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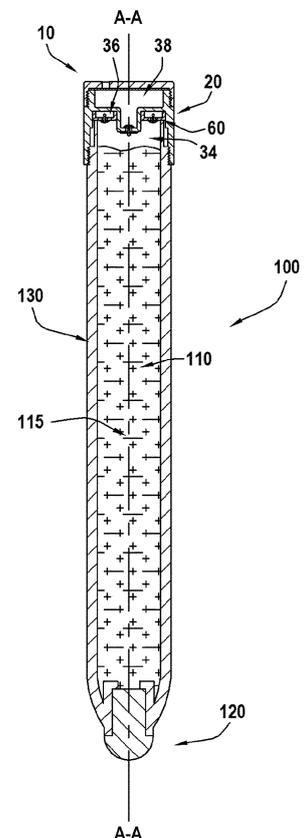
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(54) **PRESSURE REGULATION DEVICE AND METHOD FOR A WRITING INSTRUMENT**

(57) A pressure regulation device (10) including a body (20) extending between a first end (22) and a second end (24), the body (20) configured to be coupled to a free ink writing instrument (100) so as to define a first reservoir (34) between the body and the writing instrument, and the body defining a second reservoir (36) in communication with the first reservoir, a piston (60) positioned between the first end and the second end of the body, the piston configured to move axially from a first position toward a second position, wherein coupling the body to the writing instrument moves the piston from the first position toward the second position, pressure increases in the second reservoir when the piston moves from the first position toward the second position, and fluid flows from the second reservoir to the first reservoir when pressure is increased in the second reservoir.

[Fig. 2]



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Description

FIELD

[0001] The present disclosure relates generally to the field of writing instruments. More specifically, the present disclosure relates to a pressure regulation device configured for use in a free ink writing instrument.

BACKGROUND

[0002] A traditional writing instrument may include a tubular housing, a cartridge configured to store a fluid-based writing medium, such as ink, and a writing tip configured to transfer the writing medium to a surface. In a free ink writing instrument, the writing medium may freely circulate fluidly within the cartridge of the writing instrument. Additionally, the writing medium may circulate in real-time due to forces acting on the writing instrument, such as gravity. In particular, the writing medium may circulate when the writing instrument is handled and/or manipulated by a user. In a free ink writing instrument, the writing medium may require injection from the cartridge into a separate chamber of the writing instrument to mix with an additional fluid, such as water, prior to being ready for use. Downstream from the reservoir, the writing medium, once mixed with the additional fluid, may be fed to the writing tip.

[0003] To extend the lifetime of a writing instrument, the writing instrument may be configured to be refilled with the writing medium. However, in the case of a free ink writing instrument, refilling the writing instrument with the writing medium may create a messy situation for a user attempting to refill the writing instrument. In particular, injection of the writing medium from the cartridge into the separate chamber of the writing instrument may cause over pressure within the separate chamber of the writing instrument, resulting in leakage of the writing medium from the writing instrument.

[0004] It is desirable to provide a pressure regulation device configured for use in a writing instrument, which includes structures and/or relationships configured to regulate pressure variation within the writing instrument, to improve refilling of the writing instrument in a hassle-free and convenient manner.

SUMMARY

[0005] According to aspects of the present disclosure, a pressure regulation device configured for use in a free ink writing instrument is provided. The pressure regulation device comprises a body extending between a first end and a second end along an axis, the body configured to be coupled to the free ink writing instrument so as to define a first reservoir between the body and the free ink writing instrument and the body defining a second reservoir in communication with the first reservoir, a piston positioned between the first end and the second end of

the body, the piston configured to move axially from a first position toward a second position, and wherein coupling the body to the free ink writing instrument moves the piston from the first position toward the second position, pressure increases in the second reservoir when the piston moves from the first position toward the second position, and fluid flows from the second reservoir to the first reservoir when pressure is increased in the second reservoir.

[0006] According to aspects of the present disclosure, the body comprises a third reservoir.

[0007] According to aspects of the present disclosure, the second reservoir is positioned between the first reservoir and at least a portion of the third reservoir.

[0008] According to aspects of the present disclosure, at least a portion of the third reservoir is configured to extend through the second reservoir.

[0009] According to aspects of the present disclosure, the body defines a fluid passage configured to allow a fluid to flow from the first reservoir to the third reservoir when pressure is increased in the first reservoir.

[0010] According to aspects of the present disclosure, the fluid the fluid passage defined by the body is configured to allow to flow from the first reservoir to the third reservoir is a gas.

[0011] According to aspects of the present disclosure, a one-way valve is included at the fluid passage defined by the body and the one-way valve is configured to stop return flow from the third reservoir into the first reservoir.

[0012] According to aspects of the present disclosure, the body includes a hydrophobic membrane positioned at the fluid passage defined by the body and the hydrophobic membrane is configured to restrict fluid flow from the first reservoir into the third reservoir through the fluid passage defined by the body.

[0013] According to aspects of the present disclosure, the body includes a vent configured to allow fluid to flow out of the third reservoir.

[0014] According to aspects of the present disclosure, the piston defines a replacement passage configured to allow a fluid to flow from the second reservoir to the first reservoir when the piston moves from the first position toward the second position.

[0015] According to aspects of the present disclosure, a one-way valve is included at the replacement passage defined by the piston and the one-way valve is configured to stop return flow from the first reservoir into the second reservoir.

[0016] According to aspects of the present disclosure, the piston includes an engagement surface configured to receive a force exerted by pressure inside the first reservoir when the body is coupled to the free ink writing instrument.

[0017] According to aspects of the present disclosure, a method for regulating pressure within a free ink writing instrument is provided. The method comprises providing the pressure regulation device according to any aspect disclosed herein, and coupling the pressure regulation

device to the free ink writing instrument.

