valve head, the valve head including a flow control valve that is operable to control fluid dispensing from the vessel.

Brief Description of the Drawings

[0011] The disclosure may be more completely understood in consideration of the following description of various illustrative embodiments in connection with the accompanying drawings

[0012] FIGS. 1A-1F are cross-sectional elevation, top and enlarged views of a pressure regulator apparatus for a pressure-regulated fluid storage and dispensing vessel according to the teachings of the invention.

[0013] FIGS. 2A-2C are cross-sectional elevation, top and enlarged views of an improved bellows structure of a pressure regulator apparatus for a pressure-regulated fluid storage and dispensing vessel according to the teachings of the invention.

[0014] FIG. 3 is a schematic elevation view, in partial cross-section, of a fluid supply package utilizing the pressure regulator devices of FIGS. 1 and 2.

[0015] FIG. 4 is a cross-sectional view of a pressure regulator of the general type utilized in the vessels shown and described with respect to the FIG. 3.

[0016] FIG. 5 is a schematic representation of a series-arranged dual regulator assembly, of a type as shown and described with reference to the fluid supply package of FIG 3.

[0017] While the disclosure is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit aspects of the disclosure to the particular illustrative embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the disclosure.

Detailed Description

[0018] The following detailed description should be read with reference to the drawings in which similar elements in different drawings are numbered the same. The detailed description and the drawings, which are not necessarily to scale, depict illustrative embodiments and are not intended to limit the scope of the invention. The illustrative embodiments depicted are intended only as exemplary. Selected features of any illustrative embodiment may be incorporated into an additional embodiment unless clearly stated to the contrary.

[0019] The various embodiments of the present disclosure relate to pressure management of pressure-regulated fluid storage and dispensing vessels that can be susceptible to substantial fluctuations in pressure behavior, high or low, upon initiation of a fluid dispensing operation, and to pressure management arrangements, apparatus and methods for combating continual periodic

[0026] Referring to FIG. 1A and to FIG. 1E, the stationary 132 and movable portions 134 of pressure-sensing assembly 130 are joined together by a flexible member, such as bellows 142. One form of bellows 142 includes a series of annular members or diaphragms that are alternately secured at radially inner and outer regions (in double weld fashion) to define an accordion-like arrangement. Opposite ends of bellows assembly 142 are then secured to stationary 132 and movable portions 134 of pressure-sensing assembly 130, respectively. Such a bellows arrangement has a relatively small stack height in a fully collapsed condition (FIG. 1E). In its fully collapsed condition, a poppet closure assembly 160, operatively coupled to movable portion 134 and adjacent to inlet 120, is closed.

[0027] Referring now to FIGS. 1A, 1C and 1F, a poppet closure assembly 160 is secured to movable portion 134 of pressure-sensing assembly 130 to open or close inlet 120. More particularly, poppet closure assembly 160 includes a stem 162 having an enlarged base 164 coupled to movable portion 134 on one end and coupled to a poppet 167 on the other end of stem 162. Poppet 167 engages a poppet seat structure 170. The base 164 is mounted adjacent the pressure-sensing assembly 130 while the stem 162 extends axially toward the inlet 120. Stem 162 proceeds outwardly of chamber 124 and into the inlet 120 of the regulator. A second or outer end 166 of the stem is threaded and receives an elastomeric member 168 that defines poppet 167. Preferably, poppet 167 is self-tapping so that during assembly, it may be threaded onto the stem, and through a predetermined selected number of turns backed off of seat structure 170 to define a precise opening. In a related embodiment, an O-ring 172 is interposed between an upper end of poppet 167 and seat structure 170 to assist in avoiding stiction problems during operation.

[0028] In this example embodiment, poppet 167 mounted on poppet stem 162 has been modified to provide a semi-hemispherical shape at its proximal end near stem 162 for matably sealingly engaging seat structure 170. In this embodiment, seat structure 170 may be formed of any suitable material, and may for example comprise a hard, stiff, fluid compatible polymer, such as a polyacetal material or a fluoropolymer such as, for example, polychlorotetrafluoroethylene. Likewise, poppet 167 may be formed of any suitable material compatible with the seat structure, and may for example be formed of a metal, such as stainless steel, titanium, nickel, or other metal or material of construction that is compatible with the other components of poppet assembly 160 of regulator 100, as well as the fluids to be flowed through such regulator in use.

