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Pressure-regulating vial adaptors

Abstract

In certain embodiments, a vial adaptor comprises a housing configured to couple the adaptor with a vial, an access channel, a regulator channel, and a regulator assembly. The access channel is configured to facilitate withdrawal of fluid from the vial when the adaptor is coupled to the vial. The regulator channel is configured to facilitate a flow of a regulating fluid from the regulator assembly to compensate for changes in volume of a medical fluid in the vial. In some embodiments, the regulator assembly includes a flexible member configured to expand and contract in accordance with changes in the volume of the medical fluid in the vial. In some embodiments, the flexible member is substantially free to expand and contract. In some embodiments, the flexible member is not partly or completely located in a rigid enclosure.

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Background/Summary

RELATED APPLICATIONS (1) This application is a continuation of U.S. application Ser. No. 18/308,500, filed Apr. 27, 2023, which is a continuation of U.S. application Ser. No. 17/445,705, filed Aug. 23, 2021, titled “PRESSURE-REGULATING VIAL ADAPTORS,” now U.S. Pat. No. 11,672,734, which is a continuation of U.S. application Ser. No. 16/872,754, filed May 12, 2020, titled “PRESSURE-REGULATING VIAL ADAPTORS,” now U.S. Pat. No. 11,129,773, which is a continuation of U.S. application Ser. No. 15/932,248, filed Feb. 16, 2018, titled “PRESSURE-REGULATING VIAL ADAPTORS,” now U.S. Pat. No. 10,688,022, which is a continuation of U.S. application Ser. No. 14/789,806, filed Jul. 1, 2015, titled “PRESSURE-REGULATING VIAL ADAPTORS,” now U.S. Pat. No. 9,895,291, which is a continuation of U.S. application Ser. No. 14/179,475, filed Feb. 12, 2014, titled “PRESSURE-REGULATING VIAL ADAPTORS,” now U.S. Pat. No. 9,132,062, which claims the benefit under 35 U.S.C. § 120 and 35 U.S.C. § 365(c) as a continuation of International Application No. PCT/US2012/051226, designating the United States, with an international filing date of Aug. 16, 2012, titled “PRESSURE-REGULATING VIAL ADAPTORS,” which claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application No. 61/525,126, filed Aug. 18, 2011, titled “PRESSURE-REGULATING VIAL ADAPTORS,” and of U.S. Provisional Application No. 61/614,250, filed Mar. 22, 2012, titled “PRESSURE-REGULATING VIAL ADAPTORS.” The entire contents of each of the above-identified patent applications are incorporated by reference herein and made a part of this specification.

BACKGROUND
Field
(1) Certain embodiments disclosed herein relate to adaptors for coupling with medicinal vials, and components thereof, and to methods that contain vapors and/or aid in regulating pressure within

medicinal vials.

Description of the Related Art

(2) It is a common practice to store medicines or other medically related fluids in vials or other containers. In some instances, the medicines or fluids so stored are therapeutic if injected into the bloodstream, but harmful if inhaled or if contacted by exposed skin. Certain known systems for extracting potentially harmful medicines from vials suffer from various drawbacks.

SUMMARY

(3) In some embodiments, an adaptor is configured to couple with a sealed vial and includes a housing apparatus. In some instances, the housing apparatus includes a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In certain cases, at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus. The adaptor can also include an enclosure, such as a regulator enclosure, in fluid communication with the regulator channel. In some configurations, the regulator enclosure is configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when a fluid is withdrawn from the sealed vial via the extractor channel. Further, the adaptor can include a volume component, such as a filler, disposed within the regulator enclosure. The filler need not fill the entire enclosure. In some embodiments, the volume occupied or encompassed by the filler can be less than the majority of the interior volume of the enclosure, or at least the majority of the interior volume of the enclosure, or substantially all of the interior volume of the enclosure. In some instances, the filler is configured to ensure an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture.

(4) In certain configurations, the adaptor is configured such that the regulator enclosure is outside the sealed vial when the adaptor is coupled with the sealed vial. In some cases, at least a majority of the volume of the regulator enclosure is not within a rigid housing or at least a substantial portion of the regulator enclosure is not within a rigid housing.

(5) In certain instances, the housing apparatus comprises a medical connector interface in fluid communication with the extractor channel and is configured to couple with a syringe configured to hold a defined volume of fluid within a barrel. In some such cases, the filler is configured to ensure that the initial volume of regulator fluid is greater than or equal to the defined volume of fluid. In certain of such cases, the initial volume of regulator fluid within the regulator enclosure is greater than or equal to about 60 mL. In some embodiments, the regulator enclosure is configured to hold a maximum volume of regulator fluid when the regulator enclosure is fully expanded or unfolded, wherein the maximum volume is greater than or equal to about 180 mL.

(6) In some embodiments, the regulator enclosure is constructed from a material system including a film, such as a polyethylene terephthalate film. In some instances, the film includes a metalized coating or metal component. For example, in some cases, the metalized coating comprises aluminum.

(7) In certain embodiments, the pressure regulating vial adaptor includes a piercing member connected to the housing apparatus, and the enclosure is at least partially disposed within the piercing member. In some configurations, the pressure within the sealed vial is regulated by permitting the regulator enclosure to contract or fold in order to substantially equilibrate pressure on opposite sides of the regulator enclosure as the medicinal fluid is withdrawn from the sealed vial. In some instances, the regulator enclosure comprises a layer that is substantially impermeable to a medicinal fluid disposed within the vial, thereby impeding the passage of the medicinal fluid between an outer surface and an inner surface of the regulator enclosure.

(8) In various embodiments, the adaptor further includes a hydrophobic filter disposed between the

regulator enclosure and a distal regulator aperture. The hydrophobic filter can be configured to permit regulator fluid to flow between the regulator enclosure and the vial when the adaptor is coupled with the vial. In some arrangements, the hydrophobic filter is disposed within the regulator channel, which is itself disposed between the distal regulator aperture and the regulator enclosure. The filter can, for example, be a foamed material. For instance, in some configurations, the filler is made of polyurethane-ether foam.

(9) In some embodiments, a method of withdrawing fluid from a sealed vial includes connecting a pressure regulating vial adaptor to the sealed vial, and withdrawing fluid from the sealed vial through the pressure regulating vial adaptor. In certain aspects, the pressure regulating vial adaptor includes a housing apparatus including a distal extractor aperture. In some cases, the distal extractor aperture is configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In certain instances, at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus.

(10) In certain configurations, the pressure regulating vial adaptor also includes a regulator enclosure in fluid communication with the regulator channel. In some instances, the regulator enclosure is configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when a fluid is withdrawn from the sealed vial via the extractor channel.

(11) In some embodiments, the pressure regulating vial adaptor further includes a filler disposed within the regulator enclosure. The filler can be configured to provide an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture.

(12) In various embodiments, a method of manufacturing an adaptor for coupling with a sealed vial includes providing a housing apparatus including a distal extractor aperture. In some cases, the distal extractor aperture is configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In certain instances, at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus.

(13) The method can also include disposing a filler within a regulator enclosure. The filler can be configured to ensure an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture.

(14) In certain configurations, the method further includes placing the regulator enclosure in fluid communication with the regulator channel, such that the regulator enclosure is configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is less expanded or substantially or entirely unexpanded, or folded, when a fluid is withdrawn from the sealed vial via the extractor channel.

(15) In some embodiments of the method, disposing the filler within a regulator enclosure includes forming or providing a fill opening in the regulator enclosure configured to allow the filler to pass therethrough, filling the regulator enclosure with the filler through the fill opening, and closing the fill opening. In certain embodiments of the method, placing the regulator enclosure in fluid communication with the regulator channel comprises aligning an enclosure opening in the regulator enclosure with a proximal regulator aperture of the housing apparatus, and fastening the regulator enclosure to the housing apparatus.

(16) In various embodiments, an adaptor configured to couple with a sealed vial includes a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In some cases, at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus.

Also, the adaptor can include a regulator enclosure in fluid communication with the regulator channel. In some cases, the regulator enclosure is configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when a fluid is withdrawn from the sealed vial via the extractor channel. In certain embodiments, a rigid housing does not contain a substantial volume of the regulator enclosure.

(17) In some embodiments, the regulator enclosure comprises a first side and a second side opposite the first side. In some instances, each of the first and second sides is configured to expand, contract, fold, or unfold as regulator fluid flows between the regulator channel and the regulator enclosure. In certain cases, the second side is configured to move away from the housing apparatus or towards the housing apparatus when regulator fluid passes through the regulator channel. In some cases, the first side comprises an inner surface forming a portion of the regulator enclosure interior and an outer surface forming a portion of the regulator enclosure exterior. In certain of such cases, the outer surface of the first side is oriented towards the housing apparatus.

(18) In some embodiments, pressure within the sealed vial is regulated by allowing the regulator enclosure to contract or fold in order to substantially equilibrate pressure on opposite sides of the regulator enclosure as the medicinal fluid is withdrawn from the sealed vial. In some embodiments, the regulator enclosure comprises a layer that is substantially impermeable to a medicinal fluid disposed within the vial, thereby impeding the passage of the medicinal fluid between an outer surface and an inner surface of the enclosure.

(19) The adaptor can further include a hydrophobic filter disposed between the regulator enclosure and a distal regulator aperture. The hydrophobic filter can be configured to permit regulator fluid to flow between the regulator enclosure and the vial when the adaptor is coupled with the vial.

(20) The adaptor can also include a filler disposed within the regulator enclosure. The filler can be configured to ensure an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture.

(21) In some embodiments, a vial adaptor configured to couple with a sealed vial includes a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In some instances, at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus. In certain embodiments, the vial adaptor further includes a regulator enclosure in fluid communication with the regulator channel. In some cases, the regulator enclosure is configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when a fluid is withdrawn from the sealed vial via the extractor channel.

(22) In some embodiments of the vial adaptor, the regulator enclosure has a first side and a second side generally opposite the first side. The first side can comprise an inner surface forming a portion of the regulator enclosure interior and an outer surface forming a portion of the regulator enclosure exterior. The outer surface of the first side can be oriented towards the housing apparatus. In some instances, each of the first and second sides is configured to expand, contract, fold, or unfold when regulator fluid, such as air, gas, or vapors, passes through the regulator channel. In certain configurations, the second side is configured to move away from the housing apparatus or towards the housing apparatus when regulator fluid passes through the regulator channel. In various cases, the regulator enclosure is not entirely contained within a rigid housing.

(23) In some embodiments, a vial adaptor configured to couple with a sealed vial includes a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In various configurations, at

least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus. In certain embodiments, the vial adaptor includes a regulator enclosure in fluid communication with the regulator channel and configured to receive a volume of regulating fluid. The regulator enclosure can be configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when a fluid is withdrawn from the sealed vial via the extractor channel.

(24) In some embodiments, the regulator enclosure has a first layer connected with a second layer opposite the first layer. The first and second layers can be configured to receive the volume of regulating fluid therebetween. In certain configurations, each of the first and second sides is configured to expand, contract, fold, or unfold when regulator fluid passes through the regulator channel. In some instances, the second side is configured to move away from the housing apparatus or towards the housing apparatus when regulator fluid passes through the regulator channel. In some cases, the regulator enclosure is not entirely contained within a rigid housing.

(25) In certain configurations, the first layer is made of a first sheet of material, and the second layer is made of a second sheet of material. In some instances, the first and second layers are connected at a periphery of the first and second layers. In some cases, the first and second layers each comprise a central portion, and the first and second layers are not connected at the central portions.

(26) In some embodiments, a modular vial adaptor configured to couple with a sealed vial includes a pressure regulating vial adaptor module and a regulator fluid module. In some instances, the pressure regulating vial adaptor module includes a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In certain cases, at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus.

(27) The pressure regulating vial adaptor module can include a proximal regulator aperture in fluid communication with the regulator channel. In some configurations, the proximal regulator aperture is configured to permit ingress or egress of regulator fluid therethrough when the vial adaptor module is coupled with the sealed vial and fluid is withdrawn from the vial.

(28) In certain instances, the regulator fluid module is configured to couple with the proximal regulator aperture and includes a regulator enclosure configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when regulator fluid passes through an enclosure opening in the regulator enclosure.

(29) The regulator fluid module can include a fastener configured to couple the regulator enclosure with the proximal regulator aperture. In some instances, the regulator enclosure is not entirely contained within a rigid housing. In certain cases, the fastener includes a bonding member having first and second surfaces coated with adhesive. In some such cases, the bonding member is constructed from a material system comprising resilient material.

(30) In some embodiments, the method of manufacturing a vial adaptor configured to couple with a sealed vial includes providing a pressure regulating vial adaptor module, and providing a regulator fluid module. The pressure regulating vial adaptor module can include a housing apparatus. The housing apparatus can include a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In certain instances, at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus.

(31) The pressure regulating vial adaptor module can include a proximal regulator aperture in fluid communication with the regulator channel. The proximal regulator aperture can be configured to permit ingress or egress of regulator fluid therethrough when the vial adaptor module is coupled

with the sealed vial and fluid is withdrawn from the vial.
(32) In some embodiments, the regulator fluid module includes a regulator enclosure. The regulator enclosure can be configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when regulator fluid passes through an enclosure opening in the regulator enclosure. The regulator fluid module can include a fastener configured to couple the regulator enclosure with the proximal regulator aperture. In some cases, the regulator enclosure is not entirely contained within a rigid housing.
(33) The method can further include aligning the enclosure opening of the regulator enclosure with the proximal regulator aperture of the pressure regulating vial adaptor module. In certain embodiments, the method also includes fastening the regulator fluid module to the pressure regulating vial adaptor module.
(34) In certain instances, the fastener comprises a bonding member having first and second surfaces coated with adhesive. In some such cases, the bonding member is constructed from a material system comprising resilient material. In some cases, the bonding member has a thickness greater than or equal to about 0.01 inches and less than or equal to about 0.03 inches.
(35) In some embodiments, a regulator fluid module is configured to fasten to a pressure regulating vial adaptor module to form a vial adaptor for coupling with a sealed vial. The pressure regulating vial adaptor module can include a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial. In some cases, at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus. In certain instances, the housing apparatus also includes a proximal regulator aperture in fluid communication with the regulator channel. The proximal regulator aperture can be configured to permit ingress or egress of regulator fluid therethrough when the vial adaptor module is coupled with a sealed vial and fluid is withdrawn from the vial.
(36) The regulator fluid module can include a regulator enclosure configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when regulator fluid passes through an enclosure opening in the regulator enclosure.
(37) The regulator fluid module can include a filler within the regulator enclosure. The filler can be configured to supply an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture.
(38) In various embodiments, the regulator fluid module includes a fastener configured to couple the regulator enclosure with the proximal regulator aperture such that the regulator fluid module is permitted to move small distances with respect to the pressure regulating vial adaptor module without causing the fastener to become ripped, torn, or otherwise damaged during routine manipulation of the vial adaptor. In some cases, the regulator enclosure is not entirely contained within a rigid housing. In certain configurations, the fastener substantially airtightly couples the regulator enclosure and the proximal regulator aperture.
(39) In some embodiments, a method of manufacturing a modular adaptor for coupling with and regulating the pressure in a sealed vial includes forming a housing apparatus including a distal access aperture. The distal access aperture can be configured to permit transfer of fluid between a medical device and the sealed vial when the adaptor is coupled to the sealed vial. In some instances, at least a portion of an access channel and at least a portion of a regulator channel pass through the housing apparatus. The regulator channel can be in fluid communication with the sealed vial when the adaptor is coupled to the sealed vial.
(40) The method can include connecting a coupling assembly such that the coupling assembly is in

fluid communication with the regulator channel. The coupling assembly can include a membrane and a cover, which in turn can include an aperture. The coupling assembly can be configured to allow a flow of regulating fluid between the aperture and the regulator channel. In some instances, the flow of regulating fluid passes through the membrane.

(41) In some embodiments, the method includes providing a regulator enclosure configured to be positioned in fluid communication with the aperture, such that the regulator enclosure is configured to move between a first orientation, in which at least a portion of the regulator enclosure is at least partially expanded or unfolded, and a second orientation, in which at least a portion of the regulator enclosure is at least partially unexpanded or folded, when a regulator fluid passes through an opening in the regulator enclosure.

(42) In various cases, the method further includes selecting the regulator enclosure from a variety of sizes of regulator enclosures. In some embodiments, the selection can be based on the volume of the medicinal fluid to be withdrawn from the sealed vial. In some instances, the flow of regulating fluid passes between the aperture and the sealed vial when the medicinal fluid is withdrawn from the sealed vial via the access channel. In certain cases, the aperture is in fluid communication with ambient air prior to the regulator enclosure being positioned in fluid communication with the aperture.

(43) In certain embodiments, a vial adaptor comprises a housing configured to couple the adaptor with a vial, an access channel, a regulator channel, and a regulator assembly. The access channel is configured to facilitate withdrawal of fluid from the vial when the adaptor is coupled to the vial. The regulator channel is configured to facilitate a flow of a regulating fluid from the regulator assembly to compensate for changes in volume of a medical fluid in the vial. In some embodiments, the regulator assembly includes a flexible member configured to expand and contract in accordance with changes in the volume of the medical fluid in the vial. In some embodiments, the flexible member is substantially free to expand and contract. In some embodiments, the flexible member is not partly or completely located in a rigid enclosure. In some embodiments, at least a majority of the flexible member is located in a rigid enclosure. In some embodiments, the regulator assembly includes a filter within the regulator channel. In some embodiments, the regulator assembly includes a check valve which can prevent liquid communication between a filter within the regulator channel and the vial. In some embodiments, the check valve can prevent liquid communication between the vial and a flexible member on the end of the regulator channel.

(44) In some embodiments, a vial adaptor has an axial centerline and is configured to be used in an area with a floor. The vial adaptor can be configured to couple with a sealed vial. The vial adaptor can have a piercing member and an extractor channel, the extractor channel extending between a proximal extractor aperture and a distal extractor aperture and configured to permit withdrawal of fluid from the sealed vial when the vial adaptor is coupled to the sealed vial. In some variants, at least a portion of the extractor channel passes through at least a portion of the piercing member. The vial adaptor can include a regulator channel that extends between a proximal regulator aperture and a distal regulator aperture. In some embodiments, at least a portion of the regulator channel passes through at least a portion of the piercing member.

(45) An occluder valve can be housed in the regulator channel and can be configured to transition between a closed configuration and an opened configuration in response to rotation of the vial adaptor about an axis of rotation between an upright position and an upside down position. In some configurations, the proximal extractor aperture is further from the floor than the distal aperture when the vial adaptor is in the upright position and the proximal extractor aperture is closer to the floor than the distal extractor aperture when the vial adaptor is in the upside down position. Furthermore, the occluder valve can inhibit passage of fluid past the occluder valve toward the proximal regulator aperture when the occluder valve is in the closed configuration. The axis of rotation can be perpendicular to the axial centerline of the vial adaptor and the manner in which the

occluder valve transitions between the closed configuration and the opened configuration can be substantially independent of the axis of rotation about which the vial adaptor is rotated.

(46) In certain cases, the occluder valve transitions to the closed configuration when the vial adaptor is rotated to the upside down position. Furthermore, in some certain cases, the occluder valve transitions to the opened configuration when the vial adaptor is rotated to the upright position. The occluder valve can have a generally cylindrical shape and an axial centerline. In some embodiments, the occluder valve is rotatable about the axial centerline of the occluder valve with respect to the regulator channel.

(47) The vial adaptor can include a valve chamber in fluid communication with the regulator channel, an occluding member within the valve chamber, and a valve seat. In some embodiments, the occluder valve is configured to transition to the closed configuration upon engagement between the occluding member and the valve seat and is configured to transition to the opened configuration upon disengagement of the occluding member from the valve seat. In some cases, the occluding member moves within the valve chamber under the influence of gravity. The occluding member can be a spherical ball, have a cylindrical body with a tapered end, have an ellipsoidal shape, can have a generally cylindrical shape with an axial centerline, or can have some other suitable shape or combination of shapes.

