Claims

1. Pressure regulating device (6; 206) for compressed gas, comprising:
   - a body (18; 218) with a gas inlet (20; 220), a gas outlet (38; 238) and a gas passage (22; 222) fluidly interconnecting said gas inlet and gas outlet;
   - a valve device (24; 124; 224; 324) with a seat (26; 126; 226; 326) in the gas passage (22; 222) and an obturator (28; 128; 228; 328) configured for cooperating with the seat (26; 126; 226; 326);
   - a regulator (30; 130; 2320; 330) housed in a cavity (32; 132; 232; 332) of the body (18; 218), downstream of the valve device (24; 124; 224; 324), delimiting with said cavity (32; 132; 232; 332) a regulating chamber with a geometry that varies with the pressure in said regulating chamber, and actuating the obturator (28; 128; 228; 328) for regulating a flow of gas through the valve device;

   ~~characterized in that~~wherein

   the body (18; 218) is tubular over its whole length, with a nominal outer diameter along the regulator (30; 130; 2320; 330) and the valve device (24; 124; 224; 324) that is a maximum outer diameter of said body;

   wherein the regulator (30; 130; 230; 330) comprises a movable part (30.2; 130.2; 230.2; 330.2) in vis-à-vis of the valve device (24; 124; 224; 324), configured for moving along an inner surface of the cavity (32; 132; 232; 332) and actuating the obturator (28; 128; 228; 328), a fixed part (30.1; 130.1) opposed to the valve device (24; 124), and a bellow (30.3; 130.3) with a first end attached in a gas tight fashion to the fixed part (30.1; 130.1) and a second end attached in a gas tight fashion to the movable part (30.2; 130.2), thereby forming a sealed inner chamber.

2. Pressure regulating device (6; 206) according to claim 1, wherein the body (18; 218) comprises a main portion (18.1, 18.4; 218.1, 218.3) with the nominal outer diameter and at least one end portion (18.2, 18.3, 18.5, 18.6; 218.2, 218.4, 218.5) with the nominal outer diameter and attached to said main portion (18.1, 18.4; 218.1, 218.3).

3. Pressure regulating device (6; 206) according to claim 2, wherein the attachment of the at least one end portion (18.2, 18.3, 18.5, 18.6; 218.2, 218.4, 218.5) to the main portion (18.1, 18.4; 218.1, 218.3) of the body (18; 218) is by welding.

~~4. Pressure regulating device (6) according to one of claims 2 and 3, wherein one end of the main portion (18.1, 18.4) houses the valve device (24; 124) and comprises an annular groove (18.1.1; 18.4.1) around the seat (26; 126).~~

5.4. Pressure regulating device (6; 206) according to any one of claims 1 to 43, wherein the body (18; 218) comprises a tubular wall with an inner surface forming the cavity (32; 132; 232, 332).

6.5. Pressure regulating device (6; 206) according to any one of claims 1 to 54, wherein the obturator (28; 128; 228; 328) comprises a poppet (28.1; 128.1) located on an upstream side of the seat (26; 126; 226; 326) and configured for contacting said seat, and a stem (28.2; 128.2) extending from the poppet (28.1; 128.1) through the seat (26; 126; 226; 326), said stem being attached to the regulator (30; 130).

7. Pressure regulating device (6; 206) according to claim 6, wherein the stem (128.2) comprises a conical portion (128.2.1) adjacent the poppet (128.1) and showing a radial play with the seat (126) of less than 0.02mm.

8.6. Pressure regulating device (6; 206) according to any one of claims 1 to 75, wherein the cavity (32; 132; 332) comprises a bottom adjacent the seat (26; 126; 326), the pressure regulating device comprising a compression wave spring (34; 134; 334) resting on said bottom and acting on the regulator (30; 130; 330).

9. Pressure regulating device (6; 206) according to claim 8, wherein the regulator (30; 130; 330) comprises a shouldered end face (30.2.4; 130.2.4) engaging with the compression wave spring (34; 134; 334).

