) includes return springs (9a, 9b), who are arranged on the respective side of the safety cone (8).

[Claim 5] Device according to claim 1-4, **characterized** in that the differential pressure sensor (12) has double safety functions against to high differential pressure, in the initial position of the valve assembly (1), i.e. by connection of the valve assembly (1), by that the calibration cone (10) in this position separates the differential pressure sensor (12) from the fluid system and that the safety valve cone (8) at the same time in the initial position protects the differential pressure sensor (12).

[Claim 6] Device according to claim 1-5, **characterized** in that the safety valve cone (8) is symmetrical, in respect to it's towards each other directed moving directions.