(48) In certain embodiments, the vial adaptor includes a filter. The filter can be positioned in the regulator channel between the occluder valve and the proximal regulator aperture. In some embodiments, the filter is a hydrophobic filter.

(49) In some certain embodiments, a vial adaptor has an axial centerline and is configured to couple with a sealed vial. The vial adaptor can include a piercing member and an extractor channel. At least a portion of the extractor channel can pass through at least a portion of the piercing member. In some embodiments, the vial adaptor includes a regulator channel that can extend between a proximal regulator aperture and a distal regulator aperture, wherein at least a portion of the regulator channel passes through at least a portion of the piercing member.

(50) The vial adaptor can include an occluder valve configured to be installed in at least a portion of the regulator channel via an installation path. The occluder valve can be further configured to transition between a closed configuration and an opened configuration. In some embodiments, the occluder valve includes a valve chamber in fluid communication with the regulator channel. The valve chamber can have an occluding member, a movement path for the occluding member, and a valve seat. In some embodiments, the occluder valve includes a valve channel in fluid communication with the valve chamber and the regulator channel, the valve channel having a flow path. The occluder valve can be configured to transition to the closed configuration when the occluding member is engaged with the valve seat. In some embodiments, the occluder valve is configured to transition to the opened configuration when the occluding member is disengaged from the valve seat. The angle formed between the movement path of the occluding member and the installation path of the occluder valve can be greater than 0° and less than 180°. In some embodiments, the movement path for the occluding member is not substantially parallel to the installation path of the occluder valve.

(51) In some embodiments, the occluding member can be a spherical ball, have a cylindrical shape with one tapered end, have an ellipsoidal shape, or can have any other appropriate shape or combination of shapes. In some embodiments, the angle formed between the movement path of the occluding member and the installation path of the occluder valve is greater than about 45° and less than about 135°. In some embodiments, the angle formed between the movement path and the installation path is about 90°. The angle formed between the movement path and the installation path can be substantially the same as the angle formed between the axial centerline of the vial adaptor and the installation path. In some embodiments, the vial adaptor includes a filter in the regulator channel between the occluder valve and the proximal regulator aperture. The filter can be a hydrophobic filter.

(52) A method of manufacturing a modular vial adaptor configured to couple with a sealed vial can include selecting a connector interface having an axial centerline. The connector interface can have a piercing member and an extractor channel, wherein the extractor channel passes through at least a portion of the piercing member. In some embodiments, the connector interface has a regulator channel extending between a proximal regulator aperture and a distal regulator aperture, wherein at least a portion of the regulator channel passes through at least a portion of the piercing member.
(53) In some embodiments, the method of manufacturing can include coupling a regulator assembly with the proximal regulator aperture of the connector interface. The regulator assembly can include a regulator path configured to be in fluid communication with the regulator channel when the regulator assembly is couple with the connector interface. In some embodiments, the regulator includes an occluder valve installed at least partially within one or more of the regulator channel and the regulator path via an installation path. The occluder valve can be configured to transition between a closed configuration and an opened configuration. In some embodiments, the occluder valve includes a valve chamber in fluid communication with one or more of the regulator channel and the regulator path. The valve chamber can have an occluding member, a movement path for the occluding member, and a valve seat. In some embodiments, the occluder valve can have a valve channel in fluid communication with the valve chamber and one or more of the regulator channel and the regulator path. Furthermore, the valve channel can have a flow path.
(54) The occluder valve can be configured to transition to the closed configuration when the occluding member is engaged with the valve seat. In some embodiments, the occluder valve is configured to transition to the opened configuration when the occluding member is disengaged from the valve seat. An angle formed between the movement path for the occluding member and the installation path of the occluder valve can be greater than 0° and less than 180°.
(55) The method of manufacturing the modular vial adaptor could include installing the occluder valve at least partially into one or more of the regulator channel and the regulator path via an installation path. In some embodiments, the method includes selecting an occluder valve wherein the angle between the movement path in the occluder valve and the installation path of the occluder valve is substantially the same as the angle between the installation path and the axial centerline of the coupling interface. The method can include matching a protrusion of the regulator assembly with the proximal regulator aperture of the connector interface, wherein the protrusion and proximal regulator aperture are keyed. In some embodiments, the method includes matching an alignment feature on the occluder valve with an alignment feature of the regulator channel. Matching the alignment feature of the occluder valve with the alignment feature of the regulator channel can orient the occluder valve such that the movement path is substantially parallel to the axial centerline of the connector interface when the regulator assembly is coupled to the connector interface and the occluder valve is at least partially installed in one or more of the regulator channel and the regulator path.

Description

BRIEF DESCRIPTION
(1) Various embodiments are depicted in the accompanying drawings for illustrative purposes, and should in no way be interpreted as limiting the scope of the embodiments. In addition, various features of different disclosed embodiments can be combined to form additional embodiments, which are part of this disclosure.
(2) FIG. **1** schematically illustrates a system for removing fluid from and/or injecting fluid into a vial.
(3) FIG. **2** schematically illustrates another system for removing fluid from and/or injecting fluid into a vial.

(4) FIG. **2**A schematically illustrates another system for removing fluid from and/or injecting fluid into a vial.
(5) FIG. **3** illustrates another system for removing fluid from and/or injecting fluid into a vial.
(6) FIG. **4** illustrates a perspective view of a vial adaptor and a vial.
(7) FIG. **5** illustrates a partial cross-sectional view of the vial adaptor of FIG. **4**, coupled with a vial, in a high-volume stage.
(8) FIG. **6** illustrates a partial cross-sectional view of the vial adaptor of FIG. **4** coupled with a vial in an expanded stage.
(9) FIG. **7** illustrates an exploded perspective view of a vial adaptor.
(10) FIG. **7**A illustrates an assembled perspective view of the vial adaptor of FIG. **7**, including a partial cross-sectional view taken through line **7**A-**7**A in FIG. **7**.
(11) FIG. **8** illustrates an exploded perspective view of a portion of the vial adaptor of FIG. **7**.
(12) FIG. **9** illustrates an assembled perspective view of the portion of the vial adaptor of FIG. **8**.
(13) FIG. **10** illustrates an exploded perspective view of a base and a cover of a coupling of the vial adaptor of FIG. **7**.
(14) FIG. **11** illustrates a top view of the coupling of FIG. **10**.
(15) FIG. **12** illustrates a cross-sectional view of the coupling of FIG. **11**, taken through line **12-12** in FIG. **11**.
(16) FIG. **13** illustrates a partial cross-sectional view of a vial adaptor coupled with a vial in an initial stage.
(17) FIG. **14** illustrates a partial cross-sectional view of the vial adaptor of FIG. **13** coupled with a vial in an expanded or a higher-volume stage.
(18) FIG. **15** illustrates a partial cross-sectional view of the vial adaptor of FIG. **13** coupled with a vial in a deflated or lower-volume stage.
(19) FIG. **16** illustrates a partial cross-sectional view of a vial adaptor coupled with a vial.
(20) FIG. **17** illustrates a partial cross-sectional view of a vial adaptor coupled with a vial, the adaptor including an internal structure.
(21) FIG. **18** illustrates a partial cross-sectional view of a vial adaptor coupled with a vial, the adaptor including a plurality of regulator assemblies.
(22) FIG. **19** illustrates a partial cross-sectional view of a vial adaptor coupled with a vial, the adaptor including a counterweight.
(23) FIGS. **20**A-**20**F illustrate cross-sectional views of a keyed coupling of the vial adaptor of FIG. **19**, taken through line **20-20** in FIG. **19**.
(24) FIG. **21** illustrates a partial cross-sectional view of a vial adaptor coupled with a vial, the adaptor including a check valve.
(25) FIG. **22** illustrates a partial cross-sectional view of a vial adaptor coupled with a vial, the adaptor including a plurality of check valves.
(26) FIG. **23** illustrates a partial cross-sectional view of a substantially axially centered vial adaptor.
(27) FIG. **24** illustrates a partial cross-sectional view of a vial adaptor coupled with a vial, the adaptor including an annular bag.
(28) FIG. **25**A illustrates a partial cross-sectional view of a reservoir, the reservoir including a bag and a rigid enclosure.
(29) FIG. **25**B illustrates a partial cross-sectional view of another reservoir, the reservoir including a partially-rigid enclosure with a flexible annular ring.
(30) FIG. **25**C illustrates a partial cross-sectional view of another reservoir, the reservoir including a partially-rigid enclosure with a rigid annular ring.
(31) FIG. **25**D illustrates a partial cross-sectional view of another reservoir, the reservoir including a series of rigid and flexible rings.
(32) FIG. **25**E shows a side view of the reservoir shown in FIG. **25**D.
(33) FIG. **26**A illustrates a cross-sectional view of a vial adaptor.

(34) FIG. **26**B illustrates a partial cross-sectional view of a vial adaptor coupled with a vial, the vial adaptor including a valve.
(35) FIG. **26**C illustrates an assembled perspective view of the vial adaptor of FIG. **7**, the vial adaptor including a valve.
(36) FIG. **27**A illustrates a partial cross-sectional view of a portion of an inverted vial adaptor, the vial adaptor including a ball check valve.
(37) FIG. **27**B illustrates a close-up cross-sectional view of the ball check valve of FIG. **27**A.
(38) FIG. **27**C illustrates a perspective cross-sectional view of the ball check valve of FIG. **27**A.
(39) FIG. **28** illustrates a partial cross-sectional view of another vial adaptor, the vial adaptor including a ball check valve.
(40) FIG. **29** illustrates a close-up cross-sectional view of a domed valve.
(41) FIG. **30**A illustrates a close-up cross-sectional view of a showerhead domed valve.
(42) FIG. **30**B illustrates an elevated view of the showerhead domed valve taken through the line B-B in FIG. **30**A.
(43) FIG. **31**A illustrates a close-up cross-sectional view of a flap check valve.
(44) FIG. **31**B illustrates a perspective cross-sectional view of the flap check valve of FIG. **31**A.
(45) FIG. **32** illustrates a close-up cross-sectional view of a ball check valve in the piercing member of an adaptor.

DETAILED DESCRIPTION

(46) Although certain embodiments and examples are disclosed herein, inventive subject matter extends beyond the examples in the specifically disclosed embodiments to other alternative embodiments and/or uses, and to modifications and equivalents thereof. Thus, the scope of the claims appended hereto is not limited by any of the particular embodiments described below. For example, in any method or process disclosed herein, the acts or operations of the method or process may be performed in any suitable sequence and are not necessarily limited to any particular disclosed sequence. Various operations may be described as multiple discrete operations in turn, in a manner that may be helpful in understanding certain embodiments; however, the order of description should not be construed to imply that these operations are order dependent. Additionally, the structures, systems, and/or devices described herein may be embodied as integrated components or as separate components. For purposes of comparing various embodiments, certain aspects and advantages of these embodiments are described. Not necessarily all such aspects or advantages are achieved by any particular embodiment. Thus, for example, various embodiments may be carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other aspects or advantages as may also be taught or suggested herein.
(47) The drawing showing certain embodiments can be semi-diagrammatic and not to scale and, particularly, some of the dimensions are for the clarity of presentation and are shown greatly exaggerated in the drawings.
(48) For expository purposes, the term “horizontal” as used herein is defined as a plane parallel to the plane or surface of the floor of the area in which the device being described is used or the method being described is performed, regardless of its orientation. The term “floor” floor can be interchanged with the term “ground.” The term “vertical” refers to a direction perpendicular to the horizontal as just defined. Terms such as “above,” “below,” “bottom,” “top,” “side,” “higher,” “lower,” “upper,” “over,” and “under,” are defined with respect to the horizontal plane.
(49) Numerous medicines and other therapeutic fluids are stored and distributed in medicinal vials or other containers of various shapes and sizes. These vials are hermetically sealed to prevent contamination or leaking of the stored fluid. The pressure differences between the interior of the sealed vials and the particular atmospheric pressure in which the fluid is later removed often give rise to various problems, as well as the release of potentially harmful vapors.
(50) For instance, introducing a piercing member of a vial adaptor through the septum of a vial can

cause the pressure within the vial to rise. This pressure increase can cause fluid to leak from the vial at the interface of the septum and piercing member or at the attachment interface of the adaptor and a medical device, such as a syringe. Also, it can be difficult to withdraw an accurate amount of fluid from a sealed vial using an empty syringe, or other medical instrument, because the fluid may be naturally urged back into the vial once the syringe plunger is released. Furthermore, as the syringe is decoupled from the vial, pressure differences can often cause an amount of fluid to spurt from the syringe or the vial.

(51) Moreover, in some instances, introducing a fluid into the vial can cause the pressure to rise in the vial. For example, in certain cases it can be desirable to introduce a solvent (such as sterile saline) into the vial, e.g., to reconstitute a lyophilized pharmaceutical in the vial. Such introduction of fluid into the vial can cause the pressure in the vial to rise above the pressure of the surrounding environment, which can result in fluid leaking from the vial at the interface of the septum and piercing member or at the attachment interface of the adaptor and a medical device, such as a syringe. Further, the increased pressure in the vial can make it difficult to introduce an accurate amount of the fluid into the vial with a syringe, or other medical instrument. Also, should the syringe be decoupled from the vial when the pressure inside the vial is greater than the surrounding pressure (e.g., atmospheric), the pressure gradient can cause a portion of the fluid to spurt from the vial.

(52) Additionally, in many instances, air bubbles are drawn into the syringe as fluid is withdrawn from the vial. Such bubbles are generally undesirable as they could result in an embolus if injected into a patient. To rid a syringe of bubbles after removal from the vial, medical professionals often flick the syringe, gathering all bubbles near the opening of the syringe, and then forcing the bubbles out. In so doing, a small amount of liquid is usually expelled from the syringe as well. Medical personnel generally do not take the extra step to re-couple the syringe with the vial before expelling the bubbles and fluid. In some instances, this may even be prohibited by laws and regulations. Such laws and regulations may also necessitate expelling overdrawn fluid at some location outside of the vial in certain cases. Moreover, even if extra air or fluid were attempted to be reinserted in the vial, pressure differences can sometimes lead to inaccurate measurements of withdrawn fluid.

(53) To address these problems caused by pressure differentials, medical professionals frequently pre-fill an empty syringe with a precise volume of ambient air corresponding to the volume of fluid that they intend to withdraw from the vial. The medical professionals then pierce the vial and expel this ambient air into the vial, temporarily increasing the pressure within the vial. When the desired volume of fluid is later withdrawn, the pressure differential between the interior of the syringe and the interior of the vial is generally near equilibrium. Small adjustments of the fluid volume within the syringe can then be made to remove air bubbles without resulting in a demonstrable pressure differential between the vial and the syringe. However, a significant disadvantage to this approach is that ambient air, especially in a hospital setting, may contain various airborne viruses, bacteria, dust, spores, molds, and other unsanitary and harmful contaminants. The pre-filled ambient air in the syringe may contain one or more of these harmful substances, which may then mix with the medicine or other therapeutic fluid in the vial. If this contaminated fluid is injected directly into a patient's bloodstream, it can be particularly dangerous because it circumvents many of the body's natural defenses to airborne pathogens. Moreover, patients who need the medicine and other therapeutic fluids are more likely to be suffering from a diminished infection-fighting capacity.

(54) In the context of oncology and certain other drugs, all of the foregoing problems can be especially serious. Such drugs, although helpful when injected into the bloodstream of a patient, can be extremely harmful if inhaled or touched. Accordingly, such drugs can be dangerous if allowed to spurt unpredictably from a vial due to pressure differences. Furthermore, these drugs are often volatile and may instantly aerosolize when exposed to ambient air. Accordingly, expelling a small amount of such drugs in order to clear a syringe of bubbles or excess fluid, even in a controlled manner, is generally not a viable option, especially for medical personnel who may

repeat such activities numerous times each day.
(55) Some devices use rigid enclosures for enclosing all or a portion of a volume-changing component or region for assisting in regulating pressure within a container. Although such enclosures can provide rigidity, they generally make the devices bulky and unbalanced. Coupling such a device with a vial generally can create a top-heavy, unstable system that is prone to tipping-over and possibly spilling the contents of the device and/or the vial.
(56) Indeed, certain of such coupling devices include relatively large and/or heavy, rigid components that are cantilevered or otherwise disposed a distance from of the axial center of the device, thereby exacerbating the tendency for the device to tip-over.
(57) Additionally, such rigid enclosures can increase the size of the device, which can require an increase in material to form the device and otherwise increase costs associated manufacturing, transporting, and/or storing the device. Further, such rigid enclosures can hamper the ability of the device to expand or contract to deliver a regulating fluid to the vial. No feature, structure, or step disclosed herein is essential or indispensible.
(58) FIG. **1** is a schematic illustration of a container **10**, such as a medicinal vial, that can be coupled with an accessor **20** and a regulator **30**. In certain arrangements, the regulator **30** allows the removal of some or all of the contents of the container **10** via the accessor **20** without a significant change of pressure within the container **10**.
(59) In general, the container **10** is hermetically sealed to preserve the contents of the container **10** in a sterile environment. The container **10** can be evacuated or pressurized upon sealing. In some instances, the container **10** is partially or completely filled with a liquid, such as a drug or other medical fluid. In such instances, one or more gases can also be sealed in the container **10**. In some instances, a solid or powdered substance, such as a lyophilized pharmaceutical, is disposed in the container **10**.
(60) The accessor **20** generally provides access to contents of the container **10** such that the contents may be removed or added to. In certain arrangements, the accessor **20** includes an opening between the interior and exterior of the container **10**. The accessor **20** can further comprise a passageway between the interior and exterior of the container **10**. In some configurations, the passageway of the accessor **20** can be selectively opened and closed. In some arrangements, the accessor **20** comprises a conduit extending through a surface of the container **10**. The accessor **20** can be integrally formed with the container **10** prior to the sealing thereof or introduced to the container **10** after the container **10** has been sealed.
(61) In some configurations, the accessor **20** is in fluid communication with the container **10**, as indicated by an arrow **21**. In certain of these configurations, when the pressure inside the container **10** varies from that of the surrounding environment, the introduction of the accessor **20** to the container **10** causes a transfer through the accessor **20**. For example, in some arrangements, the pressure of the environment that surrounds the container **10** exceeds the pressure within the container **10**, which may cause ambient air from the environment to ingress through the accessor **20** upon insertion of the accessor **20** into the container **10**. In other arrangements, the pressure inside the container **10** exceeds that of the surrounding environment, causing the contents of the container **10** to egress through the accessor **20**.
(62) In some configurations, the accessor **20** is coupled with an exchange device **40**. In certain instances, the accessor **20** and the exchange device **40** are separable. In some instances, the accessor **20** and the exchange device **40** are integrally formed. The exchange device **40** is configured to accept fluids and/or gases from the container **10** via the accessor **20**, to introduce fluids and/or gases to the container **10** via the accessor **20**, or to do some combination of the two. In some arrangements, the exchange device **40** is in fluid communication with the accessor **20**, as indicated by an arrow **24**. In certain configurations, the exchange device **40** comprises a medical instrument, such as a syringe.
(63) In some instances, the exchange device **40** is configured to remove some or all of the contents

of the container **10** via the accessor **20**. In certain arrangements, the exchange device **40** can remove the contents independent of pressure differences, or lack thereof, between the interior of the container **10** and the surrounding environment. For example, in instances where the pressure outside of the container **10** exceeds that within the container **10**, an exchange device **40** comprising a syringe can remove the contents of the container **10** if sufficient force is exerted to extract the plunger from the syringe. The exchange device **40** can similarly introduce fluids and/or gases to the container **10** independent of pressure differences between the interior of the container **10** and the surrounding environment.