[0018] According to aspects of the present disclosure, a free ink writing instrument is provided. The free ink writing instrument comprises the pressure regulation device according to any aspect disclosed herein, a writing tip, a housing, and a coupling member configured to be coupled with a complementary coupling member of the pressure regulation device.

[0019] According to aspects of the present disclosure, the pressure regulation device is configured to refill the writing instrument with a writing medium.

[0020] In the manner described and according to aspects illustrated herein, the pressure regulation device and the method are capable of regulating pressure variation within a free ink writing instrument, to improve refilling of the free ink writing instrument in a hassle-free and convenient manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Aspects of an embodiment will be described in reference to the drawings, where like numerals reflect like elements:

Figure 1 is a perspective view of a pressure regulation device included by a writing instrument according to aspects of the disclosure;

Figure 2 is a cross-sectional view of the pressure regulation device included by the writing instrument of Figure 1, taken along an axis A-A;

Figure 3A is an enlarged cross-sectional view of the pressure regulation device included by the writing instrument of Figure 1, with emphasis on the pressure regulation device, and illustrating a piston of the pressure regulation device in a first position;

Figure 3B is an enlarged cross-sectional view of the pressure regulation device included by the writing instrument of Figure 1, with emphasis on the pressure regulation device, and illustrating the piston of the pressure regulation device in a second position;

Figure 4 is an enlarged cross-sectional view of the pressure regulation device included by the writing instrument of Figure 1, with emphasis on the pressure regulation device, and illustrating a body of the pressure regulation device being integrally formed.

DETAILED DESCRIPTION

[0022] An embodiment of a pressure regulation device configured for use in a writing instrument and a method of regulating pressure within a writing element according to aspects of the disclosure will now be described with reference to Figures 1-4. Like numerals represent like parts, and the pressure regulation device will generally be referred to by the reference numeral 10. Although the pressure regulation device 10 is described with reference to specific examples, it should be understood that modifications and changes may be made to these examples

without going beyond the general scope as defined by the claims. In particular, individual characteristics of the various embodiments shown and/or mentioned herein may be combined in additional embodiments. Consequently, the description and the drawings should be considered in a sense that is illustrative rather than restrictive. The Figures, which are not necessarily to scale, depict illustrative aspects and are not intended to limit the scope of the disclosure. The illustrative aspects depicted are intended only as exemplary.

[0023] The term "exemplary" is used in the sense of "example," rather than "ideal." While aspects of the disclosure are 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 embodiment(s) described. On the contrary, the intention of this disclosure is to cover all modifications, equivalents, and alternatives falling within the scope of the disclosure.

[0024] Various materials, methods of construction and methods of fastening will be discussed in the context of the disclosed embodiment(s). Those skilled in the art will recognize known substitutes for the materials, construction methods, and fastening methods, all of which are contemplated as compatible with the disclosed embodiment(s) and are intended to be encompassed by the appended claims.

[0025] As used in this disclosure and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the content clearly dictates otherwise. As used in this disclosure and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

[0026] Throughout the description, including the claims, the terms "comprising a," "including a," and "having a" should be understood as being synonymous with "comprising one or more," "including one or more," and "having one or more" unless otherwise stated. In addition, any range set forth in the description, including the claims should be understood as including its end value(s) unless otherwise stated. Specific values for described elements should be understood to be within accepted manufacturing or industry tolerances known to one of skill in the art, and any use of the terms "substantially," "approximately," and "generally" should be understood to mean falling within such accepted tolerances.

[0027] When an element or feature is referred to herein as being "on," "engaged to," "connected to," or "coupled to" another element or feature, it may be directly on, engaged, connected, or coupled to the other element or feature, or intervening elements or features may be present. In contrast, when an element or feature is referred to as being "directly on," "directly engaged to," "directly connected to," or "directly coupled to" another element or feature, there may be no intervening elements or features present. Other words used to describe the relationship between elements or features should be in-

terpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.).

[0028] Spatially relative terms, such as "top," "bottom," "middle," "inner," "outer," "beneath," "below," "lower," "above," "upper," and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the drawings. Spatially relative terms may be intended to encompass different orientations of a device in use or operation in addition to the orientation depicted in the drawings. For example, if the device in the drawings is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the example term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0029] Although the terms "first," "second," etc. may be used herein to describe various elements, components, regions, layers, sections, and/or parameters, these elements, components, regions, layers, sections, and/or parameters should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer, or section from another region, layer, or section. Thus, a first element, component, region, layer, or section discussed herein could be termed a second element, component, region, layer, or section without departing from the teachings of the present disclosure.

[0030] As shown in Figures 1-2, the pressure regulation device 10 is configured for use in a writing instrument 100. Additionally or alternatively, it is contemplated that the pressure regulation device 10 may be considered to be a part of the writing instrument 100. The term "writing instrument" as used herein may be understood to be a tool used to produce writing and/or drawing (e.g. figures, characters, lines, forms, and/or the like) upon a surface. In the disclosed embodiment, the writing instrument 100 may be a ballpoint pen, a rollerball pen, a felt pen, or the like. Additionally, the writing instrument 100 may be configured for use of free ink. It is contemplated that the term "free ink" as used herein may be understood as system in which a fluid-based writing medium 110 (hereafter, "the writing medium 110"), such as ink, freely circulates fluidly within one or more reservoir 34, 36 of the writing instrument 100. It is contemplated that the writing medium 110 may circulate in real-time due to forces acting on the writing instrument 100, such as gravity. In particular, it is contemplated that the writing medium 110 may circulate when the writing instrument 100 is handled and/or manipulated by a user. Additionally, downstream from the one or more reservoir 34, 36, the writing medium 110 may be fed to a writing tip 120 of the writing instrument 100. The writing tip 120 may include any structure suitable for absorbing and/or transferring the writing medium 110, such as a fibrous bundle, a capillarity duct, a felt

duct, and/or the like. In the disclosed embodiment, the writing instrument 100 may be configured to be refillable. Accordingly, the writing instrument 100 may be referred to and/or understood as a refillable free ink writing instrument.