10. Pressure regulating device (6; 206) according to any one of claims 1 to 9, wherein the regulator (30; 130; 230; 330) comprises a movable part (30.2; 130.2; 230.2; 330.2) in vis-à-vis of the valve device (24; 124; 224; 324), configured for moving along an inner surface of the cavity (32; 132; 232; 332) and actuating the obturator (28; 128; 228; 328).

11.7. Pressure regulating device (6) according to any one of claims 101 to 6, wherein the regulator (30; 130) comprises an open ring (30.5; 130.5) mounted around the movable part (30.2; 130.2) of said regulator and configured for contacting the inner surface of the cavity (32; 132).

12. Pressure regulating device (6) according to any one of claims 1 to 11, wherein the regulator (30; 130) comprises a fixed part (30.1; 130.1) opposed to the valve device (24; 124) and engaging with a screw (36; 136) configured for adjusting the position of said fixed part.

~~13. Pressure regulating device (6) according to claim 12, wherein the screw (36; 136) comprises a conical front face contacting an annular concave conical surface of the fixed part (30.1; 130.1) of the regulator (30; 130), forming the engagement between said screw and fixed part.~~

~~14. Pressure regulating device (6) according to one of claims 12 and 13, wherein the engagement between the screw (36; 136) and the fixed part (30.1; 130.1) of the regulator (30; 130) is configured to centre said fixed part showing a radial play in the cavity (32; 132).~~

~~15. Pressure regulating device (6) according to one of claims 2 to 4, and according to one of claims 12 to 14, wherein the screw (36; 136) threadably engages with the at least one end portion (18.3; 18.5) of the body (18).~~

~~16. Pressure regulating device (6) according to one of claims 10 and 11, and according to one of claims 12 to 15, wherein the regulator (30; 130) comprises a bellow (30.3; 130.3) with a first end attached in a gas tight fashion to the fixed part (30.1; 130.1) and a second end attached in a gas tight fashion to the movable part (30.2; 130.2), thereby forming a sealed inner chamber.~~

~~17.~~8. Pressure regulating device (6) according to any one of claims ~~16~~1 to 7, wherein the fixed part (30.1; 130.1) and the movable part (30.2; 130.2) of the regulator (30; 130) engage mutually in a sliding and longitudinally guided fashion inside the bellow (30.3; 130.3).

~~18.~~9. Pressure regulating device (6; 206) according to any one of claims 1 to ~~17~~8, wherein the valve device is a first valve device (24; 224) and the regulator is a first regulator (30; 320), the pressure regulating device further comprising a second valve device (124; 324) fluidly in series with and downstream of the first valve device (24; 224), with a seat (126; 326) in the gas passage (22; 222) and an obturator (128; 328) configured for cooperating with the seat (126; 326), and a second regulator (130; 330) housed in a cavity (132; 332) of the body (18; 218), downstream of said second valve device (124; 324), delimiting with said cavity (132; 332) a regulating chamber with a geometry that varies with the pressure in said regulating chamber, and actuating said obturator (128; 328) for regulating a flow of gas through said second valve device (124; 324).

~~19.~~10. Pressure regulating device (6; 206) according to one of claims 2 to ~~4~~3, and according to claim ~~18~~9, wherein the main portion of the body is a first main portion (18.1; 218.1)

housing the first valve device (24; 224) and the first regulator (30; 230), the body further comprising a second main portion (18.4; 218.3) housing the second valve device (124; 324) and the second regulator (130; 330).

20.11. Pressure regulating device (6; 206) according to any one of claims 1 to 1910, configured for delivering a flow of gas in the presence of an absolute pressure at the gas outlet that is less than 0.9 bar.

12. Pressure regulating device (6; 206) for compressed gas, comprising:

- a body (18; 218) with a gas inlet (20; 220), a gas outlet (38; 238) and a gas passage (22; 222) fluidly interconnecting said gas inlet and gas outlet;
- a valve device (24; 124; 224; 324) with a seat (26; 126; 226; 326) in the gas passage (22; 222) and an obturator (28; 128; 228; 328) configured for cooperating with the seat (26; 126; 226; 326);
- a regulator (30; 130; 2320; 330) housed in a cavity (32; 132; 232; 332) of the body (18; 218), downstream of the valve device (24; 124; 224; 324), delimiting with said cavity (32; 132; 232; 332) a regulating chamber with a geometry that varies with the pressure in said regulating chamber, and actuating the obturator (28; 128; 228; 328) for regulating a flow of gas through the valve device;