(64) In certain configurations, the regulator **30** is coupled with the container **10**. The regulator **30** generally regulates the pressure within the container **10**. As used herein, the term “regulate,” or any derivative thereof, is a broad term used in its ordinary sense and includes, unless otherwise noted, any active, affirmative, or positive activity, or any passive, reactive, respondent, accommodating, or compensating activity that tends to effect a change. In some instances, the regulator **30** substantially maintains a pressure difference, or equilibrium, between the interior of the container **10** and the surrounding environment. As used herein, the term “maintain,” or any derivative thereof, is a broad term used in its ordinary sense and includes the tendency to preserve an original condition for some period, with some small degree of variation permitted as may be appropriate in the circumstances. In some instances, the regulator **30** maintains a substantially constant pressure within the container **10**. In certain instances, the pressure within the container **10** varies by no more than about 1 psi, no more than about 2 psi, no more than about 3 psi, no more than about 4 psi, or no more than about 5 psi. In still further instances, the regulator **30** equalizes pressures exerted on the contents of the container **10**. As used herein, the term “equalize,” or any derivative thereof, is a broad term used in its ordinary sense and includes the tendency for causing quantities to be the same or close to the same, with some small degree of variation permitted as may be appropriate in the circumstances. In certain configurations, the regulator **30** is coupled with the container **10** to allow or encourage equalization of a pressure difference between the interior of the container **10** and some other environment, such as the environment surrounding the container **10** or an environment within the exchange device **40**. In some arrangements, a single device comprises the regulator **30** and the accessor **20**. In other arrangements, the regulator **30** and the accessor **20** are separate units.

(65) The regulator **30** is generally in communication with the container **10**, as indicated by an arrow **31**, and a reservoir **50**, as indicated by another arrow **35**. In some configurations, the reservoir **50** comprises at least a portion of the environment surrounding the container **10**. In certain configurations, the reservoir **50** comprises a container, canister, bag, or other holder dedicated to the regulator **30**. As used herein, the term “bag,” or any derivative thereof, is a broad term used in its ordinary sense and includes, for example, any sack, balloon, bladder, receptacle, enclosure, diaphragm, or membrane capable of expanding and/or contracting, including structures comprising a flexible, supple, pliable, resilient, elastic, and/or expandable material. In some embodiments, the reservoir **50** includes a gas and/or a liquid. As used herein, the term “flexible,” or any derivative thereof, is a broad term used in its ordinary sense and describes, for example, the ability of a component to bend, expand, contract, fold, unfold, or otherwise substantially deform or change shape when fluid is flowing into or out of the container **10** (e.g., via the accessor **20**). Also, as used herein, the term “rigid,” or any derivative thereof, is a broad term used in its ordinary sense and describes, for example, the ability of a component to generally avoid substantial deformation under normal usage when fluid is flowing into or out of the container **10** (e.g., via the accessor **20**).

(66) In certain embodiments, the regulator **30** provides fluid communication between the container **10** and the reservoir **50**. In certain of such embodiments, the fluid in the reservoir **50** includes mainly gas so as not to appreciably dilute liquid contents of the container **10**. In some arrangements, the regulator **30** comprises a filter to purify or remove contaminants from the gas or liquid entering the container **10**, thereby reducing the risk of contaminating the contents of the

container **10**. In certain arrangements, the filter is hydrophobic such that air can enter the container **10** but fluid cannot escape therefrom. In some configurations, the regulator **30** comprises an orientation-actuated or orientation-sensitive check valve which selectively inhibits fluid communication between the container **10** and the filter. In some configurations, the regulator **30** comprises a check valve which selectively inhibits fluid communication between the container **10** and the filter when the valve and/or the container **10** are oriented so that the regulator **30** is held above (e.g., further from the floor than) the regulator **30**.
(67) In some embodiments, the regulator **30** prevents fluid communication between the container **10** and the reservoir **50**. In certain of such embodiments, the regulator **30** serves as an interface between the container **10** and the reservoir **50**. In some arrangements, the regulator **30** comprises a substantially impervious bag for accommodating ingress of gas and/or liquid to the container **10** or egress of gas and/or liquid from the container **10**.
(68) As schematically illustrated in FIG. **2**, in certain embodiments, the accessor **20**, or some portion thereof, is located within the container **10**. As detailed above, the accessor **20** can be integrally formed with the container **10** or separate therefrom. In some embodiments, the regulator **30**, or some portion thereof, is located outside the container **10**. In some arrangements, the regulator **30** is integrally formed with the container **10**. It is possible to have any combination of the accessor **20**, or some portion thereof, entirely within, partially within, or outside of the container **10** and/or the regulator **30**, or some portion thereof, entirely within, partially within, or outside of the container **10**.
(69) In certain embodiments, the accessor **20** is in fluid communication with the container **10**. In further embodiments, the accessor **20** is in fluid communication with the exchange device **40**, as indicated by the arrow **24**.
(70) The regulator **30** can be in fluid or non-fluid communication with the container **10**. In some embodiments, the regulator **30** is located entirely outside the container **10**. In certain of such embodiments, the regulator **30** comprises a closed bag configured to expand or contract external to the container **10** to maintain a substantially constant pressure within the container **10**. In some embodiments, the regulator **30** is in communication, either fluid or non-fluid, with the reservoir **50**, as indicated by the arrow **35**.
(71) As schematically illustrated in FIG. **2**A, in certain embodiments, the accessor **20**, or some portion thereof, can be located within the container **10**. In some embodiments, the accessor **20**, or some portion thereof, can be located outside the container **10**. In some embodiments, a valve **25**, or some portion thereof, can be located outside the container **10**. In some embodiments, the valve **25**, or some portion thereof, can be located within the container **10**. In some embodiments, the regulator **30** is located entirely outside the container **10**. In some embodiments, the regulator **30**, or some portion thereof, can be located within the container **10**. It is possible to have any combination of the accessor **20**, or some portion thereof, entirely within, partially within, or outside of the container **10** and/or the valve **25**, or some portion thereof, entirely within, partially within, or outside of the container **10**. It is also possible to have any combination of the accessor **20**, or some portion thereof, entirely within, partially within, or outside of the container **10** and/or the regulator **30**, or some portion thereof, entirely within, partially within, or outside of the container **10**.
(72) The accessor **20** can be in fluid communication with the container **10**, as indicated by the arrow **21**. In some embodiments, the accessor **20** can be in fluid communication with the exchange device **40**, as indicated by the arrow **24**.
(73) In certain embodiments, the regulator **30** can be in fluid or non-fluid communication with a valve **25**, as indicated by the arrow **32**. In some embodiments, the valve **25** can be integrally formed with the container **10** or separate therefrom. In some embodiments, the valve **25** can be integrally formed with the regulator **30** or separate therefrom. In certain embodiments, the valve **25** can be in fluid or non-fluid communication with the container **10**, as indicated by the arrow **33**.
(74) In some embodiments the regulator **30** can be in fluid or non-fluid communication with the

ambient surroundings, as indicated by the arrow **35**A. In some embodiments, the regulator **30** can be in fluid or non-fluid communication with a reservoir **50**, as indicated by the arrow **35**B. In some embodiments, the reservoir **50** can comprise a bag or other flexible enclosure. In some embodiments, the reservoir **50** comprises a rigid container surrounding a flexible enclosure. In some embodiments, the reservoir **50** comprises a partially-rigid enclosure.

(75) According to some configurations, the regulator **30** can comprise a filter. In some embodiments, the filter can selectively inhibit passage of liquids and/or contaminants between the valve **25** and the reservoir **50** or the ambient surroundings. In some embodiments, the filter can selectively inhibit passage of liquids and/or contaminants between the reservoir **50** or ambient surroundings and the valve **25**.

(76) In some embodiments, the valve **25** can be a one-way check valve. In some embodiments, the valve **25** can be a two-way valve. According to some configurations, the valve **25** can selectively inhibit liquid communication between the filter and/or reservoir **50** and the container **10**. In some embodiments, the valve **25** can selectively inhibit liquid communication between the container **10** and the filter and/or reservoir **50** when the container **10** is oriented above the exchange device **40**. FIG. **3** illustrates an embodiment of a system **100** comprising a vial **110**, an accessor **120**, and a regulator **130**. The vial **110** comprises a body **112** and a cap **114**. In the illustrated embodiment, the vial **110** contains a medical fluid **116** and a relatively small amount of sterilized air **118**. In certain arrangements, the fluid **116** is removed from the vial **110** when the vial **110** is oriented with the cap **114** facing downward (e.g., the cap **114** is between the fluid and the floor). The accessor **120** comprises a conduit **122** fluidly connected at one end to an exchange device **140**, such as a standard syringe **142** with a plunger **144**. The conduit **122** extends through the cap **114** and into the fluid **116**. The regulator **130** comprises a bag **132** and a conduit **134**. The bag **132** and the conduit **134** are in fluid communication with a reservoir **150**, which comprises an amount of cleaned and/or sterilized air. The outside surface of the bag **132** is generally in contact with the ambient air surrounding both the system **100** and the exchange device **140**. The bag **132** comprises a substantially impervious material such that the fluid **116**, the air **118** inside the vial **110**, and the reservoir **150** do not contact the ambient air.

(77) In the illustrated embodiment, areas outside of the vial **110** are at atmospheric pressure. Accordingly, the pressure on the syringe plunger **144** is equal to the pressure on the interior of the bag **132**, and the system **100** is in general equilibrium. The plunger **144** can be withdrawn to fill a portion of the syringe **142** with the fluid **116**. Withdrawing the plunger **144** increases the effective volume of the vial **110**, thereby decreasing the pressure within the vial **110**. Such a decrease of pressure within the vial **110** increases the difference in pressure between the vial **110** and the syringe **142**, which causes the fluid **116** to flow into the syringe **142** and the reservoir **150** to flow into the vial **110**. Additionally, the decrease of pressure within the vial **110** increases the difference in pressure between the interior and exterior of the bag **132**, which causes the bag **132** to decrease in internal volume or contract, which in turn encourages an amount of regulatory fluid through the conduit **134** and into the vial **110**. In effect, the bag **132** contracts outside the vial **110** to a new volume that compensates for the volume of the fluid **116** withdrawn from the vial **110**. Thus, once the plunger **144** ceases from being withdrawn from the vial **110**, the system is again in equilibrium. As the system **100** operates near equilibrium, withdrawal of the fluid **116** can be facilitated. Furthermore, due to the equilibrium of the system **100**, the plunger **144** remains at the position to which it has been withdrawn, thereby allowing removal of an accurate amount of the fluid **116** from the vial **110**.

(78) In certain arrangements, the decreased volume of the bag **132** is approximately equal to the volume of liquid removed from the vial **110**. In some arrangements, the volume of the bag **132** decreases at a slower rate as greater amounts of fluid are withdrawn from the vial **110** such that the volume of fluid withdrawn from the vial **110** is greater than the decreased volume of the bag **132**.

(79) In some arrangements, the bag **132** can be substantially and/or completely deflated, such that

there is substantially no volume inside the bag **132**. In some instances, such deflation of the bag **132** effectively creates a difference in pressure between the inside of the bag **132** and the inside of the vial **110**. For example, a vacuum (relative to ambient) inside the vial **110** can be created when the bag **132** is deflated. In some instances, such deflation of the bag **132** creates substantially no restoring force that tends to create a pressure differential between the inside of the bag **132** and the inside of the vial **110**, such as when the bag **132** is generally non-resilient.

(80) In certain embodiments, the syringe **142** comprises fluid contents **143**. A portion of the fluid contents **143** can be introduced into the vial **110** by depressing (e.g., toward the vial) the plunger **144**, which can be desirable in certain instances. For example, in some instances, it is desirable to introduce a solvent and/or compounding fluid into the vial **110**. In certain instances, more of the fluid **116** than desired initially might be withdrawn inadvertently. In some instances, some of the air **118** in the vial **110** initially might be withdrawn, creating unwanted bubbles within the syringe **142**. It may thus be desirable to inject some of the withdrawn fluid **116** and/or air **118** back into the vial **110**.

(81) Depressing the plunger **144** encourages the fluid contents **143** of the syringe into the vial **110**, which decreases the effective volume of the vial **110**, thereby increasing the pressure within the vial **110**. An increase of pressure within the vial **110** increases the difference in pressure between the exterior and interior of the bag **132**, which causes the air **118** to flow into the bag **132**, which in turn causes the bag **132** to expand. In effect, the bag **132** expands or increases to a new volume that compensates for the volume of the contents **143** of the syringe **142** introduced into the vial **110**. Thus, once the plunger **144** ceases from being depressed, the system is again in equilibrium. As the system **100** operates near equilibrium, introduction of the contents **143** can be facilitated. Moreover, due to the equilibrium of the system **100**, the plunger **144** generally remains at the position to which it is depressed, thereby allowing introduction of an accurate amount of the contents **143** of the syringe **142** into the vial **110**.

(82) In certain arrangements, the increased volume of the bag **132** is approximately equal to the volume of air **118** removed from the vial **110**. In some arrangements, the volume of the bag **132** increases at a slower rate as greater amounts of the contents **143** are introduced into the vial **110**, such that the volume of the contents **143** introduced into the vial **110** is greater than the increased volume of the bag **132**.

(83) In some arrangements, the bag **132** can stretch to expand beyond a resting volume. In some instances, the stretching gives rise to a restorative force that effectively creates a difference in pressure between the inside of the bag **132** and the inside of the vial **110**. For example, a slight overpressure (relative to ambient) inside the vial **110** can be created when the bag **132** is stretched.

(84) FIG. **4** illustrates an embodiment of a vial adaptor **200** for coupling with a vial **210**. The vial **210** can comprise any suitable container for storing medical fluids. In some instances, the vial **210** comprises any of a number of standard medical vials known in the art, such as those produced by Abbott Laboratories of Abbott Park, Illinois. In some embodiments, the vial **210** is capable of being hermetically sealed. In some configurations, the vial **210** comprises a body **212** and a cap **214**. The body **212** preferably comprises a rigid, substantially impervious material, such as plastic or glass. In some embodiments, the cap **214** comprises a septum **216** and a casing **218**. The septum **216** can comprise an elastomeric material capable of deforming in such a way when punctured by an item that it forms a substantially airtight seal around that item. For example, in some instances, the septum **216** comprises silicone rubber or butyl rubber. The casing **218** can comprise any suitable material for sealing the vial **210**. In some instances, the casing **218** comprises metal that is crimped around the septum **216** and a portion of the body **212** in order to form a substantially airtight seal between the septum **216** and the vial **210**. In certain embodiments, the cap **214** defines a ridge **219** that extends outwardly from the top of the body **212**.

(85) In certain embodiments, the adaptor **200** comprises an axial centerline A and a piercing member **220** having a proximal end **221** (see FIG. **5**) and a distal end **223**. As used herein the term,

"proximal," or any derivative thereof, refers to a direction along the axial length of the piercing member **220** that is toward the cap **214** when the piercing member **220** is inserted in the vial **210**; the term "distal," or any derivative thereof, indicates the opposite direction. In some configurations, the piercing member **220** comprises a sheath **222**. The sheath **222** can be substantially cylindrical, as shown, or it can assume other geometric configurations. In some instances, the sheath **222** tapers toward the distal end **223**. In some arrangements, the distal end **223** defines a point that can be centered with respect to the axial centerline A or offset therefrom. In certain embodiments, the distal end **223** is angled from one side of the sheath **222** to the opposite side. The sheath **222** can comprise a rigid material, such as metal or plastic, suitable for insertion through the septum **216**. In certain embodiments the sheath **222** comprises polycarbonate plastic.

(86) In some configurations, the piercing member **220** comprises a tip **224**. The tip **224** can have a variety of shapes and configurations. In some instances, the tip **224** is configured to facilitate insertion of the sheath **222** through the septum **216** via an insertion axis. In some embodiments, the insertion axis corresponds to the direction in which the force required to couple the adaptor **200** with the vial **210** is applied when coupling the adaptor **200** with the vial **210**. The insertion axis can be substantially perpendicular to a plane in which the cap **214** lies. In some embodiments, as illustrated in FIG. **4**, the insertion axis is substantially parallel to the axial centerline A of the adaptor **200**. Furthermore, in some embodiments, the insertion axis is substantially parallel to the piercing member **220**. As illustrated, the tip **224**, or a portion thereof, can be substantially conical, coming to a point at or near the axial center of the piercing member **220**. In some configurations, the tip **224** angles from one side of the piercing member **220** to the other. In some instances, the tip **224** is separable from the sheath **222**. In other instances, the tip **224** and the sheath **222** are permanently joined, and can be unitarily formed. In various embodiments, the tip **224** comprises acrylic plastic, ABS plastic, or polycarbonate plastic.

(87) In some embodiments, the adaptor **200** comprises a cap connector **230**. As illustrated, the cap connector **230** can substantially conform to the shape of the cap **214**. In certain configurations, the cap connector **230** comprises a rigid material, such as plastic or metal, that substantially maintains its shape after minor deformations. In some embodiments, the cap connector **230** comprises polycarbonate plastic. In some arrangements, the cap connector **230** comprises a sleeve **235** configured to snap over the ridge **219** and tightly engage the cap **214**. As more fully described below, in some instances, the cap connector **230** comprises a material around an interior surface of the sleeve **235** for forming a substantially airtight seal with the cap **214**. The cap connector **230** can be or can include adhesive tape, as known to those of skill in the art. In some embodiments, the cap connector **230** comprises an elastic material that is stretched over the ridge **219** to form a seal around the cap **214**. In some embodiments, the cap connector **230** resembles or is identical to the structures shown in FIGS. **6** and **7** of and described in the specification of U.S. Pat. No. 5,685,866, the entire contents of which are hereby incorporated by reference herein and are made a part of this specification.

(88) In certain embodiments, the adaptor **200** comprises a connector interface **240** for coupling the adaptor **200** with a medical connector **241**, another medical device (not shown), or any other instrument used in extracting fluid from or injecting fluid into the vial **210**. In certain embodiments, the connector interface **240** comprises a sidewall **248** that defines a proximal portion of an access channel **245** through which fluid may flow. In some instances, the access channel **245** extends through the cap connector **230** and through a portion of the piercing member **220** such that the connector interface **240** is in fluid communication with the piercing member **220**. The sidewall **248** can assume any suitable configuration for coupling with the medical connector **241**, a medical device, or another instrument. In the illustrated embodiment, the sidewall **248** is substantially cylindrical and extends generally proximally from the cap connector **230**.

(89) In certain configurations, the connector interface **240** comprises a flange **247** to aid in coupling the adaptor **200** with the medical connector **241**, a medical device, or another instrument. The

flange **247** can be configured to accept any suitable medical connector **241**, including connectors capable of sealing upon removal of a medical device therefrom. In some instances, the flange **247** is sized and configured to accept the Clave® connector, available from ICU Medical, Inc. of San Clemente, California. Certain features of the Clave® connector are disclosed in U.S. Pat. No. 5,685,866, the entire contents of which are incorporated by reference herein. Connectors of many other varieties, including other needle-less connectors, can also be used. The connector **241** can be permanently or separably attached to the connector interface **240**. In other arrangements, the flange **247** is threaded, configured to accept a Luer connector, or otherwise shaped to attach directly to a medical device, such as a syringe, or to other instruments.

(90) In certain embodiments, the connector interface **240** is generally centered on the axial center of the adaptor **200**. Such a configuration provides vertical stability to a system comprising the adaptor **200** coupled with the vial **210**, thereby making the coupled system less likely to tip-over. Accordingly, the adaptor **200** is less likely to cause leaks, or spills, or disorganization of supplies occasioned by accidental bumping or tipping of the adaptor **200** or the vial **210**.

(91) In some embodiments, the piercing member **220**, the cap connector **230**, and the connector interface **240** are integrally formed of a unitary piece of material, such as polycarbonate plastic. In other embodiments, one or more of the piercing member **220**, the cap connector **230**, and the connector interface **240** comprise a separate piece. The separate pieces can be joined in any suitable manner, such as by glue, epoxy, ultrasonic welding, etc. Connections between joined pieces can create substantially airtight bonds between the pieces. In some arrangements, any of the piercing member **220**, the cap connector **230**, or the connector interface **240** can comprise more than one piece. Details and examples of some embodiments of piercing members **220**, cap connectors **230**, and connector interfaces **240** are provided in U.S. Pat. No. 7,547,300 and U.S. Patent Application Publication No. 2010/0049157, the entirety of each of which is incorporated herein by reference.