[0031] As shown in Figures 1-2 of the disclosed embodiment, the writing instrument 100 includes a cylindrical housing 130 configured to couple with the pressure regulation device 10. However, it is contemplated that the housing may have a different elongated shape, such as prismatic, e.g. hexagon-prismatic or triangular-prismatic, or any other polygonal shaped prism which may be compatible with the writing instrument 100. To this end, as shown in Figures 3A-3B, the writing instrument 100 includes a coupling member 140 configured to couple with a complementary coupling member (coupling member 26) of the pressure regulation device 10. The coupling member 140 of the writing instrument 100 may be included on the housing 130 of the writing instrument 100. In the disclosed embodiment, the coupling member 140 of the writing instrument 100 is configured to form a threaded engagement with the complementary coupling member (coupling member 26) of the pressure regulation device 10; however, it is contemplated that an alternative form of engagement may be compatible with the pressure regulation device 10, such as a bayonet connection or snap-fit connection. Additionally, the writing instrument 100 may include an engagement member 150 configured to come into contact with and/or exert a force upon a piston 60 (discussed below) of the pressure regulation device 10, to thereby move the piston 60. In the disclosed embodiment, the engagement member 150 of the writing instrument 100 extends axially, along a common axis A-A of the pressure regulation device 10, from the housing 130 of the writing instrument 100.

[0032] As shown in Figures 3A-4 of the disclosed embodiment, the pressure regulation device 10 is configured to improve regulation of pressure variation when refilling the writing instrument 100 with the writing medium 110. To this end, the pressure regulation device 10 is configured to couple with the writing instrument 100. The pressure regulation device 10 includes a body 20 extending between a first end 22 and a second end 24 along an axis A-A, and a piston 60 positioned within the body 20 between the first end 22 and the second end 24 of the body 20. Additionally or alternatively, the body 20 may include a first body portion 20a extending from the first end 22 of the body 20 toward the second end 24 of the body 20 and a second body portion 20b extending from the second end 24 of the body 20 toward the first end 22 of the body 20. The first body portion 20a and the second body portion 20b may be configured to couple with each other. For example, the first body portion 20a and the second body portion 20b may be configured to form a threaded engagement; however, it is contemplated that an alternative form of engagement may be compatible with the pressure regulation device 10, such as a bayonet connection or snap-fit connection. Including a first body

portion 20a and a second body portion 20b may allow a user to remove the second body portion 20b from the pressure regulation device 10 to relieve pressure accumulated within the pressure regulation device 10. However, it is contemplated that the first body portion 20a and the second body portion 20b may be integrally formed (see Figure 4). Accordingly, the first body portion 20a and the second body portion 20b may be referred to herein as "the body 20." In the disclosed embodiment, the body 20 may have a cylindrical shape corresponding to the cylindrical shape of the housing 130 of the writing instrument 100. Additionally, the body 20 includes a coupling member 26 at the first end 22 of the body 20, which is configured to form a threaded engagement with the coupling member 140 of the writing instrument 100. It is contemplated that the body 20 and/or the writing instrument 100 may include a seal (not shown) to prevent the writing medium 110 from leaking from the pressure regulation device 10 and/or the writing instrument 100.

[0033] Referring to Figures 3A-4, the body 20 of the pressure regulation device 10 includes an outer (first) wall 28 and an inner (second) wall 30. It is contemplated that the terms "inner" and "outer" may be understood as locations within the pressure regulation device 10 at distances relative to the axis A-A. Accordingly, the inner wall 30 may be understood as being located at a distance from the axis A-A that may be equal to or less than a distance from the axis A-A of the outer wall 28. In the disclosed embodiment, the outer wall 28 and the inner wall 30 are integrally formed. The outer wall 28 extends axially between the first end 22 and the second end 24 of the body 20. The inner wall 30 includes a first inner wall portion 30a which extends radially inwardly from the outer wall 28 and a second inner wall portion 30b that extends axially from the first inner wall portion 30a, in a direction toward the first end 22 of the body 20. It is contemplated that the terms "inwardly" and "outwardly" may be understood as directions within the pressure regulation device 10 relative to the axis A-A. Accordingly, the term "inwardly" may be understood as being a direction extending toward the axis A-A and the term "outwardly" may be understood as being a direction extending away from the axis A-A. As such, at least a portion of the inner wall 30 is configured to be concentric with the outer wall 28. In particular, the second inner wall portion 30b is configured to be concentric with the outer wall 28. In this manner, an annular slot 32 is defined between the outer wall 28 and the inner wall 30. In particular, the annular slot 32 is defined between the outer wall 28, the first inner wall portion 30a, and the second inner wall portion 30b. The annular slot 32 is configured to receive the piston 60. Accordingly, the outer wall 28 and the inner wall 30 of the body 20 are configured to surround the piston 60, in a surface-to-surface engagement with the piston 60.