[0029] Referring briefly to FIGS. 1A and 1D, stationary portion 132 and movable portion 134 coupled to bellows assembly 142 cooperate with one another to control axial movement of movable portion 134 toward and away from inlet 120 in response to varying pressure in chamber 124. A dampening assembly 150 is included in pressure-sensing assembly 130 for dampening pressure fluctuations due to sudden increases in fluid pressure as the fluid within a fluid vessel is

What is claimed is:

1. A pressure regulator assembly comprising:

a pressure regulator disposed in an interior volume of the dispensing vessel including a housing having a chamber with an inlet and an outlet, the chamber including therein a pressure-sensing assembly with a stationary portion fixed relative to the housing and a movable portion, the stationary and movable portions being interconnected by a bellows structure with diaphragm elements adapted to expand and contract in response to pressure variations in the chamber;

a damper assembly adapted to dampen oscillations and stabilize movement of the pressure-sensing assembly between open and closed positions, the damper assembly disposed within a sleeve formed on the movable portion; and

a poppet closure assembly operatively coupled to the pressure-sensing assembly and adapted to regulate fluid pressure between the inlet and outlet of the chamber, the poppet closure assembly including a poppet element and a seating structure located at the inlet of the chamber, the poppet element having an upper hemispherical-shaped surface adapted to mate and contact the seating structure to form a seal.

2. The pressure regulator assembly of claim 1, wherein the poppet closure assembly further includes an O-ring member interposed between the upper poppet element surface and the seating structure.

3. The pressure regulator assembly of claim 1, wherein the diaphragm of the bellows structure is configured to have single weld diaphragm elements.

4. The pressure regulator assembly of claim 1, wherein the poppet closure assembly is further comprised of a material of construction having a low level of deformation while under pressure.

5. The pressure regulator assembly of claim 1, wherein the poppet closure assembly is further comprised of a poppet element of a non-conical sealing shape with a complimentary-shaped seating structure.

6. The pressure regulator assembly of claim 1, wherein the poppet seating structure of the poppet closure assembly is comprised of a non-metallic material.

7. The pressure regulator assembly of claim 1, wherein the bellows structure with diaphragm elements is comprised of a material having a thickness and an elasticity configured to reduce a travel distance of the poppet element within the poppet closure assembly thereby partially attenuating a fluid dispensed from the vessel at inception of fluid dispensing.

8. The pressure regulator assembly of claim 1, wherein the damper assembly includes an axial member with a body, a circumferential sleeve and a spring member, the axial body member having a proximal end coupled to the stationary portion and a distal end protruding towards the movable portion, the axial member body having the spring member disposed circumferentially about the distal end of the axial member with the circumferential sleeve located about the proximal end of the axial member and in contact with an upper end of the spring member.

9. A fluid supply package comprising:

a pressure-regulated fluid storage and dispensing vessel;

a pressure regulator disposed in an interior volume of the dispensing vessel including a housing having a chamber with an inlet and an outlet, the chamber including therein a pressure-sensing assembly with a stationary portion fixed relative to the housing and a movable portion, the stationary and movable portions being interconnected by a bellows structure with single weld diaphragm elements adapted to expand and contract in response to pressure variations in the chamber;

a damper assembly adapted to dampen oscillations and stabilize movement of the pressure-sensing assembly between open and closed positions, the damper assembly disposed within a sleeve formed on the movable portion;

a poppet closure assembly operatively coupled to the pressure-sensing assembly and adapted to regulate fluid pressure between the inlet and outlet of the chamber, the poppet closure assembly including a poppet element and a seating structure located at the inlet of the chamber, the poppet element having an upper hemispherical-shaped surface adapted to mate and contact the seating structure to form a seal; and

a valve head coupled to the dispensing vessel and adapted for dispensing of a fluid from the vessel through a discharge port, the pressure regulator being disposed upstream of the discharge port and coupled to the valve head, the valve head including a flow control valve that is operable to control fluid dispensing from the vessel.

10. The fluid supply package of claim 9, wherein the damper assembly includes an axial member with a body, a circumferential sleeve and a spring member, the axial body member having a

proximal end coupled to the stationary portion and a distal end protruding towards the movable portion, the axial member body having the spring member disposed circumferentially about the distal end of the axial member with the circumferential sleeve located about the proximal end of the axial member and in contact with an upper end of the spring member.