(92) In certain embodiments, the adaptor **200** comprises a regulator channel **225**, which extends through the connector interface **240** and/or the cap connector **230**, and through the piercing member **220** (see, e.g., FIG. **5**). In the illustrated embodiment, the regulator channel **225** passes through a lumen **226** that extends radially outward from the connector interface **240**. In some embodiments, the channel **225** is formed as a part of the cap connector **230**. In certain embodiments, the regulator channel **225** terminates in a regulator aperture **228**.

(93) In some embodiments, the adaptor **200** includes a regulator assembly **250**. In certain embodiments, the regulator assembly **250** comprises a coupling **252**. The coupling **252** can be configured to connect the regulator assembly **250** with the remainder of the adaptor **200**. For example, the coupling **252** can connect with the lumen **226** in substantially airtight engagement, thereby placing the coupling **252** in fluid communication with the regulator channel **225**. In some instances, the coupling **252** and the lumen **226** engage with a slip or interference fit. In certain embodiments, the coupling **252** and the lumen **226** comprise complimentary threads, such that the coupling **252** can be threadably connected with the lumen **226**. In some embodiments, the coupling **252** includes a passage **253** that extends through the coupling **252**.

(94) In the illustrated embodiment, the regulator assembly comprises a bag **254** with an interior chamber **255**. The bag **254** is generally configured to stretch, flex, unfold, or otherwise expand and contract or cause a change in interior volume. In some cases, the bag **254** includes one or more folds, pleats, or the like. In certain arrangements, the interior chamber **255** of the bag **254** is in fluid communication with the regulator channel **225**, thereby allowing fluid to pass from the regulator channel **225** into the interior chamber **255** and/or from the interior chamber **255** into the regulator channel **225**. In some arrangements, the interior chamber **255** is in fluid communication with the passage **253** of the coupling **252**.

(95) In certain embodiments, the regulator assembly **250** comprises a filler **256**, which can be located in the inner chamber **255** of the bag **254**. As used herein, the term “filler,” or any derivative thereof, is a broad term used in its ordinary sense and includes, for example, any support, stuffing,

spacing, wadding, padding, lining, enclosure, reservoir, or other structure configured to inhibit or prevent the bag **254** from fully deflating at ambient pressure, or a combination of structures. In certain configurations, the filler **256** occupies substantially the entire volume of the entire inner chamber **255**. In other arrangements, the filler **256** occupies only a portion of the volume of the inner chamber **255**. In some configurations, the filler **256** comprises a network of woven or non-woven fibers. In some embodiments, the filler **256** is porous, such that regulating fluid (e.g., air) in the inner chamber **255** can enter a network or plurality of hollows within the filler **256**. For example, in some cases, the filler **256** is a sponge-like material. In certain configurations, the filler **256** is configured to be compressed by the bag **254**, without causing damage to the bag **254**. In some embodiments the filler **256** has a lower durometer than the bag **254**.

(96) As illustrated, the filler **256** can be positioned in the bag **254**. In certain embodiments, the filler **256** is positioned at about the radial center in the bag **254**. In other instances, the position of the filler **256** is offset with respect to the center of the bag **254**. In some embodiments, the position of the filler **256** changes relative to the bag **254**. For example, in some embodiments, the filler **256** moves (e.g., by force of gravity) relative to the bag **254** when the bag **254** changes volume, such as when the bag **254** expands. Such a configuration can, for example, enhance the ability of the bag **254** to expand and can decrease the likelihood of the bag **254** becoming snagged on or bound-up by the filler **256**.

(97) In other embodiments, the position of the filler **256** is substantially constant with respect to the bag **254** and/or a coupling **252**. In some such embodiments, the filler **256** moves substantially in unison with the bag **254**. For example, the filler **256** can be configured to expand and contract at substantially the same rate as the bag **254**. In certain embodiments, the filler **256** is bonded with the bag **254**. In some such cases, the filler **256** is adhered or at least partially adhered to at least a portion of the bag **254**. In some cases, at least a portion of the filler **256** is formed as a part of the bag **254**. In certain embodiments, at least a portion of the filler **256** is maintained in position by one or more flexible legs that abut an inner surface of the bag **254**. In some configurations, at least a portion of the filler **256** is maintained in position by one or more beams that connect with the coupling **252**. In certain arrangements, at least a portion of the filler **256** is joined with the coupling **252**.

(98) FIGS. **5** and **6** illustrate cross-sections of the vial adaptor **200** coupled with the vial **210**. FIG. **5** illustrates a non-fully expanded condition and FIG. **6** illustrates a fully-expanded condition. In the illustrated embodiment, the cap connector **230** firmly secures the adaptor **200** to the cap **214** and the piercing member **220** extends through the septum **216** into the interior of the vial **210**. Additionally, the regulator assembly **250** is engaged with the connector interface **240** such that the inner chamber **255** of the bag **254** is in fluid communication with the regulator channel **255** through the coupling **252**. In some embodiments, the piercing member **220** is oriented substantially perpendicularly with respect to the cap **214** when the adaptor **200** and the vial **210** are coupled. Other configurations are also contemplated.

(99) In certain embodiments, the cap connector **230** comprises one or more projections **237** that aid in securing the adaptor **200** to the vial **210**. The one or more projections **237** extend toward an axial center of the cap connector **230**. In some configurations, the one or more projections **237** comprise a single circular flange extending around the interior of the cap connector **230**. The cap connector **230** can be sized and configured such that an upper surface of the one or more projections **237** abuts a lower surface of the ridge **219**, helping secure the adaptor **200** in place.

(100) The one or more projections **237** can be rounded, chamfered, or otherwise shaped to facilitate the coupling of the adaptor **200** and the vial **210**. For example, as the adaptor **200** having rounded projections **237** is introduced to the vial **210**, a lower surface of the rounded projections **237** abuts a top surface of the cap **214**. As the adaptor **200** is advanced onto the vial **210**, the rounded surfaces cause the cap connector **230** to expand radially outward. As the adaptor **200** is advanced further onto the vial **210**, a resilient force of the deformed cap connector **220** seats the one or more

projections **237** under the ridge **219**, securing the adaptor **200** in place.

(101) In some embodiments, the cap connector **230** is sized and configured such that an inner surface **238** of the cap connector **230** contacts the cap **214**. In some embodiments, a portion of the cap connector **230** contacts the cap **214** in substantially airtight engagement. In certain embodiments, a portion of the inner surface **238** surrounding either the septum **216** or the casing **218** is lined with a material, such as rubber or plastic, to ensure the formation of a substantially airtight seal between the adaptor **200** and the vial **210**.

(102) In the embodiment illustrated, the piercing member **220** comprises the sheath **222** and the tip **224**. The sheath **222** is generally sized and dimensioned to be inserted through the septum **216** without breaking and, in some instances, with relative ease. Accordingly, in various embodiments, the sheath **222** has a cross-sectional area of between about 0.025 and about 0.075 square inches, between about 0.040 and about 0.060 square inches, or between about 0.045 and about 0.055 square inches. In other embodiments, the cross-sectional area is less than about 0.075 square inches, less than about 0.060 square inches, or less than or equal to about 0.055 square inches. In still other embodiments, the cross-sectional area is greater than or equal to about 0.025 square inches, greater than or equal to about 0.035 square inches, or greater than or equal to about 0.045 square inches. In some embodiments, the cross-sectional area is about 0.050 square inches.

(103) The sheath **222** can assume any of a number of cross-sectional geometries, such as, for example, oval, ellipsoidal, square, rectangular, hexagonal, or diamond-shaped. The cross-sectional geometry of the sheath **222** can vary along a length thereof in size and/or shape. In some embodiments, the sheath **222** has substantially circular cross-sections along a substantial portion of a length thereof. A circular geometry provides the sheath **222** with substantially equal strength in all radial directions, thereby preventing bending or breaking that might otherwise occur upon insertion of the sheath **222**. The symmetry of an opening created in the septum **216** by the circular sheath **222** prevents pinching that might occur with angled geometries, allowing the sheath **222** to more easily be inserted through the septum **216**. Advantageously, the matching circular symmetries of the piercing member **220** and the opening in the septum **216** ensure a tight fit between the piercing member **220** and the septum **216**, even if the adaptor **200** is inadvertently twisted. Accordingly, the risk of dangerous liquids or gases escaping the vial **210**, or of impure air entering the vial **210** and contaminating the contents thereof, can be reduced in some instances with a circularly symmetric configuration.

(104) In some embodiments, the sheath **222** is hollow. In the illustrated embodiment, the inner and outer surfaces of the sheath **222** substantially conform to each other such that the sheath **222** has a substantially uniform thickness. In various embodiments, the thickness is between about 0.015 inches and about 0.040 inches, between about 0.020 inches and about 0.030 inches, or between about 0.024 inches and about 0.026 inches. In other embodiments, the thickness is greater than or equal to about 0.015 inches, greater than or equal to about 0.020 inches, or greater than or equal to about 0.025 inches. In still other embodiments, the thickness is less than or equal to about 0.040 inches, less than or equal to about 0.035 inches, or less than or equal to about 0.030 inches. In some embodiments, the thickness is about 0.025 inches.

(105) In some embodiments, the inner surface of the sheath **222** varies in configuration from that of the outer surface of the sheath **222**. Accordingly, in some arrangements, the thickness varies along the length of the sheath **222**. In various embodiments, the thickness at one end, such as a proximal end, of the sheath is between about 0.015 inches and about 0.050 inches, between about 0.020 inches and about 0.040 inches, or between about 0.025 inches and about 0.035 inches, and the thickness at another end, such as the distal end **223**, is between about 0.015 inches and 0.040 inches, between about 0.020 inches and 0.030 inches, or between about 0.023 inches and about 0.027 inches. In some embodiments, the thickness at one end of the sheath **222** is greater than or equal to about 0.015 inches, greater than or equal to about 0.020 inches, or greater than or equal to about 0.025 inches, and the thickness at another end thereof is greater than or equal to about 0.015

inches, greater than or equal to about 0.020 inches, or greater than or equal to about 0.025 inches. In still other embodiments, the thickness at one end of the sheath **222** is less than or equal to about 0.050 inches, less than or equal to about 0.040 inches, or less than or equal to about 0.035 inches, and the thickness at another end thereof is less than or equal to about 0.045 inches, less than or equal to about 0.035 inches, or less than or equal to about 0.030 inches. In some embodiments, the thickness at a proximal end of the sheath **222** is about 0.030 inches and the thickness at the distal end **223** is about 0.025 inches. In some arrangements, the cross-section of the inner surface of the sheath **222** is shaped differently from that of the outer surface. The shape and thickness of the sheath **222** can be altered, e.g., to optimize the strength of the sheath **222**.

(106) In some instances, the length of the sheath **222**, as measured from a distal surface of the cap connector **230** to the distal end **223**, is between about 0.8 inches to about 1.4 inches, between about 0.9 inches and about 1.3 inches, or between about 1.0 inches and 1.2 inches. In other instances, the length is greater than or equal to about 0.8 inches, greater than or equal to about 0.9 inches, or greater than or equal to about 1.0 inches. In still other instances, the length is less than or equal to about 1.4 inches, less than or equal to about 1.3 inches, or less than or equal to about 1.2 inches. In some embodiments, the length is about 1.1 inches.

(107) In certain embodiments, the sheath **222** at least partially encloses one or more channels. For example, in the embodiment of FIG. **5**, the sheath **22** partially encloses the regulator channel **225** and the access channel **245**. In some arrangements, the sheath **222** defines the outer boundary of a distal portion of the regulator channel **225** and the outer boundary of a distal portion of the access channel **245**. An inner wall **227** extending from an inner surface of the sheath **222** to a distal portion of the medical connector interface **240** defines an inner boundary between the regulator channel **225** and the access channel **245**.

(108) In the embodiment shown, the access channel **245** extends from an access aperture **246** formed in the sheath **222**, through the cap connector **230**, and through the connector interface **240**. Thus, when a medical device, such as a syringe, is connected with the medical connector **241**, which in turn is coupled with the connector interface **240**, the medical device is in fluid communication with the inside of the vial **210**. In such arrangements, the contents of the vial **210** and the contents of the medical device can be exchanged between the vial **210** and the medical device.

(109) In the illustrated embodiment, the regulator channel **225** extends from a distal end **223** of the sheath **222**, through the cap connector **230**, through a portion of the connector interface **240**, through the lumen **226**, and terminates at the regulator aperture **228**. In certain arrangements, such as in the arrangement shown, the regulator aperture **228** is in fluid communication with the passage **253** of the coupling **252**, which is in fluid communication with the inner chamber **255** of the bag **254**. Thus, in such arrangements, the inner chamber **255** is in fluid communication with the regulator channel **225**. Additionally, because in the illustrated embodiment the filler **256** is located in the inner chamber **255**, the filler **256** is also in fluid communication with the regulator channel **225**.

(110) In certain configurations, the adaptor **200** comprises a filter **260**. In the embodiment illustrated, the filter **260** is located in the regulator channel **225** within the lumen **226**. In other embodiments, the filter **260** is located in the regulator channel **225** in the sheath **222**. In yet other embodiments, the filter **260** is located in the passage **253** in the coupling **252**. Still further embodiments have the filter **260** positioned in the inner chamber **255** of the bag **254**. Generally, the filter **260** is chemically or mechanically held in position, e.g., by adhesive or a snap ring. Certain embodiments include a plurality of filters **260**. For example, certain embodiments have a first filter located in the lumen **226** and a second filter located in the coupling **252**.

(111) In some arrangements, the filter **260** is a hydrophobic membrane, which is generally configured to allow gases to pass therethrough, but to inhibit or prevent passage of liquids therethrough. In some configurations, gases (e.g., sterilized air) are able to pass through the filter

260 so as to move between the vial **210** and the bag **254**, but liquid from the vial **210** is blocked by the filter **260**. Embodiments of the adaptor **200** in which the filter **260** is located in the regulator channel **225** can therefore reduce the likelihood of liquid spilling from the vial **210** even if the regulator assembly **250** is detached.

(112) In certain configurations, the filter **260** can remove particles and/or contaminants from the gas that passes through the filter. For example, in certain embodiments, the filter **260** is configured to remove nearly all or about 99.9% of airborne particles 0.3 micrometers in diameter. In some cases, the filter **260** is configured to remove microbes. In some embodiments, the filter **260** comprises nylon, polypropylene, polyvinylidene fluoride, polytetrafluoroethylene, or other plastics. In some embodiments, the filter **260** includes activated carbon, e.g., activated charcoal. In certain configurations, the filter **260** comprises a mat of regularly or randomly arranged fibers, e.g., fiberglass. In some arrangements, the filter **260** comprises Gortex® material or Teflon® material.

(113) In the illustrated embodiment, the lumen **226** is a hollow cylindrical member extending radially outward from the connector interface **240**. In other embodiments, the lumen **226** comprises other shapes, such as conical. The lumen **226** can have a variety of cross-sectional shapes, such as circular, square, rectangular, elliptical, diamond, star-shaped, polygonal, or irregular. As shown, in some embodiments, the lumen **226** extends radially outward less than the sleeve **235** of the cap connector **230**. However, in certain configurations, the lumen **226** extends radially outward beyond the sleeve **235** of the cap connector **230**. Such a configuration can, for example, facilitate a connection with the regulator assembly **250** such that the regulator assembly **250** is spaced-apart from the remainder of the adaptor **200** and from the vial **210**.

(114) In some embodiments, the coupling **252** has a shape that is corresponding or complementary with the shape of the lumen **226**. For example, in some cases, the lumen **226** has a triangular shape and the coupling **252** has a triangular shape as well. The coupling **252** can have most any cross-sectional shape, such as circular, square, rectangular, elliptical, diamond, star-shaped, polygonal, or irregular. In certain configurations, the coupling **252** and the lumen **226** are correspondingly shaped to promote an orientation of the coupling **252** (and thus the regulator assembly **250**) relative to the lumen **226** (and thus the remainder of the adaptor **200**), as discussed below.

(115) The coupling **252** can be configured to engage the lumen **226**. For example, in the embodiments illustrated, the coupling **252** is configured to be received by the lumen **226**. In other cases, the coupling **252** is configured to receive the lumen **226**. In some instances, the coupling **252** and the lumen **226** connect with a slip fit or a press fit. In some configurations, the coupling **252** and the lumen **226** connect with a hose-barb connection. In certain arrangements, the coupling **252** and the lumen **226** connect with a threaded connection. For example, in certain cases the coupling **252** and the lumen **226** have corresponding standard luer lock connections. In some embodiments, the connection between the coupling **252** and the lumen **226** is substantially airtight, so as to inhibit or prevent outside air from entering the regulator channel **225**. Such a configuration can reduce the likelihood that microbes or impurities will enter vial **210**, thereby enhancing patient safety by reducing the likelihood of contaminating the medical fluid.

(116) In some arrangements, the connection between the coupling **252** and the lumen **226** includes a feedback device to alert the user that the connection has been made. For example, in certain arrangements, the connection between the coupling **252** and the lumen **226** includes a detent mechanism, e.g., a ball detent, which can provide a tactile indication that the connection has been made. Some embodiments include an audible signal, e.g., a click, snap, or the like, to indicate that coupling **252** has been connected with the lumen **226**.

(117) In some embodiments, the connection between the coupling **252** and the lumen **226** is substantially permanent. For example, in certain configurations, the coupling **252** and lumen **226** are sonically welded. In some cases, the coupling **252** and lumen **226** are permanently attached with an adhesive, such as glue, epoxy, double-sided tape, solvent bond, or otherwise. In some embodiments, the coupling **252** and lumen **226** joined with a permanent snap fit mechanism (e.g., a

generally 90° hook and a corresponding generally 90° valley), such that the coupling **252** and lumen **226** are substantially restrained from being separated after the snap mechanism has been engaged. Permanent connection of the coupling **252** and lumen **226** can encourage one-time-use of the adaptor **200**, including one-time-use of the regulator assembly **250**. Further, permanent connection of the regulator assembly **250** and with the remainder of the adaptor **200** reduces the total number of unique parts to be inventoried, maintained, and prepared prior to use. In some embodiments, the coupling **252** is formed substantially monolithically with (e.g., molded during the same operation as) the remainder of the adaptor **200**.

(118) In some cases, the coupling **252** and lumen **226** are connected during the process of manufacturing the adaptor **200**, e.g., at the factory. In some configurations, the regulator assembly **250** is a separate item from the remainder of the adaptor **200** and is configured to be connected with the remainder of the adaptor **200** by a user. For example, the piercing member **220**, cap connector **230**, and connector interface **240** may be provided in a first package and the regulator assembly **250** may be provided in a second package. In some user-connected configurations, the connection is substantially permanent. For example, in some cases one of the coupling **252** and the lumen **226** includes an adhesive (e.g., double-sided tape) which substantially permanently bonds the coupling **252** and the lumen **226** when the user connects the coupling **252** and the lumen **226**. On the other hand, in certain user-connected embodiments, the coupling **252** is configured to be detachable from the lumen **226**, even after the coupling **252** has been connected with the lumen **226**. For example, in certain embodiments the coupling **252** and the lumen **226** are releasably joined with threads or a release mechanism, such as a detent or a set-screw. Such a configuration can facilitate operations (e.g., voluminous pharmaceutical compounding operations) in which the transfer of a volume of regulating fluid from the regulator assembly **250** into the vial **210** is desired that is greater that the volume of regulating fluid contained in the regulator assembly **250**, as discussed below. In some embodiments, when the regulator assembly **250** is detached, the contents therein are sealed off from the environment, such as by way of a one-way valve.

(119) In the illustrated embodiment, the coupling **252** is joined with the bag **254**. In some cases, the bag **254** and coupling **252** are welded or joined with adhesive. As shown, the connection of the bag **254** and the coupling **252** generally fluidly connects the passage **253** with the inner chamber **255** of the bag **254**. To facilitate fluid communication, the bag **254** can include a bag aperture **257**, such as a slit or hole. In some cases, the bag aperture **257** is produced with a hot implement, such as a soldering iron.