[0034] In the disclosed embodiment, the body 20 of the pressure regulation device 10 is configured to receive at least a portion of the writing instrument 100. In particular, the body 20 is configured to receive the engagement

member 150 of the writing instrument 100, so that the engagement member 150 may come into contact with and/or exert a force upon the piston 60 to move the piston 60 when the pressure regulation device 10 is coupled to the writing instrument 100. Additionally, the body 20 is configured to define a first reservoir 34, a second reservoir 36, and a third reservoir 38. In the disclosed embodiment, the first reservoir 34 is defined between the body 20, the piston 60, and the housing 130 of the writing instrument 100 when the pressure regulation device 10 is coupled to the writing instrument 100. In particular, the first reservoir 34 is defined between the inner wall 30 of the body 20, the piston 60, and the housing 130 of the writing instrument 100 when the pressure regulation device 10 is coupled to the writing instrument 100. Additionally, at least a portion of the first reservoir 34 is defined at the first end 22 of the body 20. The first reservoir 34 may be configured to store the writing medium 110. Additionally or alternatively, the first reservoir 34 may be configured to store a fluid 115 which may be mixed with the writing medium 110 (see Figure 3A). In the disclosed embodiment, the fluid 115 to be mixed with the writing medium 110 may be water. It is contemplated that a user may add the fluid (water) 115 into the housing of the writing instrument 100 prior to coupling the pressure regulation device 10 to the writing instrument 100, such that the fluid 115 may then be stored within the first reservoir 34.

[0035] In the disclosed embodiment, the second reservoir 36 is defined between the body 20 and the piston 60. Additionally, the second reservoir 36 is defined between the outer wall 28 of the body 20, the inner wall 30 of the body 20, and the piston 60. In particular, the second reservoir 36 is defined between the outer wall 28 of the body 20, the first inner wall portion 30a and second inner wall portion 30b of the body 20, and the piston 60. Accordingly, the second reservoir 36 is included within the annular slot 32. As such, the second reservoir 36 has an annular shape and is configured to surround at least a portion of the third reservoir 38 defined by the second inner wall portion 30b (discussed below), as well as a second passage 42 defined by the body 20 (discussed below). As such, at least a portion of the third reservoir 38 extends through the second reservoir 36. Additionally, the second reservoir 36 is defined at a position between the first reservoir 34 and at least a portion of the third reservoir 38. In this manner, the second reservoir 36 is configured such that the third reservoir 38 is in direct communication with the first reservoir 34, through the second passage 42 defined by the body 20. Additionally, the second reservoir 36 is also in direct communication with the first reservoir 34. Having the second reservoir 36 in direct communication with the first reservoir 34 allows the second reservoir 36 to deliver a fluid to the first reservoir 34.

[0036] As shown in Figures 3A and 4, the second reservoir 36 is configured to store the fluid, which is to be delivered to the first reservoir 34 during a refilling process.

In the disclosed embodiment, the fluid stored by the second reservoir 36 is the writing medium 110. Additionally, in the disclosed embodiment, the writing medium 110 which is stored by the second reservoir 36 may be concentrated ink, which may be mixed with the fluid (water) 115 which may be stored in the first reservoir 34. To this end, the piston 60 defines a first passage (also referred to herein as a "replacement passage") 62 configured to allow fluid (the writing medium 110) to flow from the second reservoir 36 to the first reservoir 34. It is contemplated that the piston 60 may include a plurality of first passages 62 configured to allow the fluid (the writing medium 110) to flow from the second reservoir 36 to the first reservoir 34; however, the plurality of first passages 62 will be referred to herein as "the first passage 62," unless reference to a plurality of the first passages 62 is otherwise necessary. In the disclosed embodiment, the piston 60 may include a first one-way valve 64 at and/or in the first passage 62. It is contemplated that the piston 60 may include a plurality of first one-way valves 64 included at and/or in a corresponding first passage 62; however, the plurality of first one-way valves 64 will be referred to herein as "the first one-way valve 64," unless reference to a plurality of the first one-way valves 64 is otherwise necessary. The first one-way valve 64 is configured to allow fluid flow from the second reservoir 36 into the first reservoir 34 and to stop return fluid flow from the first reservoir 34 into the second reservoir 36. In this manner, the writing medium 110 may be delivered from the second reservoir 36 to the first reservoir 34 and the writing medium 110 and/or the fluid (water) 115 are prevented from entering the second reservoir 36 from the first reservoir 34.

[0037] In the disclosed embodiment, the third reservoir 38 is defined between the body 20 of the pressure regulation device 10. In particular, the third reservoir 38 is defined between the outer wall 28 of the body 20 and the inner wall 30 of the body 20. At least a portion of the third reservoir 38 is defined at the second end 24 of the body 20. The third reservoir 38 is configured to receive fluid from the first reservoir 34. In the disclosed embodiment, the fluid received by the third reservoir 38 from the first reservoir 34 may be a gas. In particular, the fluid received by the third reservoir 38 from the first reservoir 34 may be air. Accordingly, the first reservoir 34 includes a first volume configured to be occupied by a gas and the third reservoir 38 includes a second volume configured to be occupied by a gas. It is contemplated that the first volume configured to be occupied by a gas of the first reservoir 34 is a volume of the first reservoir 34 that is not occupied by the writing medium 110 and fluid (water) 115 once the pressure regulation device 10 has been coupled to the writing instrument 10 and the writing medium 110 and the fluid 115 have been mixed. In the disclosed embodiment, the second volume configured to be occupied by a gas of the third reservoir 38 is greater than the first volume configured to be occupied by a gas of the first reservoir 34. Accordingly, pressure in the third reservoir

38 is lower than pressure in the first reservoir 34. As such, fluid (gas) present in the first reservoir 34 flows from the first reservoir 34 (high pressure) to the third reservoir 38 (low pressure) when the pressure regulation device 10 is coupled to the writing instrument 100. Additionally or alternatively, fluid (gas) present in the first reservoir 34 flows from the first reservoir 34 (high pressure) to the third reservoir 38 (low pressure) when pressure is increased in the first reservoir 34.