wherein the body (18; 218) is tubular over its whole length, with a nominal outer diameter along the regulator (30; 130; 2320; 330) and the valve device (24; 124; 224; 324) that is a maximum outer diameter of said body; 21.Pressure regulating device (206) according to any one of claims 1 to 19, and further comprising a port (240; 340) fluidly connected via a plug (230.1.4; 330.1.4) to a sealed chamber of the regulator (230; 330) and configured for fluidly connecting an external source (244) of auxiliary gas to said sealed chamber for adjusting a pressure of the auxiliary gas in said sealed chamber.

22.13. Pressure regulating device (206) according to claim 2112, wherein the port (240; 340) opens out of the body (218).

23.14. Pressure regulating device (206) according to one of claims 2112 and 2213, wherein the port (240; 340) shows a main axis that is transversal to a longitudinal axis of the pressure regulating device, preferably radial to said longitudinal axis.

24.15. Pressure regulating device (206) according to any one of claims 2112 to 2314, wherein the plug (230.1.4; 330.1.4) comprises a threaded portion (230.1.4.1; 330.1.4.1) engaging with a fixed portion (230.1; 330.1) of the regulator (230; 330), and a conical

needle portion (230.1.4.2; 330.1.4.2) engaging with an auxiliary seat formed in said fixed portion.

25.16. Pressure regulating device (206) according to any one of claims 2112 to 2415, wherein the plug (230.1.4; 330.1.4) is entirely located in a channel (230.1.3; 330.3.1) between the port (240; 340) and the sealed chamber of the regulator (230; 330).

26.17. Pressure regulating device (206) according to claims 2415 and 2516, wherein the plug (230.1.4; 330.1.4) comprises an internal passage (230.1.4.4; 330.1.4.4) for the auxiliary gas between the threaded portion (230.1.4.1; 330.1.4.1) and the conical needle portion (230.1.4.2; 330.1.4.2).

27.18. Pressure regulating device (206) according to one of claims 2516 and 2617, wherein the plug (230.1.4; 330.1.4) comprises, at an end opposed to the sealed chamber of the regulator (230; 330), an engagement surface (230.1.4.3; 330.1.4.3) for engaging with a tool (246) by insertion of said tool (246) into the port (230.1.4; 330.1.4).

28. Pressure regulating device (206) according to claim 27, wherein the engagement surface (230.1.4.3.; 330.1.4.3) of the plug (230.1.4; 330.1.4) shows an insertion direction for the tool (246) that is aligned with the port (240; 340).

29. Pressure regulating device (206) according to one of claims 27 and 28, wherein the engagement surface (230.1.4.3.; 330.1.4.3) of the plug (230.1.4; 330.1.4) is configured such that the engagement with the tool (246) is in rotation so that rotation of the tool (246) rotates the plug (230.1.4; 330.1.4).

30.19. Pressure regulating device (206) according to any one of claims 2112 to 2918, wherein the regulator (230; 330) comprises a fixed portion (230.1; 330.1), a movable portion (230.2; 330.2) and at least one flexible wall (230.3; 330.3) attached to said fixed portion (230.1; 330.1) and said movable portion (230.2; 330.2) in a gas-tight fashion, the sealed chamber of the regulator (230; 330) being delimited by said at least one flexible wall (230.3; 330.3), said fixed portion (230.1; 330.1) and said movable portion (230.2; 330.2).

31.20. Device (2) for a gas cylinder, comprising:

- a main body (8) with a male threaded portion (8.1) configured for engaging with a collar of the gas cylinder, a gas inlet in said male threaded portion, a gas outlet (12) and a gas passage interconnecting the gas inlet with the gas outlet;
- a shut-off valve (10) for the gas passage, housed in the main body (8); and

- a pressure regulating device (6; 206) fluidly connected to the gas inlet at the male threaded portion (8.1), configured for being inserted into the gas cylinder;

characterized in that

the pressure regulating device (6; 206) is according to any one claims 1-~~30~~19.

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