(120) The bag **254** is generally configured to unfold, unroll, expand, contract, inflate, deflate, compress, and/or decompress. The bag **254** can comprise any of a wide variety of flexible and/or expandable materials. For example, in certain embodiments, the bag **254** comprises polyester, polyethylene, polypropylene, saran, latex rubber, polyisoprene, silicone rubber, vinyl, polyurethane, or other materials. In certain embodiments, the bag **254** comprises a material having a metal component to further inhibit fluid (including gas or air) leakage through the material of the bag, e.g., metalized biaxially-oriented polyethylene terephthalate (also known as PET and available under the trade name Mylar®). In some embodiments, the bag **254** comprises a laminate. For example, the bag **254** can be constructed of a layer of 0.36 Mil (7.8 #) metalized (e.g., aluminum) PET film and a layer of 0.65 Mil (9.4 #) linear low-density polyethylene. In some embodiments, the bag **254** comprises a material capable of forming a substantially airtight seal with the coupling **252**. In certain embodiments, the bag **254** is transparent or substantially transparent. In other embodiments, the bag **254** is opaque. In many instances, the bag **254** comprises a material that is generally impervious to liquid and air. In certain embodiments, the bag **254** comprises a material that is inert with respect to the intended contents of the vial **210**. For example, in certain cases, the bag **254** comprises a material that does not react with certain drugs used in chemotherapy. In some embodiments, the bag **254** comprises latex-free silicone having a durometer between about 10 and about 40.

(121) In certain configurations, the bag **254** includes a coating. For example, in some embodiments, the bag **254** includes a coating that reduces the porosity of the bag **254**. In some cases, the coating is evaporated aluminum or gold. In some cases, the coating includes a water soluble plastic configured to form a barrier to inhibit passage of gases thereacross. In certain instances, the coating is applied to the outside of the bag **254**. In other instances, the coating is applied to the inside of the bag **254**. In some cases, the coating is applied to the inside and the outside of the bag **254**. In some embodiments, the coating is a polyolefin.

(122) In certain embodiments, the bag **254** is located entirely outside of the vial **210**. In certain arrangements, the bag **254** is positioned entirely outside of the remainder of the adaptor (e.g., the piercing member **220**, cap connector **230**, and connector interface **240**). In some embodiments, the bag **254** is substantially free to expand in generally any direction. For example, in the embodiment illustrated, there is no rigid enclosure surrounding or partially surrounding a portion of the bag **254**. In some instances, a rigid housing does not contain a substantial portion of the bag **254**. In some embodiments, in the fully deflated state, the bag **254** is not within a rigid enclosure. In certain configurations, the bag **254** is substantially free to expand in generally any direction, e.g., proximally, distally, radially away from the vial **210**, radially toward the vial **210**, etc.

(123) In some embodiments, the bag **254** is configured to freely expand without being constrained by, for example, a rigid enclosure. Such unconstrained expansion of the bag **254** can reduce the force needed to expand the bag **254**. For instance, as the bag **254** does not contact a rigid enclosure, there is no frictional force between the bag **254** and such an enclosure, which could otherwise increase the force needed to expand the bag **254**. In certain aspects, unconstrained expansion of the bag **254** reduces the likelihood of the bag **254** being damaged during expansion. For example, because the bag **254** does not contact a rigid enclosure, there is less risk of the bag **254** being damaged (e.g., pierced, torn, or snagged on a burr or other defect of such an enclosure) during expansion or deflation. Further, unconstrained movement of the bag **254** lessens the chance of a coating on the bag **254** being smeared or rubbed-off. In some embodiments, the bag **254** does not bump, rub, slide against, or otherwise statically or dynamically contact a rigid surface of the adaptor **200** during expansion. In certain configurations, the bag **254** contacts only the coupling **252**, regulating fluid, and ambient air.

(124) In certain embodiments, the bag **254** includes a first side **258** and a second side **259**. In some instances, the first side **258** is closer to the connector interface **240** than the second side **259**. In some cases, the first side **258** is bonded with the coupling **252**, but the second side **259** is not. In certain configurations, the first side **258** connects with the second side **259**. In some such cases, the first side **258** connects with the second side **259** at a peripheral edge of each of the sides **258**, **259**. In certain instances, the second side **259** does not touch a rigid surface during expansion of the bag **254**. In some configurations, substantially all or a majority of the surface area of the bag **254** that is exposed to the ambient environment is flexible. In certain embodiments, generally the entire bag **254** is flexible.

(125) In some embodiments, each of the sides **258**, **259** includes an inner surface and an outer surface. As illustrated in FIG. **6**, the inner surface of each of the sides **258**, **259** can be in contact with the inner chamber **255**, and the outer surface of each of the sides **258**, **259** can be in contact with the ambient environment.

(126) In certain instances, the inner surface of each of the sides **258**, **259** is oriented towards the inside of the bag **254**. As used herein, the phrase “oriented towards,” or any derivative thereof, is a broad term used in its ordinary sense and describes, for example, generally aligning or positioning something in the direction of the member indicated. For example, if a first member is oriented towards a second member, then the first member is generally aligned or positioned in the direction of the second member. In the case of a side or a surface being oriented toward a member, the side or surface is aligned or positioned such that a normal from the side or surface intersects the member. In certain configurations, the first side **258** is oriented towards the connector interface

240.

(127) In certain instances, the outer surface of each of the sides **258**, **259** is oriented outwardly from the bag **254**. In some cases, the second side **259** is oriented away from the connector interface **240**. In some such cases, a normal extending from the outer surface of the second side **259** does not intersect the connector interface **240**.

(128) In certain embodiments, the second side **259** is oriented opposite from the first side **258**. As used herein, the term "opposite," or any derivative thereof, is a broad term used in its ordinary sense and describes, for example, something at the other end, side, or region from a member. For example, each side in a rectangle is opposite one other side and non-opposite two other sides. In some instances, the second side **259** is oriented away from the connector interface **240**. In such instances, a normal extending from the outer surface of the second side **259** does not intersect the connector interface **240**.

(129) In some embodiments, the bag **254** includes a first layer and a second layer. As used herein, the term "layer," or any derivative thereof, is a broad term used in its ordinary sense and describes, for example, a thickness, ply, or stratum of material. In some embodiments, a layer can include multiple components, plies, or strata of material. In some instances, the first layer is the first side **258** and the second layer is the second side **259**. In certain configurations, the first and second layers are connected. For example, a periphery of the first layer can be connected to or formed unitarily or monolithically with a periphery of the second layer. Such configurations can, for example, aid in forming the bag **254**, e.g., by rendering the bag **254** substantially airtight at the periphery. In some instances, the first layer is a first sheet of metalized PET and the second layer is a second sheet of metalized PET, and the first and second layers are bonded (e.g., heat sealed) together at the peripheries. In certain embodiments, the first and second layers each have a central portion. For example, in a configuration in which the first and second layers are each substantially circular in peripheral shape, the central portions can be at about the radial center of each of the first and second layers. In certain instances, the central portion of the first layer is unattached or not connected with the central portion of the second layer. Thus, in some such instances, the first and second portions can move relative to each other.

(130) In some embodiments, one or both of the first and second layers include one or more sub-layers. For example, the first and/or second layers can each include a plastic sub-layer and a metal sub-layer. In certain embodiments, the first and second sub-layers have interfacing surfaces that are bonded together. In some cases, substantially the entire area of the interfacing are bonded. Generally, the sub-layers are not configured to receive a substantial volume or any appreciable volume (e.g., of regulating fluid) therebetween. On the other hand, in some embodiments, the first and second layers are configured to receive the regulating fluid therebetween. For example, in a configuration in which the first layer is the first side **258** and the second layer is the second side **259**, the regulating fluid can be received between the first and second layers (see FIG. **6**).

(131) In various embodiments, the adaptor **200** does not include a rigid enclosure that wholly or partially contains the bag **254**. For example, any volume of the bag inside a rigid enclosure may encompass (if at all) less than half of the bag **254** or a very small portion of the volume of the bag (e.g., smaller than or equal to the volume inside the piercing member on the adapter or smaller than or equal to the volume inside the cap of the connector). In some embodiments, any volume of the bag inside a rigid enclosure (if at all) is less than or equal to half of the volume inside a vial or vials to which the adapter is configured to be connected. A rigid enclosure can increase the weight and total material of the adaptor **200**, thereby increasing material and manufacturing costs. Moreover, since rigid enclosures may be positioned a distance apart from the axial center of the adaptor, omitting a rigid enclosure can eliminate the moment of force that is imposed by the weight of such an enclosure. Thus, the adaptor **200** can promote stability and reduce the chance of tipping-over. Stability of the adaptor and vial can be particularly important in dealing with cytotoxic drugs, as tipping could increase the likelihood of spills or other unintended exposure and/or release.

(132) Certain embodiments of the adaptor **200** have a center of mass that is not substantially disposed from the axial center of the adaptor **200**, when the regulator assembly **250** is connected with the remainder of the adaptor **200** and the adaptor **200** is mated with the vial **210**. For instance, some embodiments of the adaptor **200** have center of mass that is less than or equal to about 0.50 inches, less than or equal to about 0.25 inches, less than or equal to about 0.125 inches, or less than or equal to about 0.063 inches apart from the axial center of the adaptor **200**.
(133) In some instances, the bag **254** is expandable to substantially fill a range of volumes such that a single adaptor **200** can be configured to operate with vials **210** of various sizes. In some embodiments, the bag **254** is configured to hold a volume equal to at least about 30, at least about 70, or at least about 90 percent of the volume of fluid contained within the vial **210** prior to the coupling of the adaptor **200** and the vial **210**. In some embodiments, the bag **254** is configured to hold a volume equal to about 70 percent of the volume of fluid contained within the vial **210** prior to the coupling of the adaptor **200** and the vial **210**. In various embodiments, the fluid in the bag **254** is a gas. For example, air, sterilized air, cleaned air, nitrogen, oxygen, inert gas (e.g., argon) or otherwise. In some embodiments, the sterilized air can be supplied by providing ambient air within the bag and then sterilizing the bag and air together.
(134) The bag **254** has a fully expanded configuration (FIG. **6**) and at least one non-fully expanded configuration (FIG. **5**). In certain instances, in the fully expanded configuration, the volume of the inner chamber **255** of the bag **254** is at its maximum recommended volume. In certain instances, in the fully expanded configuration, the bag **254** contains at least about 100 mL, at least about 200 mL, or at least about 300 mL of fluid. In certain instances, in the fully expanded configuration, the bag **254** holds at least about 250 mL of fluid. In certain embodiments, in the fully expanded configuration, the bag **254** contains at least 180 mL of fluid.
(135) In certain instances, in a non-fully expanded configuration, the bag **254** contains less than or equal to about 5 mL, less than or equal to about 40 mL, less than or equal to about 100 mL, or less than or equal to about 250 mL of fluid. In some instances, a non-fully expanded configuration of the bag **254** is a fully deflated configuration, in which the volume of the inner chamber **255** of the bag **254** is about zero. In some such instances, in the fully deflated configuration, the bag **254** contains substantially no fluid.
(136) The bag **254** further has an initial configuration (e.g., the configuration prior to any regulating fluid being transferred between the vial **210** and the bag **254**). Generally, the bag **254** contains a volume of fluid in the initial configuration to facilitate rapid and accurate withdrawal of fluid from the vial **210** upon connection of the adaptor **200** with the vial **210**. In certain embodiments, in the initial configuration, the bag **254** contains at least about 10 mL, at least about 50 mL, or at least about 90 mL of fluid. In certain embodiments, in the initial configuration, the bag **254** contains at least about 60 mL of fluid. In some embodiments, in the initial configuration, the bag **254** contains a volume of fluid that generally corresponds to the volume of a standard medical device or devices to which the adapter is configured to attach. For example, in certain instances, in the initial configuration, the bag **254** holds at least about 30 mL of fluid, which corresponds to the volume of a 30 ml syringe. In such instances, upon connection of the adaptor **200** with the vial **210**, about 30 mL of fluid are immediately available to be transferred between the bag **254** to the vial **210**, thereby allowing 30 mL of fluid to be immediately transferred between the vial **210** and the syringe. In some embodiments, the bag **254** has an initial volume of at least about the volume inside the cap plus inside of the piercing member, or at least about twice as large as the volume insider the cap plus inside of the piercing member.
(137) In various arrangements, the bag **254** has an outer dimension (e.g., diameter or cross-sectional width or height) D of between about 1.0 inches and about 6.0 inches, between about 2.0 inches and about 5.0 inches, or between about 3.0 inches and about 4.0 inches. In some arrangements, the outer dimension is greater than or equal to about 3.0 inches, greater than or equal to about 4.0 inches, or greater than or equal to about 6.0 inches. In other arrangements, the outer

diameter is less than or equal to about 8.0 inches, less than or equal to about 7.5 inches, or less than or equal to about 7.0 inches. In some embodiments, an outer dimension of the bag is greater than or equal to about the height or cross-sectional width of the vial or vials to which the adapter is configured to attach. In various arrangements, the bag **254** has a maximum total thickness T of between about 0.50 inches and about 2.00 inches, between about 0.60 inches and about 0.90 inches, and between about 0.70 inches and about 0.80 inches. In other arrangements, the maximum total thickness is less than about 1.00 inches, less than about 0.90 inches, or less than about 0.80 inches. In some arrangements, the maximum total thickness is about 0.75 inches. In certain instances, the diameter of the bag **254** is greater than the maximum total thickness of the bag **254**. In certain instances, the diameter of the bag **254** is greater than twice the maximum total thickness of the bag **254**. In some instances, it is desirable to prevent the bag **254** from bearing against the vial **210**. Accordingly, in some instances, the bag **254** is configured (e.g., dimensioned) such that even in the fully expanded state, the bag **254** is spaced apart from the vial **210**.

(138) In some configurations, the bag **254** has a wall thickness W between about 0.001 and about 0.025 inches, between about 0.001 and about 0.010 inches, or between about 0.010 and about 0.025 inches. In other configurations, the wall thickness is greater than about 0.001 inches, greater than about 0.005 inches, greater than about 0.010 inches, greater than about 0.015 inches, or greater than about 0.020 inches. In still other configurations, the wall thickness is less than about 0.025 inches, less than about 0.020 inches, less than about 0.015 inches, less than about 0.010 inches, or less than about 0.005 inches. In some configurations, the wall thickness is about 0.015 inches. In some embodiments, the wall thickness is substantially constant. In some embodiments, the wall thickness can vary. For example, in some configurations, the wall thickness increases in an area of the bag **254** around the coupling **252**.

(139) In some configurations, such as in the non-fully expanded configuration, the bag **254** is substantially irregularly shaped, as shown in FIG. **5**. In other configurations, the bag **254** has shape that is generally spherical, generally conical, generally cylindrical, generally torroidal, or otherwise. For example, in some embodiments, in the fully expanded configuration, the bag **254** is shaped as a generally oblate spheroid. In certain instances, the bag **254** is substantially bulbous. In some arrangements, the bag **254** has a convex shape. In some configurations, the bag **254** has a concave shape. In some configurations, the shape of the bag **254** generally conforms to the shape of the filler **256**. In some arrangements, the bag **254** generally conforms to the shape of the filler **256** in a non-fully expanded configuration and deviates from the shape of the filler **256** in the fully expanded configuration.

(140) The filler **256** can be configured to occupy various volumes within the bag **254**. For example, in some arrangements, the filler **256** occupies a volume greater than or equal to about 30, about 75, or about 90 percent of the volume of the bag **254**. In certain arrangements, the filler **256** is configured to maintain a space between the first and second sides **258**, **259** of the bag **254**. In certain arrangements, the filler **256** is configured to ensure that the volume of the inner chamber **255** is not zero.

(141) In general, the filler **256** is configured to provide a ready supply of regulating fluid, e.g., sterilized air, to the vial **210**. As discussed above, when the adaptor **200** is engaged with the vial **210** and a medical device (such as a syringe), and a portion of the fluid in the vial **210** is transferred from the vial **210** through the adaptor **200** into the medical device, the reduction in fluid volume in the vial **210** causes a pressure decrease in the vial **210**, thereby creating a pressure gradient between the interior and exterior of the vial **210**. This pressure gradient can cause surrounding air—which can contain microbes, impurities, and other contaminants—to leak into the vial **210** at the interface of the septum **216** and piercing member **220** or at the attachment interface of the adaptor **200** and a medical device. Further, such a pressure gradient can produce a restoring force that hinders the ability to withdraw an accurate amount of fluid from the vial **210**. However, the filler **256** can provide a ready supply of regulating fluid to the adaptor **200** to replace some or all of the fluid

volume that has been transferred out to generally maintain equilibrium in the vial **210**, thereby lessening or preventing the aforementioned problems.

(142) In certain arrangements, as fluid is removed from the vial **210** though the extraction channel **245**, a corresponding amount of regulating fluid from the filler **256** can substantially concurrently be introduced through the bag aperture **257**, the passage **253** in the coupling **252**, the regulator channel **225**, and into the vial **210**, thereby maintaining equilibrium. In some arrangements, the filler **256** includes a ready supply of regulating fluid prior to the regulator assembly **250** being connected with the remainder of the adaptor **200**. In some aspects, the filler **256** provides a reservoir of regulating fluid to the adaptor **200**. In certain arrangements, the filler **256** is configured such that a substantial portion of the first and second sides **258**, **259** of the bag **254** do not contact each other.

(143) In some configurations, the filler **256** has a similar shape as the bag **254**. For example, in some cases, in the fully expanded configuration, the bag **254** and the filler **256** are each generally shaped as an oblate spheroid. In other configurations, the filler **256** has a shape that is different than the bag **254**. For example, in certain instances, in the fully expanded configuration, the bag **254** has a substantially spheroidal shape and the filler **256** has a substantially cylindrical shape. In some such instances, the longitudinal axis of the cylindrically shaped filler **256** is generally parallel with the axial centerline of the adaptor **200**. In other such instances, the longitudinal axis of the cylindrically shaped filler **256** is orthogonal to the axial centerline of the adaptor **200**.

(144) In certain embodiments, the filler **256** is configured to be deformed by the bag **254** when the bag **254** deflates. For example, in some instances, when the bag **254** deflates, the filler **256** decreases in volume by at least about 30, at least about 50, or at least about 90 percent. In certain instances, when the bag **254** is in the fully expanded configuration, the filler **256** has a first shape (e.g., spheroidal) and when the bag **254** is in the fully deflated configuration, the filler **256** has a second shape (e.g., disk-like).

(145) In some such embodiments, the filler **256** is configured to be crushable or compressible and then return substantially to its original shape. For example, when the bag **254** deflates from the fully deflated configuration, the bag **254** substantially collapses the filler **256**, but during subsequent expansion of the bag **254**, the filler **256** returns to about its original shape. In other embodiments, the filler **256** is configured to be permanently deformed when it is crushed. For example, in some cases, the filler **256** comprises a thin-walled hollow member (e.g., an aluminum foil ball), which is configured to be permanently or irreversibly deformed, crushed, or otherwise decreased in volume during deflation of the bag **254**. This can provide an indicator that the adaptor **200** has already been used. In some embodiments, the filler **256** substantially maintains its shape when the bag **254** deflates.

(146) In certain arrangements, the filler **256** is configured to contain a volume of gas, such as sterilized air. In certain cases, the filler **256** is porous. In some instances, the filler **256** is a sponge or sponge-like material. In certain arrangements, the filler **256** comprises cotton wadding. In certain configurations, the filler **256** comprises a mat of regularly or randomly arranged fibers configured to provide a network of chambers or spaces therein. In some embodiments, the filler **256** is made of low density foam. For example, in certain embodiments, the filler **256** is made of polyurethane-ether foam, and has a weight of, for example, about 1.05 pounds per cubic foot and an indentation load deflection (ILD) of, for example, about 38. In some embodiments, the filler **256** is made of polyether, polyester, polyethylene, or ether-like-ester (ELE). In some cases, the filler **256** is made of nylon, polypropylene, polyvinylidene fluoride, polytetrafluoroethylene, or other plastics. In certain embodiments, the filler **256** is a metal, e.g., aluminum or stainless steel. In certain embodiments, the filler **256** is treated with an anti-microbial or other compound to enhance sterility. In certain cases, the filler **256** comprises a sealed chamber, e.g., containing sterilized air, which is configured to open when a fluid is withdrawn from the vial **210**. In some embodiments, the filler **256** can be configured to bind with, absorb, generally neutralize, or otherwise chemically

and/or mechanically interact with the fluid (such as vapors) entering the bag.