[0038] As shown in Figures 3A-4, the body 20 defines a second passage (also referred to herein as a "fluid passage") 42 configured to allow the fluid (gas) to flow from the first reservoir 34 to the third reservoir 38. Additionally or alternatively, the second passage 42 is configured to allow the fluid (gas) to flow from the first reservoir 34 to the third reservoir 38 when pressure is increased in the first reservoir 34. In the disclosed embodiment, the second passage 42 is defined by the inner wall 30 of the body 20. Additionally, the second passage 42 is defined at a position inward of the second inner wall portion 30b of the body 20. In this position, the second passage 42 extends directly between the first reservoir 34 and the third reservoir 38. Accordingly, the third reservoir 38 is in direct communication with the first reservoir 34. In the disclosed embodiment, the body 20 includes a second one-way valve 44 at and/or in the second passage 42 defined by the body 20. The second one-way valve 44 is configured to allow fluid flow from the first reservoir 34 into the third reservoir 38 and to stop return fluid flow from the third reservoir 38 into the first reservoir 34. In this manner, the fluid (gas) may only flow from the first reservoir 34 to the third reservoir 38. Additionally, a first hydrophobic membrane 46 may be included at the second passage 42 defined by the body 20. The first hydrophobic membrane 46 may be configured to restrict fluid flow from the first reservoir 34 into the third reservoir 38 through the second passage 42 defined by the body 20. In this manner, the writing medium 110 and/or the fluid (water) 115 may be further prevented from entering the third reservoir 38 from the first reservoir 34. Additionally or alternatively, the body 20 may include a vent 50 configured to allow fluid (gas) to flow out of the third reservoir 38. Accordingly, the vent 50 may be positioned at or near the second end 24 of the body 20. In this manner, fluid (gas) may be allowed to exit the third reservoir 38 through the vent 50 included by the body 20. Additionally or alternatively, a second hydrophobic membrane 52 may be included at the second end 24 of the body 20 and/or at the vent 50. The second hydrophobic membrane 52 may be configured to restrict fluid flow out of the third reservoir 38 through the vent. In this manner, if the writing medium 110 and/or the fluid (water) 115 have entered the third reservoir 38, the writing medium 110 and/or the fluid (water) 115 may be further prevented from leaking from the third reservoir 38 through the vent 50.

[0039] As illustrated by Figures 3A-3B the piston 60 is configured to move axially from a first position (see Figure 3A) toward a second position (see Figure 3B). Accord-

ingly, the piston 60 is configured to move from the first position to the second position within the annular slot defined by the outer wall 28 and the inner wall 30 of the body 20 of the pressure regulation device 10. As such, the piston 60 has an annular shape configured for surface-to-surface contact with the body 20 within the annular slot 32. In the disclosed embodiment, the piston 60 moves toward the second end 24 of the body 20 when the piston 60 moves toward the second position. The piston 60 is configured to move from the first position toward the second position as the pressure regulation device 10 is coupled to the writing instrument 100. To this end, the piston 60 is configured to move toward the second position as the pressure regulation device 10 is threadably engaged and/or screwed onto the housing 130 of the writing instrument 100.

[0040] Coupling the pressure regulation device 10 to the writing instrument 100 decreases the volume of the first reservoir 34. As the volume of the first reservoir 34 decreases, pressure increases within the first reservoir 34. To this end, the piston 60 includes an engagement surface 66 configured to receive a force exerted by the increased pressure within the first reservoir 34 when the pressure regulation device 10 is coupled to the writing instrument 100. The force exerted by the increased pressure within the first reservoir 34 upon the engagement surface 66 causes the piston 60 to move from the first position toward the second position. Additionally or alternatively, the engagement surface 66 may be configured to come into contact with and/or receive a force exerted by the engagement member 150 of the writing instrument 100. As the pressure regulation device 10 is coupled to the writing instrument 100, the engagement surface 66 of the piston 60 comes into contact with the engagement member 150 of the writing instrument 100 and receives the force exerted by the engagement member 150 of the writing instrument 100. Receiving the force exerted by the engagement member 150 causes the piston 60 to move from the first position toward the second position. Moving the piston 60 from the first position toward the second position decreases a volume of the second reservoir 36. As the volume of the second reservoir 36 decreases, pressure within the second reservoir 36 increases. This decrease in volume of the second reservoir 36 may take place simultaneously with the decrease in volume of the first reservoir 34. Increasing pressure in the second reservoir 36 forces the writing medium 110 through the first one-way valve 64, from the second reservoir 36 into the first reservoir 34. In this manner, the piston 60 moves from the first position toward the second position when the pressure regulation device 10 is coupled to the writing instrument 100. Additionally, the writing medium 110 flows from the second reservoir 36 into the first reservoir 34 when the pressure regulation device 10 is coupled to the writing instrument 100 and/or as the piston 60 moves from the first position toward the second position.

[0041] Referring to Figures 3A-3B, the writing medium

110 flowing from the second reservoir 36 to the first reservoir 34 causes a volume of the first reservoir 34 occupied by a mixture of the writing medium 110 and fluid (water) 115 within the first reservoir 34 to increase. As the volume occupied by the writing medium 110 and fluid (water) 115 mixture increases, pressure within the first reservoir 34 increases. Increased pressure within the first reservoir 34 may cause leakage of the writing medium 110 and fluid (water) 115 mixture from the writing instrument 100, creating a messy situation for a user. However, in the disclosed embodiment, gas (air) is forced through the second one-way valve 44 when pressure within the first reservoir 34 is increased. As such, increased pressure within the first reservoir 34 is relieved via the third reservoir 38, through the second one-way valve 44. Additionally, the gas (air) forced from the first reservoir 34 into the third reservoir 38 through the second one-way valve 44 may exit the pressure regulation device 10 and the writing instrument 100 through the vent 50 defined by the body 20 of the pressure regulation device 10. Additionally or alternatively, the gas (air) forced from the first reservoir 34 into the third reservoir 38 through the second one-way valve 44 may exit the pressure regulation device 10 and the writing instrument 100 by removal of the second body portion 20b from the first body portion 20a, effectively opening the third reservoir 38 to the environment surrounding the pressure regulation device 10 and the writing instrument 100. In this manner, pressure variation within the writing instrument 100 is regulated when refilling the writing instrument 100 with the writing medium 110, thereby improving the refilling of the writing instrument 100 with the writing medium 110 in a hassle-free and convenient manner.

[0042] Although the present disclosure herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present disclosure.

[0043] It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims.

[0044] Additionally, all of the disclosed features of an apparatus may be transposed, alone or in combination, to a method and vice versa.

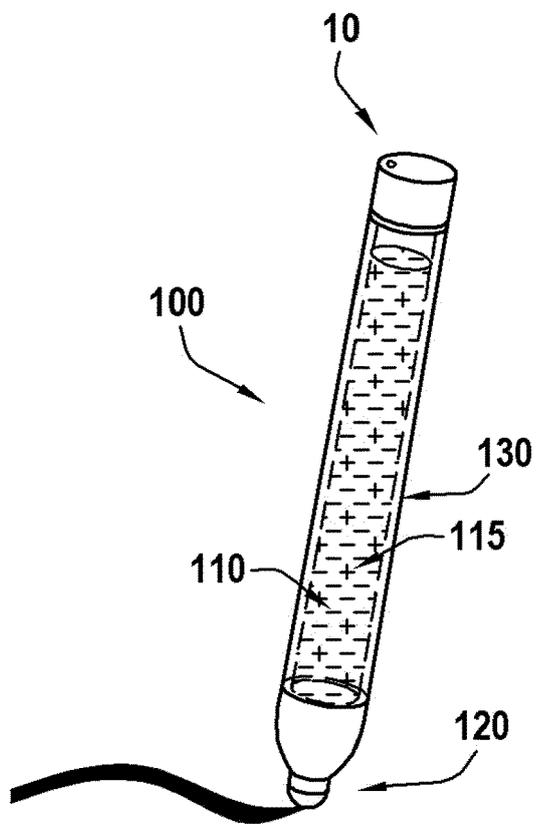
Claims

1. A pressure regulation device (10) configured for use in a free ink writing instrument (100), the pressure regulation device comprising:

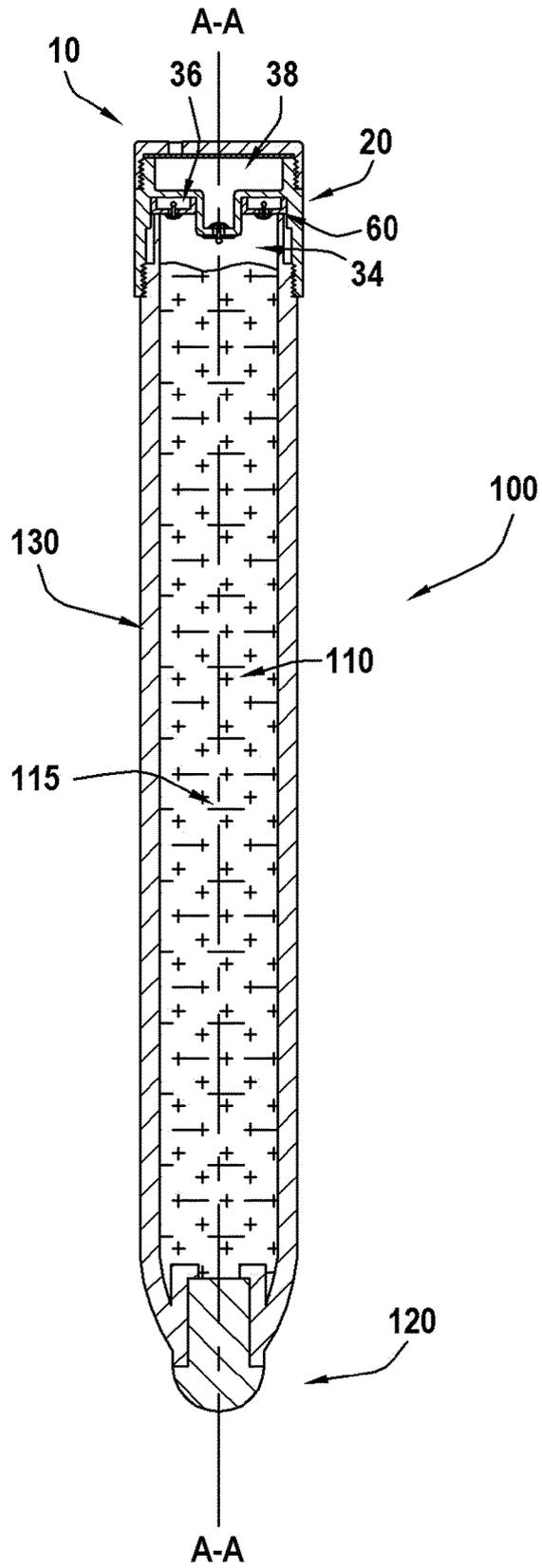
a body (20) extending between a first end (22) and a second end (24) along an axis (A-A), the body (20) configured to be coupled to the free ink writing instrument (100) so as to define a first reservoir (34) between the body (20) and the free ink writing instrument (100) and the body