(147) In various arrangements, at ambient pressure, the filler **256** has an outer dimension (e.g., a diameter or cross-sectional width or height) of between about 1.0 inches and about 6.0 inches, between about 2.0 inches and about 5.0 inches, or between about 3.0 inches and about 4.0 inches. In some arrangements, at ambient pressure the outer diameter of the filler **256** is greater than or equal to about 3.0 inches, greater than or equal to about 4.0 inches, or greater than or equal to about 6.0 inches. In certain embodiments, the diameter of the filler **256** at ambient pressure is about 4.00 inches. In other arrangements, at ambient pressure the outer diameter is less than or equal to about 8.0 inches, less than or equal to about 7.5 inches, or less than or equal to about 7.0 inches. In various arrangements, at ambient pressure the filler **256** has a maximum total thickness of between about 0.05 inches and about 0.99 inches, between about 0.20 inches and about 0.60 inches, and between about 0.25 inches and about 0.35 inches. In certain embodiments, the thickness of the filler **256** at ambient pressure is about 0.30 inches. In some arrangements, the maximum total thickness of the filler **256** at ambient pressure is about 1.00 inches. In some embodiments, at ambient pressure the diameter and thickness of the filler **256** are about the same as the diameter D and thickness T of the bag **254**.

(148) With continued reference to FIGS. **5** and **6**, certain processes for using the adaptor **200** comprise inserting the piercing member **220** through the septum **216** until the cap connector **230** is firmly in place. Accordingly, the coupling of the adaptor **200** and the vial **210** can be accomplished in one simple step. In certain instances, the medical connector **241** is coupled with the medical connector interface **240**. A medical device or other instrument (not shown), such as a syringe, can be coupled with the interface **240** or, if present, with the medical connector **241** (see FIG. **4**). For convenience, reference will be made hereafter only to a syringe as an example of a medical device suitable for attachment to the medical connector interface **240**, although numerous medical devices or other instruments can be used in connection with the adaptor **200** or the medical connector **241**. In some instances, the syringe is placed in fluid communication with the vial **210**. In some instances, the vial **210**, the adaptor **200**, the syringe, and, if present, the medical connector **241** are inverted such that the cap **214** is pointing downward (e.g., toward the floor). Any of the above procedures, or any combination thereof, can be performed in any possible order.

(149) In some instances, a volume of fluid is withdrawn from the vial **210** into the syringe. As described above, the pressure within the vial **210** decreases as the fluid is withdrawn. Accordingly, in some instances, the regulating fluid in the filler **256** in the bag **254** flows through the regulator channel **225** and into the vial **210**. In some instances, the regulating fluid passes through the filter **260**. In some instances, the transfer of the regulating fluid from the filler **256** causes the bag **254** to deflate. In some arrangements, the transfer of the regulating fluid from the filler **256** and/or elsewhere in the bag **254** into the vial **210** generally maintains equilibrium in the vial **210**. In some cases, the volume of regulating fluid transferred from the filler **256** into the vial **210** is about equal to the volume of fluid withdrawn from the vial **210** into the syringe.

(150) In certain instances, a volume of fluid is introduced into the vial **210** from the syringe. For example, in certain cases, a volume of fluid is introduced into the vial **210** to reconstitute a freeze-dried drug or for drug compounding purposes. As another example, in some instances, more fluid than is desired may inadvertently be withdrawn from the vial **210** by the syringe. As discussed above, as the fluid is introduced into the vial **210**, the pressure in the vial **210** increases. Thus, in some instances, regulating fluid in the vial **210** flows through the regulator channel **225** and into the bag **254**, as shown by the arrows in FIG. **6**. In some instances, the regulating fluid passes through the filter **260**. In some instances, the transfer of the regulating fluid from the vial **210** causes the bag **254** to inflate. In certain of such instances, as the bag **254** inflates, it stretches, unfolds, or unrolls outward. In certain embodiments, the bag **254** is sufficiently flexible so as to substantially avoid producing a restoring force (e.g., a force in opposition to expansion or contraction of the bag **254**). In some embodiments, the bag **254** does exert a restoring force. In

some arrangements, the transfer of the regulating fluid from the vial **210** into the bag **254** maintains equilibrium in the vial **210**. In some cases, the volume of regulating fluid transferred from the vial **210** into the bag **254** is about equal to the volume of fluid introduced into the vial **210** from the syringe.

(151) Thus, in certain embodiments, the adaptor **200** accommodates the withdrawal of fluid from, or the addition of fluid to, the vial **210** in order to maintain the pressure within the vial **210**. In various instances, the pressure within the vial **210** changes no more than about 1 psi, no more than about 2 psi, no more than about 3 psi, no more than about 4 psi, or no more than about 5 psi.

(152) In some embodiments, a process for containing gases and/or vapors includes providing the piercing member **220**, cap connector **230**, and connector interface **240**. Generally, the process also includes piercing the septum of the vial **210** with the piercing member **220**. The piercing member **220** can provide access to medical fluid in the vial **210**. In certain embodiments, the process includes joining the regulator assembly **250** with the cap connector **230** or connector interface **240**, thereby fluidly connecting the regulator assembly **250** and the vial **210**. In some embodiments, the process also includes storing gases and/or or vapors displaced by a fluid that is introduced into the vial **210**. In certain configurations, all or a portion of the gases and/or vapors are stored in the regulator assembly **250**. Thus, the gases and/or vapors—which may pose substantial health hazards—can be sequestered and generally maintained apart from the ambient environment. In some embodiments, the process can include detaching the regulator assembly **250**.

(153) As is evident from the embodiments and processes described above, the adaptor **200** allows a user to introduce liquid into (including returning unwanted liquid and/or air) and withdrawn liquid from the vial **210** without significantly changing the pressure within the vial **210**. As previously discussed, the capability to inject liquid into the vial can be particularly desirable in the reconstitution of lyophilized drugs. Also, as detailed earlier, the ability to inject air bubbles and excess fluid into the vial **210** can be particularly desirable in the context of oncology drugs.

(154) Furthermore, the above discussion demonstrates that certain embodiments of the adaptor **200** can be configured to regulate the pressure within the vial **210** without introducing outside or ambient air into the vial **210**. For example, in some embodiments, the bag **254** comprises a substantially impervious material that serves as a barrier, rather than a passageway, between interior of the vial **210** and the ambient environment. Some embodiments of the adaptor **200** substantially reduce the risk of introducing airborne contaminants into the bloodstream of a patient.

(155) As noted above, in some instances, the vial **210** is oriented with the cap **214** pointing downward when liquid is removed from the vial **210**. In certain embodiments, the access aperture **246** is located adjacent a bottom surface of the cap **214**, thereby allowing removal of most or substantially all of the liquid in the vial **210**. In other embodiments, access aperture **246** is located near the distal end **223** of the piercing member **220**. In some arrangements, the adaptor **200** comprises more than one access aperture **246** to aid in the removal of substantially all of the liquid in the vial **210**.

(156) FIGS. **7-12** illustrate another embodiment of an adaptor **300**. The adaptor **300** resembles or is identical to the adaptor **200** discussed above in many respects. Accordingly, numerals used to identify features of the adaptor **200** are incremented by a factor of 100 to identify like features of the adaptor **300**. This numbering convention generally applies to the remainder of the figures. Any component or step disclosed in any embodiment in this specification can be used in other embodiments.

(157) In certain embodiments, the adaptor **300** comprises a piercing member **320**, a cap connector **330**, a connector interface **340**, and a regulator assembly **350**. Further details and examples regarding some embodiments of piercing members **320**, cap connectors **330**, and connector interfaces **340** are provided in U.S. Patent Application Publication No. 2009/0216212, the entirety of each of which is incorporated herein by reference and is made a part of this specification. For clarity, the vial **210** is not illustrated. The adaptor **300** can mate with the vial **210** in a similar

manner as the adaptor **200**. For example, when the adaptor **300** is mated with the vial **210**, the piercing member **320** extends through the septum **216** into the interior of the vial **210**.
(158) In some embodiments, such as in the illustrated embodiment, the cap connector **330** comprises a body portion **380**, which in turn comprises a central portion **381** (that can be curved) and one or more tabs **382** (which can be opposing) attached to the central portion **381**. Each of the tabs **382** can be supported at a proximal end of the tab **382** by the central portion **381** of the body portion **380**. As shown, the distal end of the tabs **382** can each be unrestrained so as to allow the tab to deflect outward.
(159) The body portion **380**, including the central portion **381** and tabs **382**, can help removably secure the vial adaptor **300** to the outside surface of the vial **210** and can help facilitate the removal of the vial adaptor **300** from the vial **210**. In some embodiments, the body portion **380** defines only one tab **382**, as opposed to a pair of opposing tabs **382**, the single tab being configured to removably secure the vial adaptor **300** to the outside surface of the vial **210** and to facilitate the removal of the vial adaptor **300** from the vial **210**. The single tab **382** can be of any suitable configuration, including those set forth herein.
(160) In certain configurations, such as in the configuration illustrated in FIG. **7**A, the piercing member **320** is supported by the body portion **380**. As illustrated, the piercing member **320** can project distally from the central portion **381** of the body portion **380**. The piercing member **320** can comprise an access channel **345** and a regulator channel **325**. In some embodiments, the regulator channel **325** begins at a distal regulator aperture **328***a*, passes generally through the piercing member **320**, passes through a lumen **326** that extends radially outward from the connector interface **340**, and terminates at a proximal regulator aperture **328** (FIG. **8**). In certain instances, the lumen **326** extends radially outward from the connector interface **340** in only one direction. In some instances, the lumen **326** extends radially outward from the connector interface **340** in more than one direction, e.g., in two opposite directions.
(161) In certain embodiments, the lumen **326** includes a barrier **383**, such as a wall, cap, plug, dam, cork, partition, or otherwise. In other configurations, the barrier **383** is configured to permit fluid to flow thereacross. For example, in some cases the barrier **383** is a filter, such as a hydrophobic or activated charcoal filter. In certain configurations, the barrier is configured to inhibit or prevent fluid flow thereacross. For example, in some cases the barrier is a continuous wall. In some such configurations, the barrier **383** blocks regulating fluid from exiting the adaptor **300**.
(162) The regulator assembly **350** can include a coupling **352**, a bonding member **384**, and a bag **354**. In some instances, the bag includes a filler (not shown), such as the filler **254** discussed above. The bag **354** can include a bag aperture **357**, which is illustrated as a linear slit but can take the form of most any opening in the bag. In certain configurations, the bag **354** is constructed of multiple sheets of material that have been joined (e.g., heat sealed) around the periphery. In some such configurations, such as shown in FIG. **8**, the sealing operation produces a peripheral ridge **354***a* on the bag **354**. In cases, the bag **354** is produced from a balloon having a narrowing neck portion (such as the “4 Inch Round” balloon produced by Pioneer Balloon Company of Wichita, Kansas), wherein the neck portion is removed and the bag **354** is heat sealed around the periphery to enclose (aside from the bag aperture **357**) a volume therein. In some instances, removal of the neck portion produces a flattened, truncated, or otherwise asymmetrical portion of the bag **359**, as shown in FIG. **7**.
(163) In certain embodiments, the bonding member **384** joins the coupling **352** with the bag **354**. For example, in certain instances, the bonding member **384** includes a double-sided adhesive, e.g., a member with an adhesive surface facing the coupling **352** and an adhesive surface facing the bag **354**. In the illustrated embodiment, the bonding member **384** comprises an adhesive first surface **834***a* and an adhesive second surface **834***b*. As shown, the bonding member **384** can include an aperture **384***c*. In some embodiments, the bonding member **384** is about 0.015 inches thick. In some embodiments, the bonding member **384** has a thickness of at least 0.01 inches and/or equal to

or less than 0.03 inches.

(164) In certain embodiments, the bonding member **384** is made of a flexible material, which can, for example, provide resiliency in the connection between the bonding member **384** and the coupling **352** and the bonding member **384** and the bag **354**. Such resiliency can allow the coupling **352** to slightly move relative to the bag **350**. Likewise, such resiliency can reduce the likelihood of the bag **354** being ripped, torn, or otherwise damaged during manipulation of the regulator assembly **350**, such as in the process of connecting the regulator assembly **350** with the remainder of the adaptor **300**. In certain configurations, the bonding member **384** is a foam (e.g., urethane, polyethylene, or otherwise), non-rigid plastic, rubber, paper, or cloth (e.g., cotton) material. In certain aspects, the bonding member **384** is made of doubled-sided foam tape.

(165) In certain instances, the coupling **352** includes a base **385** and a cover **386**, which in turn can include an outer face **386***a* (FIG. **8**). In some embodiments, the bonding member **384** is configured to adhere to or otherwise join with the outer face **386***a*. In some embodiments, the bonding member **384** is configured to adhere to or otherwise join with the bag **354**. The connections between the bonding member **384** and the outer face **386***a*, as well as the connection between the bonding member **384** and the bag **354**, is substantially fluid tight (e.g., airtight) so that fluid passing between the coupling **352** and the bag **354** is inhibited from escaping. In some embodiments, the connection between the bonding member **384** and the coupling **352**, and the bonding member **384** and the bag **354**, is substantially permanent, such that once these components are joined they are not intended to be separated. In some embodiments, the connection between the bonding member **384** and the coupling **352**, and the bonding member **384** and the bag **354**, is configured to be temporary or detachable.

(166) As shown in FIG. **8**, a filter **360** can be housed between the base **385** and the cover **386**. The cover **386** can be substantially sealingly received by the base **385** so that substantially all of the fluid that is permitted to flow through the filter **360** flows through an opening **387** formed in the cover **386**. The base **385** and the cover **386** can be formed from any suitable material, such as plastic or metal. In some embodiments, the perimeter of the coupling **352** defines a non-circular shape, such as a square, triangular, polygonal, or other suitable or desired shape.

(167) The cover **386** can be press-fit with or otherwise attached to the base **385** using adhesive, sonic welds, or by any other similar or suitable means. For example, as illustrated in FIG. **12**, the cover **386** can be attached to the base **385** with one or more sonic welds **388**. The cover **385** and the base **386** can be joined together so that an annular protrusion **389** of the cover **385** is adjacent to an annular protrusion **390** on the base **385**. The protrusion **390** can have a stepped or extended lip portion **390***a* that can overlap the protrusion **389** formed on the cover **386** in the assembled configuration. The base **385** and the cover **386** can be made of various materials, such as metal or plastic. In some cases, the base **385** and the cover **386** are made of polycarbonate plastic.

(168) In some embodiments, the cross-sectional area of the filter **360** is substantially larger than the cross-sectional area of the proximal regulator aperture **328**. Such a configuration can increase the rate that regulating fluid flows through the filter **360**, thereby providing sufficient regulating fluid to compensate for the introduction or withdrawal of fluid from the vial **210**. As discussed above, providing sufficient regulating fluid can inhibit or avoid a pressure gradient (e.g., a vacuum) between the inside and outside of the vial and can reduce or eliminate a restoring force on the plunger of the syringe. In some embodiments, the cross-sectional area of the filter **360** is at least about 5 times greater than the cross-sectional area of the proximal regulator aperture **328**. In some embodiments, the cross-sectional area of the filter **360** is between approximately 2 times greater and approximately 9 times greater than the cross-sectional area of the proximal regulator aperture **328**, or to or from any values within these ranges. Similarly, in some embodiments, the cross-sectional area of the filter **360** can be approximately 400 times greater than the cross-sectional area of the distal regulator aperture **328***a*. In some embodiments, the cross-sectional area of the filter **360** can be between approximately 100 times greater and approximately 250 times greater, or

between approximately 250 times greater and approximately 400 times greater, or between approximately 400 times greater and approximately 550 times greater than the cross-sectional area of the distal regulator aperture **328***a*, or to or from any values within these ranges.

(169) The filter **360** can be configured to remove or diminish particulate matter such as dirt or other debris, germs, viruses, bacteria, and/or other forms of contamination from fluid flowing into the vial adaptor **300**. The filter **360** can be formed from any suitable filter material. In some embodiments, the filter **360** can be hydrophobic and can have a mean pore size of approximately 0.1 micron, or between approximately 0.1 micron and approximately 0.5 micron.

(170) As illustrated in FIG. **9**, in certain configurations, the coupling **352** can be received in the proximal regulator aperture **328**. In some embodiments, a protrusion **385***a* (e.g., a boss) extending from the base **385** is configured to be substantially sealingly received within or around the outer perimeter of the proximal regulator aperture **328**. The protrusion **385***a* can generally define a regulator path. In some embodiments, the protrusion **385***a* is press-fit into the proximal regulator aperture **328** so as to create a generally sealed connection between the protrusion **385***a* and the proximal regulator aperture **328**. In some embodiments, adhesive, welds, or other materials or features can be used to provide the connection between the protrusion **385***a* and the proximal regulator aperture **328**. In some instances, the protrusion **385***a* and the proximal regulator aperture **328** are bonded with a solvent. The protrusion **385***a* can be sized and configured to have a sufficient wall thickness and diameter to ensure that the protrusion **385***a* is not inadvertently broken during use by an inadvertent contact with coupling **352**. In some embodiments, the regulator path can be in fluid communication with the regulator channel **425** when the protrusion **385***a* is connected to the proximal regulator aperture **328**.

(171) An opening **387***a* can be formed through the protrusion **385***a* so that fluid flowing between the base **385** and the cover **386** will be filtered by the filter **360** before flowing through the opening **387** or **387***a*. The size of the opening **387***a* formed through the protrusion **385***a*, as well as the opening **387** formed in the cover **386**, can be designed to ensure a sufficient amount of fluid flow through the filter **360**. The diameter of the proximal regulator aperture **328** can be adjusted to accommodate any desired or suitable outside diameter of the protrusion **385***a*.

(172) With reference to FIGS. **10**, **11**, and **12**, the cover **386** can have a first inner annular protrusion **391** having one or more openings **391***a* therethrough, a second inner annular protrusion **392** having one or more openings **392***a* therethrough, and an outer annular protrusion **389**. In some embodiments, when the cover **386** is assembled with the base **385** and the filter **360**, the annular protrusions **389**, **391**, **392** and the openings **391***a*, **392***a* form a volume of space **393** between the inner surface of the cover **386** and the surface of the filter **360** into which regulating fluid can flow and circulate before or after passing through the filter **360**. Similarly, the base **385** can have a first inner annular protrusion **394** having one or more openings **394***a* therethrough, a second inner annular protrusion **395** having one or more openings **395***a* therethrough, and an outer annular protrusion **390**. In some embodiments, when the base **385** is assembled with the cover **386** and the filter **360**, the annular protrusions **390**, **394**, **395** and the openings **394***a*, **395***a* form a volume of space **396** between the inner surface of the base **386** and the surface of the filter **360** into which the regulating fluid can flow and circulate before or after passing through the filter **360**. In some configurations, the regulating fluid can access substantially the entire surface area of the filter **360**.