- (20) defining a second reservoir (36) in communication with the first reservoir (34);
 a piston (60) positioned between the first end (22) and the second end (24) of the body (20), the piston (60) configured to move axially from a first position toward a second position; and wherein, coupling the body (20) to the free ink writing instrument (100) moves the piston (60) from the first position toward the second position, pressure increases in the second reservoir (36) when the piston (60) moves from the first position toward the second position, and fluid flows from the second reservoir (36) to the first reservoir (34) when pressure is increased in the second reservoir (36).
2. The pressure regulation device (100) according to claim 1, wherein the body (20) comprises a third reservoir (38).
 3. The pressure regulation device (10) according to claim 2, wherein the second reservoir (36) is positioned between the first reservoir (34) and at least a portion of the third reservoir (38).
 4. The pressure regulation device (10) according to any of claims 2-3, wherein at least a portion of the third reservoir (38) is configured to extend through the second reservoir (36).
 5. The pressure regulation device (10) according to any of claims 2-4, wherein the body (20) defines a fluid passage (42) configured to allow a fluid to flow from the first reservoir (34) to the third reservoir (38) when pressure is increased in the first reservoir (34).
 6. The pressure regulation device (10) according to claim 5, wherein the fluid the fluid passage (42) defined by the body (20) is configured to allow to flow from the first reservoir (34) to the third reservoir (38) is a gas.
 7. The pressure regulation device (10) according to any of claims 5-6, wherein a one-way valve (44) is included at the fluid passage (42) defined by the body (20) and the one-way valve (44) is configured to stop return flow from the third reservoir (38) into the first reservoir (34).
 8. The pressure regulation device (10) according to any of claims 5-7, wherein the body (20) includes a hydrophobic membrane (46) positioned at the fluid passage (42) defined by the body (20) and the hydrophobic membrane (46) is configured to restrict fluid flow from the first reservoir (34) into the third reservoir (38) through the fluid passage (42) defined by the body (20).
 9. The pressure regulation device (10) according to any of claims 2-8, wherein the body (20) includes a vent (50) configured to allow fluid to flow out of the third reservoir (38).
 10. The pressure regulation device (10) according to any of claims 1-9, wherein the piston (60) defines a replacement passage (62) configured to allow a fluid (110) to flow from the second reservoir (36) to the first reservoir (34) when the piston (60) moves from the first position toward the second position.
 11. The pressure regulation device (10) according to claim 10, wherein a one-way valve (64) is included at the replacement passage (62) defined by the piston (60) and the one-way valve (64) is configured to stop return flow from the first reservoir (34) into the second reservoir (36).
 12. The pressure regulation device (10) according to any of claims 1-11, wherein the piston (60) includes an engagement surface (66) configured to receive a force exerted by pressure inside the first reservoir (34) when the body (20) is coupled to the free ink writing instrument (100).
 13. A method for regulating pressure within a free ink writing instrument (100), the method comprising:
 - providing the pressure regulation device (10) according to any of claims 1-12; and
 - coupling the pressure regulation device (10) to the free ink writing instrument (100).
 14. A free ink writing instrument (100) comprising the pressure regulation device (10) according to any of claims 1-12, a writing tip (120), a housing (130), and a coupling member (140) configured to be coupled with a complementary coupling member (26) of the pressure regulation device (10).
 15. The free ink writing instrument (100) according to claim 14, wherein the pressure regulation device (10) is configured to refill the writing instrument (100) with a writing medium (110).

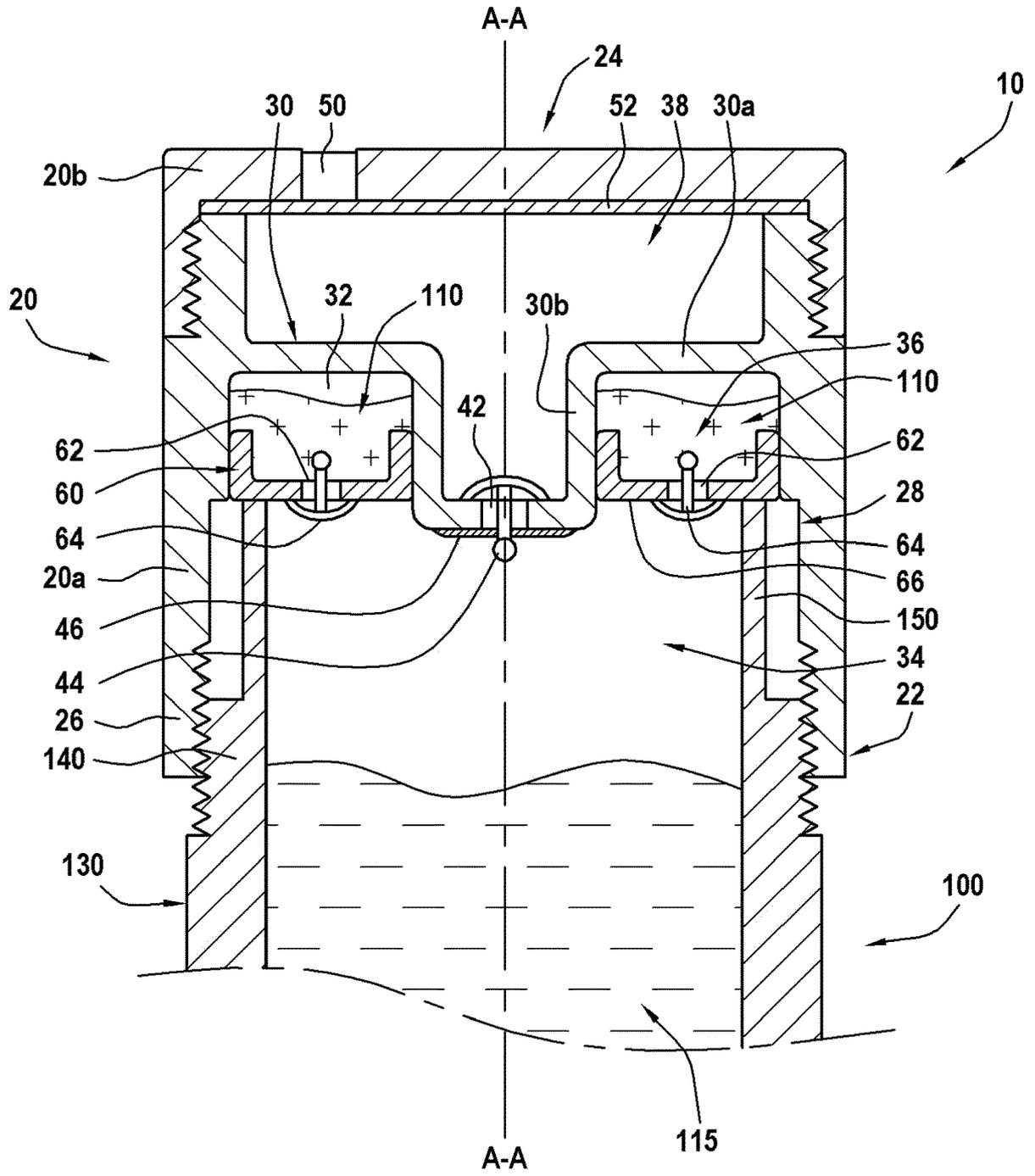
[Fig. 1]