(173) In some embodiments, regulating fluid can flow through the opening **387** formed in the cover **386** into the space **393** defined between the cover **386** and the filter **360**, through the filter **360**, into the space **395** defined between the filter **360** and the base **385**, through the opening **385***a* formed in the base **385**, through the proximal regulator aperture **382**, and into the regulator channel **325** formed in the vial adaptor **300**. Likewise, in certain embodiments, regulating fluid can flow through the regulator channel **325** formed in the vial adaptor **300**, through the proximal regulator aperture **382**, through the opening **385***a* formed in the base **385**, into the space **395** defined between the filter **360** and the base **385**, through the filter **360**, into the space **393** defined between the cover

386 and the filter **360**, and through the opening **387** formed in the cover **386**. In some instances, the opening **387** is in fluid communication with ambient air.
(174) In some instances, the annular protrusions **390**, **394**, **395** are configured to maintain the shape and position of the filter **360** relative to the base **385** and the cover **386**. For example, the annular protrusion **390** can be configured to maintain the filter **360** about radially centered in the base **385** and the cover **386**, which can reduce the chance of fluid passing around (rather than through) the filter **360**. In some configurations, the annular protrusions **394**, **395** are configured to substantially inhibit the filter **360** from becoming concave shaped as regulating fluid passes through the filter **360**, which can reduce the likelihood of the filter **360** being torn or otherwise damaged.
(175) In certain embodiments, the adaptor **300** is modularly configured. Such a configuration can, for example, facilitate manufacturability and promote user convenience by standardizing one or more parts of the adaptor **300**. For example, in some instances, the configuration of the piercing member **320**, cap connector **330**, the connector interface **340**, and the coupling **352** is substantially unchanged regardless of the volume of fluid to be transferred between the medical device and the vial **210**. Such standardization can, for example, reduce the number of unique components to be purchased, stored, and inventoried, while maintaining the functionality of the adaptor **300**.
(176) In some modular embodiments, the adaptor **300** includes a first portion (e.g., the piercing member **320**, cap connector **330**, connector interface **340**, and coupling **352**—such as is shown in FIG. **9**) and a second portion (e.g., the bag **354**). In certain embodiments, the first portion is separate and spaced-apart from the second portion in a first arrangement, and the first portion is connected with the second portion in a second arrangement. Some embodiments can allow for variety of configurations (e.g., sizes) of the bag **354** to be mated with a common configuration of the remainder of the adaptor **300**. For example, in some embodiments, 20 mL, 40 mL, and 60 mL configurations of the bag **354** are each connectable with a common configuration of the remainder of the adaptor **300**. In certain embodiments, the bag **354** configuration is selectable while the remainder of the adaptor **300** is unchanged. In some cases, the configuration of the bag **354** is selected based on the volume of fluid to be transferred between the medical device (e.g., syringe) and the vial **210**. For example, if about 25 mL of fluid is to be transferred from the medical device into the vial **210**, then a configuration of the bag **354** that is able to contain greater than or equal to about 25 mL of fluid can be selected and connected to the remainder of the adaptor **300**; if, however, it is determined that a different volume of fluid is to be transferred from the medical device into the vial **210**, then the selection of the bag **354** can be changed without the need to change the remainder of the adaptor **300**.
(177) Certain modular embodiments can provide a ready supply of filtered or otherwise cleaned regulating fluid without being connected with the bag **354**. For example, in some embodiments, the opening **387** of the cover **386** of the coupling **352** is in fluid communication with ambient air, thereby providing a supply of filtered air through the coupling **352**, the regulator channel **325**, and into the vial **210**, when the piercing member **320** is disposed in the vial **210** and fluid is withdrawn through the access channel **345**. In certain instances, the adaptor **300** does not include the bag **354** and/or the bonding member **384**. In some embodiments, the lumen **326** is configured to connect with a filtered or otherwise cleaned regulating fluid source. For example, the lumen **326** can be configured to connect with a tube in fluid communication with a tank of sterilized air.
(178) In some embodiments, a process of manufacturing the vial adaptor **300** includes forming the piercing member **320**, cap connector **330**, and connector interface **340** in a first assembly. For example, in certain embodiments, the piercing member **320**, a cap connector **330**, a connector interface **340** are produced by the same operation (e.g., molding, machining, or otherwise). The process can also include forming the coupling **352**. For example, in some configurations, the base **385** and cover **386** are assembled with the filter **360** therebetween, as discussed above. In certain embodiments, the process also includes mating the coupling **352** with the lumen **326**, such as is shown in FIG. **9**. Further, the process can include joining the bonding member **384** with the outer

face **386***a* of the cover **386**. In some instances, the bonding member **384** is joined with the bag **354**. As shown in FIG. **7**, the lumen **326**, the opening **387***a* in the base, the opening **387** in the cover **386**, and the bag aperture **357** can be aligned, thereby allowing regulating fluid to flow between the vial **210** and the bag **354**.

(179) In some instances, the process of manufacturing the vial adaptor **300** can, for example, enable production of the adaptor **300** in discrete sub-assemblies, which can facilitate manufacturability. For example, a first sub-assembly can include the piercing member **320**, cap connector **330**, and connector interface **340**; a second sub-assembly can include the coupling **352** (including the base **385**, the cover **386**, and the filter **360**); and a third sub-assembly can include the bag **354** and bonding member **384**. Of course, other sub-assemblies are contemplated; for example, the second sub-assembly can include the coupling **352** and the bonding member **384**. In some cases, one or more of the sub-assemblies are supplied separately to the user (e.g., a healthcare worker).

(180) FIGS. **13**, **14**, and **15** illustrate another embodiment of an adaptor **400**. The adaptor **400** can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. In certain embodiments, the adaptor **400** comprises a piercing member **420**, a cap connector **430**, a connector interface **440**, and a regulator assembly **450**. In the illustrated embodiment, the cap connector **430** comprises a platform **439**.

(181) The piercing member **420** comprises a sheath **422** having a distal end **423**. As shown, the piercing member **420** is relatively short (compared with the piercing member **220** of FIGS. **5** and **6**), which can provide enhanced strength and can aid in extracting fluid from the neck region of the vial **210** when the vial **210** is inverted, as discussed above. Also, as illustrated, the piercing member **420** has an access channel **445** and a regulator channel **425**, each of which terminate near the distal end **423** of the piercing member **420**.

(182) As shown, the cap connector **430** can include a lumen **426**, such that the regulator channel **425** routes through the cap connector **430**. The lumen **426** extends radially outward through a connection member **429**. The illustrated connection member **429** is a slip-fit flange, however many other configurations are contemplated, such as threads, press fit, barb connection, or otherwise. A filter **460**, which can be hydrophobic, is disposed in the lumen **426**. The regulator assembly **450** comprises an annular washer **451**, a coupling **452**, a bag **454**, and a filler **456**. The coupling **452** comprises a passage **453** therethrough and an outwardly extending flange **461**. The coupling **452** is positioned through a bag aperture **457** with the flange **461** inside the bag **454**. The washer **451** is positioned external to the bag **454** and generally opposite the flange **461**. In some instance, the bag **454** is compressed or otherwise held between the washer **451** and the flange **461**. For example, in some embodiments, the outside of the coupling **452** is threaded and the center of the annular washer is correspondingly threaded, thereby allowing the washer to be threaded on the coupling **452** and to compress the bag **454** between the washer **451** and the flange **461**. As shown, the coupling **452** is received into connection member **429**, thereby placing the bag **454** in fluid communication with the vial **210** through the regulator channel **425**.

(183) In FIG. **13**, the bag **454** is illustrated in an initial state, which can be, for example, the state of the bag **454** when the regulator assembly **450** is initially connected with the cap connector **430**. The filler **456** can contain a volume of regulating fluid, such as sterilized air. As shown, in this embodiment and in this state, the filler **456** substantially fills the volume of the bag **454**. In some aspects, the bag **454** substantially follows the shape of the filler **456**.

(184) In FIG. **14**, the bag **454** is illustrated in an at least partly inflated state, which can be, for example, the state of the bag **456** after a volume of fluid has been introduced into the vial **210** through the access channel **445**. Such introduction of fluid generally encourages a volume of regulating fluid in the vial **210** to move through the regulator channel **425**, lumen **426**, filter **460**, connection member **429**, passage **453**, bag aperture **457** and into the bag **454**, as shown by the arrows in FIG. **14**. In many embodiments, the filter **460** substantially blocks liquids in the vial **210** from entering the bag **454**. As shown, such a transfer of regulating fluid can expand the bag **454**. In

certain embodiments, such as in the illustrated embodiment, the filler **456** is configured to expand as the bag **454** expands.

(185) In FIG. **15**, the bag **454** is illustrated in an at least partly deflated state, which can be, for example, the state of the bag **456** after a volume of fluid has been withdrawn from the vial **210** through the access channel **445**. Such withdrawal of fluid generally encourages a volume of regulating fluid in the bag **454** to move through the bag aperture **457**, passage **453**, connection member **429**, filter **460**, lumen **426**, regulator channel **425**, and into the vial **210**, as shown by the arrows in FIG. **15**. As shown, such a transfer of regulating fluid can at least partly deflate the bag **454**. In certain embodiments, such as in the illustrated embodiment, the filler **456** is configured to compress as the bag **454** deflates. As shown, in some arrangements, the filler **456** is configured to provide a structural framework for the bag **454** (even in a deflated state), which can inhibit sagging of the bag **454**. In some embodiments, the bag **354** comprises a material having sufficient rigidity to inhibit sagging of the bag **454**.

(186) In various embodiments, the adaptor **400** is configured to transition between the various states illustrated in FIGS. **13**, **14**, and **15**. In some instances, the adaptor **400** begins at the state illustrated in FIG. **13** and transitions to the state illustrated in FIG. **14** (e.g., fluid is introduced from the syringe into the vial **210**). In certain instances, the adaptor **400** begins at the state illustrated in FIG. **13** and transitions to the state illustrated in FIG. **15** (e.g., fluid is withdrawn from the vial **210** into the syringe). In some instances, the adaptor **400** begins at the state illustrated in FIG. **13**, transitions to the state illustrated in FIG. **14**, then transitions to the state illustrated in FIG. **15** (e.g., fluid is introduced from the syringe into the vial **210**, then a greater volume of fluid than was introduced is withdrawn from the vial **210** into the syringe). In certain instances, the adaptor **300** begins at the state illustrated in FIG. **13**, transitions to the state illustrated in FIG. **15**, then transitions to the state illustrated in FIG. **14** (e.g., fluid is withdrawn from the vial **210** into the syringe, then a greater volume of fluid than was withdrawn is introduced into the vial **210**).

(187) FIG. **16** illustrates an embodiment of an adaptor **500** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. Adaptor **500** comprises a filter **560** located in a coupling **552**. Additionally, the adaptor **500** comprises a filler **556**, which is substantially round in cross-section. In some embodiments, the filler **556** is spheroidal. In other embodiments, the filler **556** is substantially cylindrical. The adaptor **500** also comprises a bag **554** and a coupling **552** with a flange **561**. As shown, the bag **554** can be joined, e.g., welded, adhered, or otherwise, with the flange **561**. In certain embodiments, the filler **556** is also joined with the flange **561**, which can facilitate keeping the bag **554** stationary with respect to the coupling **552**. In some arrangements, the filler **556** acts as a secondary filter for the gases passing between the vial **210** and the bag **554**. For example, in some cases, certain impurities that passed through the filter **560** are trapped by the filler **556** before such impurities enter the bag **554**. In some arrangements, the filler **556** acts as a pre-filter with respect to the filter **560**, thereby reducing the amount of impurities passing through the filter **560** and into the vial **210**.

(188) FIG. **17** illustrates an embodiment of an adaptor **600** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. Adaptor **600** comprises a bag **654** comprising an internal structure, rather than, or in addition to, a filler. Such internal structure can, for example, inhibit or prevent complete deflation of the bag **654**, in order to provide an initial supply of regulating fluid. In the illustrated embodiment, the internal structure comprises a plurality of inwardly extending elongate members **662**. In some configurations, the elongate members are generally flexible. In other configurations, the elongate members are substantially rigid. As shown, the elongate members **662** can contact and interfere with each other as the bag **654** deflates, which can hinder the bag **654** from fully deflating. In some embodiments, the regulating fluid is stored in a network of voids **663**, so as to provide an initial readily available supply of the regulating fluid to the vial **210**. In some such arrangements, the voids **663** are located between the elongate members **662**.

(189) Other embodiments include various other types of internal structure. For example, in some embodiments, the internal structure includes a plurality of inwardly-projecting bumps, ridges, rings, hemispheres, or the like. In some embodiments, the internal structure divides the bag **654** into segments. For example, in certain configurations, the internal structure is a membrane that divides the bag **654** into a first portion and a second portion, each of which can include an amount of regulating fluid. In some arrangements, when the bag **654** changes volume, the amount of regulating fluid in the first portion changes (e.g., decreases) more rapidly than in the second portion. In certain configurations, the first and second portions are fluidly connected by a valve. In some such configurations, the valve permits the regulating fluid to flow from the second portion into the first portion once a desired pressure difference between the portions has been achieved. In certain instances, the first portion inflates or deflates completely before the second portion begins to inflate or deflate.

(190) Another embodiment of an adaptor **700** is illustrated in FIG. **18**. The adaptor **700** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. In the illustrated embodiment, the adaptor **700** comprises a piercing member **720**, a cap connector **730**, a connector interface **740**, and a plurality of regulator assemblies **750**, **750′**. In certain embodiments, the expansion assemblies **750**, **750′** each include a bag **754**, **754′** and a filler **756**, **756′**. In some embodiments, as in the embodiment shown, the piercing member **720**, cap connector **730**, and connector interface **740** are substantially monolithic. In certain embodiments, each bag **754**, **754′** connects with the cap connector **730**, such as with an adhesive, pipe clamp, snap ring, or otherwise.

(191) In some configurations, the plurality of regulator assemblies **750**, **750′** provide a greater total volume of regulating fluid than a single regulator assembly. In certain embodiments, because the volume of regulating fluid is divided between the plurality of regulator assemblies **750**, **750′**, the size of each of the regulator assemblies **750**, **750′** (and thus adaptor **600** overall) can be reduced, compared with, for example, embodiments with a single regulator assembly. Furthermore, the regulator assemblies **750**, **750′** can be symmetrically spaced with respect to the remainder of the adaptor **600**, thereby enhancing stability and reducing the likelihood of tipping.

(192) Various embodiments have various numbers of regulator assemblies. For example, some embodiments have greater than or equal to three regulator assemblies. Some embodiments have at least four regulator assemblies. Generally, the regulator assemblies are equally radially spaced around the circumference of the adaptor **700** or are otherwise positioned to facilitate stability of the adaptor **700**.

(193) In certain configurations, when the piercing member **720** is disposed into the vial **210**, the interior of each of the regulator assemblies **750**, **750′** is in fluid communication with the vial **210** via outwardly extending passages **728**, **728′** and a regulator channel **725**. Thus, when fluid is withdrawn from the vial **210** through an access channel **745**, regulating fluid can flow from each of the regulator assemblies **750**, **750′** into the vial **210** and thereby maintain equilibrium in the vial **210**. Similarly, when fluid is introduced into the vial **210** through an access channel **745**, regulating fluid can flow from the vial **210** into each of the regulator assemblies **750**, **750′**, thereby maintaining equilibrium in the vial **210**.

(194) In some embodiments, the regulator assemblies **750**, **750′** operate in tandem, e.g., they change volume substantially simultaneously and in about equal amounts. For example, in certain cases, when about 5.0 mL of fluid is withdrawn from the vial **210**, about 2.5 mL of regulating fluid flows from regulator assembly **750** into the vial **210** and concurrently about 2.5 mL of regulating fluid flows from regulator assembly **750′** into the vial **210**.

(195) In some embodiments, the regulator assemblies **750**, **750′** do not operate in tandem. For instance, in some arrangements, the regulator assemblies **750**, **750′** operate in series. In some such instances, a first regulator assembly fully expands or fully deflates before the second regulator assembly begins expanding or deflating. In certain instances, the first regulator assembly changes

volume initially, then, after a condition has been achieved, the second regulator assembly changes volume. In some cases, the condition is a certain pressure difference (e.g., at least about 1 psi, at least about 2 psi, or at least about 5 psi) between the interior of the second regulator assembly and the vial **210**. In certain configurations, a valve (e.g., a duckbill valve) is configured to open when the condition has been achieved.

(196) FIG. **19** illustrates an embodiment of an adaptor **800** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. The adaptor comprises a regulator assembly **850** with a seal **864**, a counterweight **831**, and a keyed coupling **852**. As used herein, a "keyed coupling" is used in its broad and ordinary sense and includes couplings having a shape configured to match another coupling in one or more orientations. Furthermore, the illustrated embodiment of the adaptor **800** does not include a filler. In some such embodiments, the adaptor **800** includes a bag **854** that is sufficiently rigid to substantially inhibit the bag **854** from fully deflating (e.g., enclosing about zero volume).

(197) In some embodiments, the seal **864** is configured to inhibit or prevent unintended transfer of regulating fluid out of the regulator assembly **850** and/or unintended transfer of ambient air into the regulator assembly **850**. For example, in the embodiment shown, prior to the regulator assembly **850** being connected with the remainder of the adaptor **800**, the seal **864** generally blocks the initial volume of regulating fluid (which may be at a pressure above ambient pressure) contained in the regulator assembly **850** from escaping into the ambient environment. Additionally, the seal **864** can generally block ambient air, which may contain microbes or impurities, from entering the regulator assembly **850**.

(198) In the illustrated embodiment, the seal **864** comprises a membrane with a slit **865**. In certain instances, such as when the regulator assembly **850** is connected with the adaptor **800** and fluid is introduced or withdrawn through an access channel **845**, the pressure difference between the vial **210** and the bag **854** causes the slit **865** to open, thereby allowing regulating fluid to flow between the regulator assembly **850** and the vial **210**. Various other kinds and configurations of the seal **864** are contemplated. For example, in some embodiments, the seal **864** is a duck-bill valve. As another example, in some embodiments, the seal **864** comprises a substantially continuous (e.g., without a slit) membrane that is configured to rupture at a certain pressure differential (e.g., at least about 1 psi, at least about 2 psi, at least about 5 psi).

(199) In the embodiment shown, the seal **864** is located in the coupling **852**. In some other embodiments, the seal **864** is disposed in alternate locations. For example, the seal **864** can be located in a passage **826**. In some arrangements, the seal **864** is configured to dislodge or detach from the adaptor **800** when fluid is introduced or withdrawn through the access channel **845**. For example, in certain instances, when fluid is withdrawn from the vial **210** through the access channel **845**, the seal **864** is dislodged from the regulator channel **825**, thereby allowing regulating fluid to flow into the vial **210**. In some such cases, the seal **864** is a tab or a sticker. In some such cases, the seal **864** separates from the adaptor **800** and falls into the vial **210**.

(200) As shown, certain configurations of the adaptor **800** include a cap connector **830**, which in turn includes the counterweight **831**. The counterweight **831** can, for example, enhance the stability of the mated vial **210** and adaptor **800** and reduce the chances of the combination tipping. In certain arrangements, the counterweight **831** is configured to locate the center of mass of the adaptor **800** substantially on the axial centerline of the adaptor **800** when the regulator assembly **850** is connected to the adaptor **800**. In certain arrangements, the counterweight **831** has a mass that is about equal to the sum of the mass of an outwardly extending connection member **829** plus the mass of the regulator assembly **850** in the initial configuration. In some instances, the counterweight **831** comprises a mass of material generally located on the opposite side of the axial centerline as the regulator assembly **850**. In some instances, the counterweight **831** comprises an area of reduced mass (e.g., grooves, notches, or thinner walls) on the same side of the axial centerline as the regulator assembly **850**.