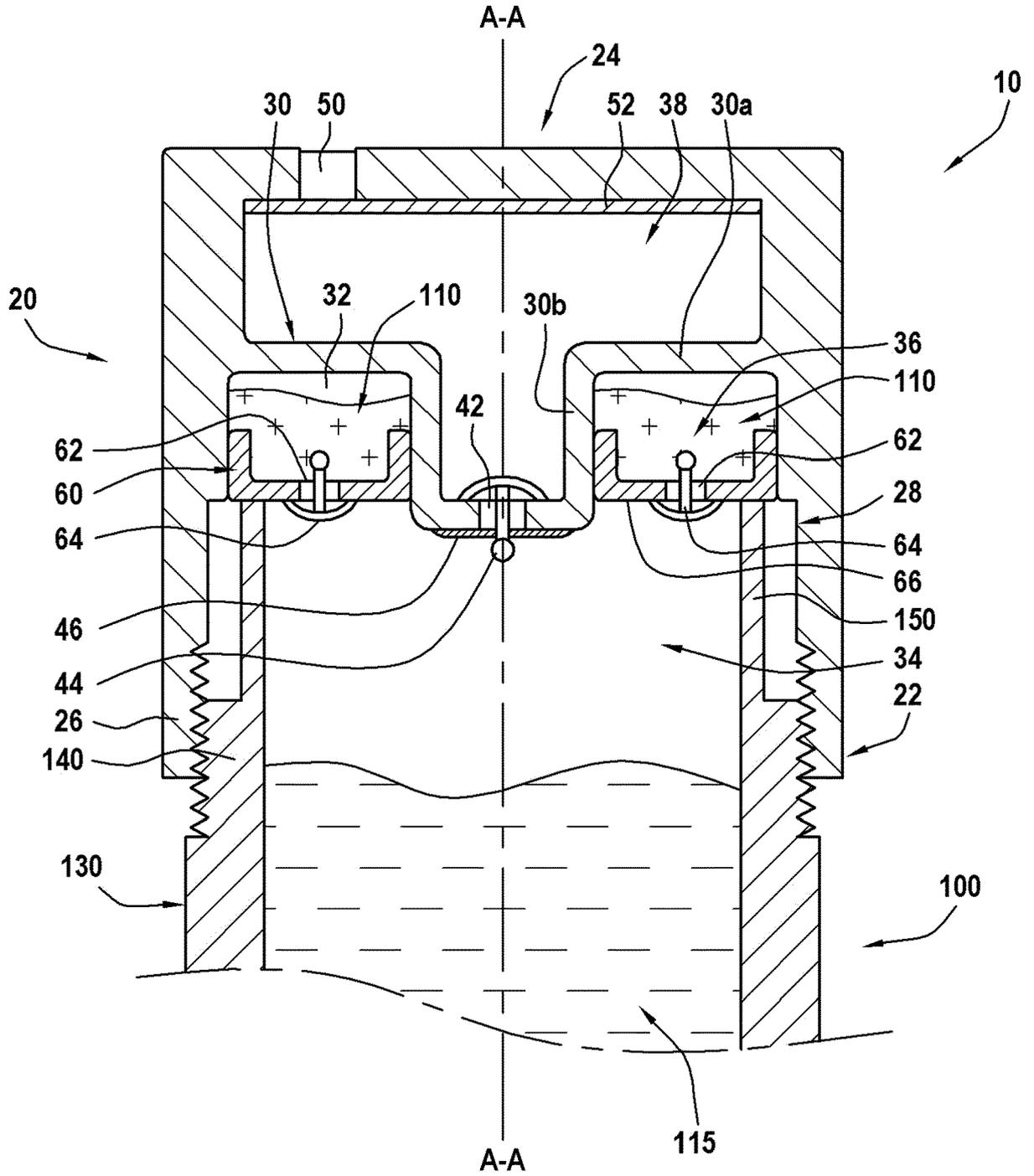
[Fig. 2]



[Fig. 3A]



[Fig. 4]





EUROPEAN SEARCH REPORT

Application Number
EP 21 30 5524

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			B43K
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 September 2021	Examiner Kelliher, Cormac
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