(201) As shown in FIGS. **20**A-**20**F, which illustrate cross-sectional views of various examples of the coupling **852**, the coupling **852** can be keyed or otherwise specially shaped. The connection member **829** typically is correspondingly keyed or otherwise specially shaped. Such a configuration can be useful to signal, control, or restrict the regulator assemblies **850** that can be connected with a given adaptor **800**. For example, a relatively large regulator assembly **850** (e.g., initially containing at least about 100 mL of regulating fluid) may be keyed so at not to mate with a relatively small adaptor **800** (e.g., sized and configured for to mate with vials **210** containing less than about 3 mL of fluid). In certain cases, the combination of a large regulator assembly and a small vial could be unstable and could exhibit an increased tendency to tip-over, and thus would be undesirable. However, by keying sizes of the regulator assembly **850** so as to mate only with appropriate sizes of the adaptor **800**, such concerns can be reduced or avoided. In various embodiments, the coupling **852** can be male or female and the connection member **829** can be correspondingly female or male.
(202) Various types of keyed couplings **852** are contemplated. In some embodiments, the shape of the coupling **852** inhibits or prevents rotation of the regulator assembly in relation to the remainder of the adaptor **800**. For example, as shown in FIG. **20**A, the coupling **852** can be substantially rectangular. The connection member **829** can be correspondingly rectangular to matingly engage with the coupling **852**. Similarly, as shown in FIG. **20**B, the coupling **852** can be substantially diamond-shaped. The connection member **829** can be correspondingly diamond-shaped to matingly engage with the coupling **852**. Likewise, as shown in FIG. **20**C, the coupling **852** can include notches, grooves, bumps or the like. The connection member **829** can be correspondingly shaped to matingly engage with the notches, grooves, bumps or the like of the coupling **852**.
(203) In certain embodiments, the shape of the coupling **852** establishes the orientation of the regulator assembly **850** with regard to the remainder of the adaptor **800**. For example, in the embodiment illustrated in FIG. **20**C, the coupling **852** (and thus the regulator assembly **850**) are configured to mate with the connection member **829** in only two possible orientations. In some embodiments, such as the embodiments illustrated in FIGS. **20**D, **20**E, and **20**F, the coupling **852** (and thus the regulator assembly **850**) is configured to mate with the connection member **829** in only a single possible orientation.
(204) Some embodiments provide feedback to alert the user that mating engagement of the coupling **852** and the connection member **829** has been achieved. For example, in certain instances, the connection between the coupling **852** and the connection member **829** includes a detent mechanism, e.g., a ball detent, which can provide tactile indication of engagement. Some embodiments include an audible signal, e.g., a click, snap, or the like, to indicate engagement.
(205) Certain embodiments link the coupling **852** and the connection member **829** so as to inhibit or prevent subsequent separation. For example, some arrangements include an adhesive in one or both of the coupling **852** and connection member **829**, such that mating engagement adheres the coupling **852** and the connection member **829** together. In certain other arrangements, mating engagement of the coupling **852** and connection member **829** engages one-way snap-fit features.
(206) FIG. **21** illustrates another embodiment of an adaptor **900**. The adaptor **900** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. In the illustrated embodiment, the adaptor **900** comprises a piercing member **920**, a cap connector **930**, a connector interface **940**, and a regulator assembly **950**. As shown, aside from a regulator channel **925**, the piercing member **920** is substantially solid, which can provide additional strength and rigidity for piercing vials having stiff or unyielding septums. Such a configuration for the piercing member **920** can also facilitate manufacturability.
(207) In the illustrated embodiment, the regulator assembly **950** includes a coupling **952**, bag **954**, filter **960**, and check valve **966**. Various types and kinds of check valves can be used, such as a duckbill valve, flapper valve, diaphragm-check valve, lift-check-valve, or other. In some configurations, the check valve **966** permits fluid to flow from the ambient surroundings into the

coupling **952**. Such a configuration can provide regulating fluid to the vial **210** even when the bag **954** is substantially empty of regulating fluid. Such a scenario could be encountered, for example, when the bag **954** contains a volume V.sub.1 of regulating fluid, a volume V.sub.2 of fluid is withdrawn from the vial **210** via an access channel **945**, and wherein V.sub.1 is less than V.sub.2. Thus, in such a scenario the bag **954** would have insufficient regulating fluid to compensate for the fluid withdrawn from the vial **210**. To provide the regulating fluid deficiency (e.g., the difference between V.sub.2 and V.sub.1) the check valve **966** can allow ambient air to enter the vial **210** via the adapter **800**.

(208) Generally, the check valve **966** is opened by a certain pressure gradient (e.g., at least about 1 psi, at least about 2 psi, at least about 5 psi) from one side of the valve to the other, also known as the cracking pressure. As discussed above, the withdrawal of fluid from the vial **210** can decrease the pressure in the vial **210**. Generally, the regulating fluid in the bag **954** maintains equilibrium in the vial **210**, but when the volume of regulating fluid in the bag **954** is exhausted, the pressure in the vial **210** can begin to decrease. However, when the pressure difference between the inside and outside of the vial **210** exceeds the cracking pressure of the check valve **966**, the check valve **966** opens, thereby permitting ambient air to enter the vial **210** (via the adaptor **900**), thus substantially maintaining equilibrium therein. Accordingly, the check valve **966** can facilitate the withdrawal of fluid from the vial **210** even when the bag **954** is fully deflated.

(209) FIG. **22** illustrates an embodiment of an adaptor **1000** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. The adaptor **1000** comprises a first check valve **1066** and a second check valve **1067**. Similar to the check valve **966** discussed above in connection with the adaptor **900**, the first check valve **1066** can allow ambient air to compensate for a regulating fluid deficiency. Thus, in the case that a regulator assembly **1050** is fully deflated, the first check valve **1066** can facilitate maintaining equilibrium in the vial **210**. In some cases, the first check valve **1066** is positioned in a lumen **1026**. In other cases, the first check valve **1066** is located in a coupling **1052**.

(210) As shown, in some arrangements, the second check valve **1067** is positioned to permit regulating fluid to enter the regulator assembly **1050** and to block such fluid from exiting the regulator assembly **1050**. Such a configuration can provide a trap for aerosolized or gaseous components of the contents of the vial **210**. In some cases, when fluid is introduced into the vial **210** through an access channel **1045**, regulating fluid flows from the vial **210**, through a regulator channel **1025** and a filter **1060**, through the second check valve **1067** and into the regulator assembly **1050**. As the second check valve **1067** inhibits or prevents such regulating fluid from exiting the regulator assembly **1050**, to the extent that the regulator fluid includes noxious components, such components are substantially trapped in the regulator assembly **1050** and can be disposed-of. In the illustrated embodiment, in the case in which fluid is withdrawn from the vial **210** through the access channel **1045**, because the second check valve **1067** substantially blocks regulating fluid from flowing out of the bag **1054**, the first check valve **1066** opens to supply regulating fluid (e.g., ambient air) to the vial **210** in order maintain equilibrium therein.

(211) In some embodiments, as in the embodiment shown, the adaptor **1000** includes the first and the second check valve, **1066**, **1067**. Some other instances include only the first check valve **1066**. Certain other instances include only the second check valve **1066**.

(212) As illustrated, in certain configurations, a bag **1054** of the regulator assembly **1050** contacts the vial **210**. This can, for example, allow for a wider array of geometries of the bag **1054**. In some cases, in the fully expanded state, the bag **1054** contacts vial **210**. In other configurations, the bag **1054** remains spaced apart from the vial **210**. This can, for example, decrease stress on the bag **1054** and reduce the likelihood that the structural integrity of the bag **1054** will be compromised, e.g., by a burr or label on the vial **210** piercing the bag **1054**.

(213) FIG. **23** illustrates another embodiment of an adaptor **1100**. The adaptor **1100** can have components or portions that are the same as or similar to the components or portions of other vial

adaptors disclosed herein. In the illustrated embodiment, the adaptor **1100** comprises a piercing member **1120**, a cap connector **1130**, a connector interface **1140**, and a regulator assembly **1150**. In some configurations, the piercing member **1120** includes a first regulator aperture **1168**, which is in fluid communication with a regulator channel **1125**, which in turn is in fluid communication with a second regulator aperture **1169**.

(214) In the illustrated embodiment, the regulator assembly **1150** includes a bag **1154** and a filler **1156**. However, in certain implementations, the regulator assembly **1150** does not include the filler **1156**. The filler **1156** is shown as annular and having a triangular cross-section, but can have various other configurations. In some embodiments, the bag **1154** is annular. In some embodiments, the bag **1154** has a proximal end **1168** with a proximal aperture **1169** and a distal end **1170** with a distal aperture **1171**. In some arrangements, the distal end **1170** connects with the cap connector **1130** in substantially airtight engagement and the proximal end **1168** connects with the connector interface **1140** in substantially airtight engagement. As shown, the regulator channel **1125** and an extraction channel **1145** can extend through some or the entire axial length of the bag **1154**. Also as shown, the interior of the bag **1154** can be in fluid communication with the regulator channel **1125** via the second regulator aperture **1169**. The bag **1154** can include a regulating fluid, such as a sterilized gas.

(215) In some arrangements, the regulator channel **1125** includes a portion that is substantially tortuous (e.g., winding, bending, undulating, or the like). Such a configuration can, for example, inhibit or prevent liquid in the vial **210** from flowing into the bag **1154** without the use of a liquid-rejecting filter. In some embodiments, such as in the embodiment illustrated, the regulator channel **1125** includes a hairpin turn 1172, which causes fluid flowing in the regulator channel **1125** to reverse direction (e.g., from the proximal direction to the distal direction). In some configurations, the regulator channel **1125** is substantially sinusoidally shaped. In certain embodiments, the regulator channel **1125** extends distally beyond the second regulator aperture **1169**, thereby providing a catch-basin **1173** for liquid flowing through the tortuous portion of the regulator channel **1125**.

(216) In the illustrated embodiment, the bag **1154** is substantially centered with respect to the axial center of the adaptor **1100**. Such a configuration can, for example, promote stability of the adaptor **1100** and reduce the chance of tipping when the adaptor **1100** is coupled with a vial (not shown). In certain arrangements, such a configuration can reduce the radial size of the adaptor **1100**. In some embodiments, in the fully deflated state, the bag **1154** is axially taller than diametrically wide. In some embodiments, the bag **1154** is axially taller than diametrically wide in the fully expanded state. In some embodiments, in the fully expanded state, the bag **1154** does not extend radially outward beyond the radially widest point of the cap connector **1130**, which can provide a more compact adaptor **1100**. In other embodiments, in some states (such as the fully expanded state), the bag **1154** comprises the radially widest portion of the adaptor **1100**. In such embodiments, should the adaptor **1100** tip-over, the bag **1154** will generally be the first portion of the adaptor **1100** to contact another surface (e.g., a table top). In some such embodiments, the bag **1154** acts as a pillow, cushion, damper, or shock-absorber to reduce the likelihood of damage to the adaptor **1100** or the vial.

(217) In various embodiments, the regulator assembly **1150** is positioned in a rigid housing (not shown), which can support, provide structure for, and/or protect the regulator assembly **1150**. For example, the rigid housing can inhibit or prevent the regulator assembly **1150** from being punctured or otherwise damaged. Certain variants of the rigid housing have an internal space in which some of the regulator assembly **1150** is located. In some implementations, the regulator assembly **1150** is located entirely within the internal space. In certain embodiments, a portion of the internal space is in fluid communication with the ambient environment, such as via an opening in the rigid housing. Some embodiments of the rigid housing extend between the cap connector **1130** and the connector interface **1140**.

(218) As noted above, the bag **1154** of the regulator assembly **1150** can include a regulating fluid. Some embodiments of the bag **1154** include the regulating fluid prior to coupling of the adaptor **1100** and the vial **210**. In certain implementations, the regulator assembly **1150** has a sufficient volume of regulating fluid upon (e g, immediately thereafter) coupling of the adaptor **1100** and the vial **210**. Some embodiments of the regulator assembly **1150** have a sufficient volume of regulating fluid to offset an amount of medicinal fluid that is withdrawn from the vial **210**. For example, the bag **1154** can contain about 5 mL of regulating fluid to offset the withdrawal of about 5 mL of medicinal fluid from the vial **210**. In certain embodiments, at the time of that the adaptor **1100** is coupled with the vial **210**, the regulator assembly **1150** includes a volume of regulating fluid that is greater than or equal to the volume of medicinal fluid in the vial **210**. In certain implementations, the bag **1154** contracts within the rigid enclosure as the regulating fluid exits of the bag **1154**.
(219) In some embodiments, the bag **1154** can expand within the rigid housing. For example, when an amount of diluent fluid (e.g., saline) is introduced into the vial **210**, the bag **1154** can expand within the rigid housing to accept a corresponding amount of regulating fluid from the vial **210**. In certain implementations, the bag **1154** expands completely within the rigid housing. In some variants, a portion of the bag **1154** expands out of the rigid housing, such that some of the bag is not in the internal space of the rigid housing.
(220) Certain implementations of the bag **1154** expand and contract between a maximum size and minimum size based on the volume of the regulating fluid contained in the bag **1154**. For example, in certain variants of the regulator assembly **1150**, the maximum size of the bag **1154** is sufficient to contain a volume that is greater than or equal to the volume of the vial **210**. In some embodiments, at the maximum size, the bag **1154** has a volume that is at least about: 25%, 50%, 75%, 99%, 200%, 300%, values in between, or otherwise, of the volume of the vial **210**. In some embodiments, the rigid housing is configured to partly contain the bag **1154** when the bag **1154** is at the maximum size. Certain variants of the rigid housing are configured to completely contain the bag **1154** when the bag **1154** is at the maximum size. In certain embodiments, the bag **1154** contains substantially no regulating fluid in the minimum size. In some embodiments, at the minimum size, the bag **1154** has a volume that is at least about: 0.1%, 1%, 5%, 10%, 25%, values in between, or otherwise, of the volume of the vial **210**.
(221) FIG. **24** illustrates a further embodiment of an adaptor **1200**. The adaptor **1200** can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. In the illustrated embodiment, the adaptor **1200** comprises a first piercing member **1220**, a second piercing member **1220′**, a cap connector **1230**, a connector interface **1240**, and a regulator assembly **1250**. In some embodiments, the first piercing member **1220** includes an access channel **1245**. In certain embodiments, the second piercing member **1220′** includes a regulator channel **1225**. In some arrangements, the regulator channel **1225** extends through the cap connector **1230** at an angle (e.g., at least about 45°) with respect to the axial centerline of the adaptor **1200**. In various embodiments, the first and second piercing members **1220**, **1220′** each pierce the septum of the vial **210** when the adaptor **1200** is coupled with the vial **210**. In certain embodiments, a distal end of one or both of the first and second piercing members **1220**, **1220′** is angled from one side of to the opposite side.
(222) As illustrated, the regulator assembly **1250** can include a filler **1256** and a bag **1254** in fluid communication with the regulator channel **1225**. As shown, the bag **1254** can be annular, which can facilitate the adaptor **1200** having a center of mass that is about on the axial centerline of the adaptor **1200**, and thus provides enhanced stability.
(223) FIG. **25**A illustrates an embodiment of a reservoir **1350** which can be attached to a lumen **1326** of a vial adaptor. As illustrated, a bag **1354** includes an interior chamber **1355**. The bag **1354** is generally configured to stretch, flex, unfold, or otherwise expand and contract or cause a change in interior volume within an inner chamber **1355**. In some cases, the bag **1354** includes one or more folds, pleats, or the like. In certain embodiments, the bag **1354** connects with a lumen **1326** of the

vial adaptor, such as with an adhesive, pipe clamp, snap ring or otherwise. In certain arrangements, the interior chamber **1355** of the bag **1354** is in fluid communication with a regulator channel **1325**, thereby allowing fluid to pass from the regulator channel **1325** into the interior chamber **1355** and/or from the interior chamber **1355** into the regulator channel **1325**. Furthermore, in some embodiments, the bag **1354** includes an interior filler. The filler can be constructed to inhibit the bag **1354** from fully deflating at ambient pressure. In some embodiments, the filler can occupy a portion of or substantially the entire interior volume of the inner chamber **1355**.

(224) According to some embodiments, at least a majority, or the entirety or nearly the entirety, of the bag **1354** is contained within a rigid enclosure **1374**. As illustrated, the bag **1354** is virtually entirely surrounded by the rigid enclosure **1374**. In some configurations, the rigid enclosure **1374** has substantially the same shape as the bag **1354**. In some embodiments, the rigid enclosure **1374** includes one or more vents **1375**. As illustrated, the vents **1375** can be smaller than the outer diameter of the lumen **1326**. In the illustrated embodiment, the rigid enclosure **1374** and lumen **1326** are a unitary part. In some embodiments, the rigid enclosure **1374** can be fixedly or removably attached to the lumen **1326**.

(225) In some embodiments, the reservoir **1350** includes an intermediate chamber **1376** defined by the space between the outer surface of the bag **1354** and the inner surface of the rigid enclosure **1374**. According to some configurations, the intermediate chamber **1376** is in fluid or non-fluid communication with the ambient surroundings of the reservoir **1350**. In some embodiments, the connection between the bag aperture **1357** and the lumen **1326** creates a hermetic seal which can prevent fluid communication between the regulator channel **1325** and the intermediate chamber **1376**.

(226) In some embodiments, the bag **1354** can be configured to expand when regulator fluid moves from the regulator channel **1325** to the interior volume **1355** of the bag **1354** in response to injection of fluid into a container **10** via an exchange device **40**. In some configurations, the expansion of the bag **1354** is limited by the size of the rigid enclosure **1374**. In some embodiments, the bag **1354** is configured to contract when regulator fluid is moved from the interior volume **1355** of the bag **1354** to the regulator channel **1325** in response to withdrawal of fluid from a container **10** via an exchange device **40**. In some embodiments, the expansion and contraction of the bag **1354** can help maintain substantially constant pressure within the container **10**. In some embodiments, the one or more vents **1375** in the rigid enclosure **1374** can help inhibit pressure increase and decrease within the intermediate enclosure **1376** when the bag **1354** expands and contracts.

(227) In certain embodiments, the bag **1354** has a generally constant wall thickness T2. In some embodiments, the wall thickness T2 of the bag **1354** varies from a first side **1358** to a second side **1359** of the bag. In some embodiments, variable thickness of the bag **1354** can cause the bag **1354** to expand in one or more controlled directions. For example, thinner walls on the first side **1358** as compared to the second side **1359** can cause the first side **1358** to expand at a higher rate than the second side **1359**. This variable rate of expansion can facilitate, upon expansion of the bag **1354**, translation of the second side **1359** of the bag **1354** away from the bag aperture **1357**.

(228) FIG. **25**B illustrates an embodiment of a reservoir **1450** which can be attached to a lumen **1426** of a vial adaptor. As illustrated, the reservoir **1450** can include an enclosure **1454**. In some embodiments, an enclosure includes a first side **1458** and a second side **1450** connected to each other via an annular ring **1454**A. The annular ring **1454**A can be constructed of a flexible material which can, for example, be crumpled, folded and/or stretched. The first side **1458** and second side **1459** of the enclosure **1454** can be constructed of a rigid or semi-rigid material. The enclosure **1454** can include an interior chamber **1455**.

(229) In some embodiments, the interior chamber **1455** is in fluid or non-fluid communication with a regulator channel **1425**. In such embodiments, fluid can be permitted to pass between the regulator channel **1425** and the interior chamber **1455** via an aperture **1457** in the enclosure **1454**.

Furthermore, in some embodiments, the enclosure **1454** includes an interior filler. The filler can be constructed to inhibit the enclosure **1454** from fully collapsing at ambient pressure. In some embodiments, the filler occupies a portion of or substantially the entire interior volume of the inner chamber **1455**.

(230) According to some embodiments, the annular ring **1454**A of the enclosure is configured to stretch, unfold, uncrumple and/or deform in some other manner so as to increase the volume within the inner chamber **1455** in response to injection of fluid into a container **10** via an exchange device **40**. In some embodiments, the annular ring **1454**A is configured to crumple, fold, compress and/or deform in some other manner as to decrease the volume within the inner chamber **1455** in response to a withdrawal of fluid from the container **10** via an exchange device **40**. According to some embodiments, the expansion and contraction of the enclosure **1454** can help maintain substantially constant pressure within the container **10** and inner chamber **1455**.

(231) In some embodiments, as illustrated, the first side **1458** of the enclosure **1454** is a unitary part with the lumen **1426**. In some embodiments, the first side **1458** of the enclosure **1454** can be fixedly or removably attached to the lumen **1426**. The first side **1458** of the enclosure **1454** can be attached to the lumen **1426** in a hermetically sealed fashion, thus inhibiting the escape of fluid from the connection point between the first side **1458** and the lumen **1426**. According to some embodiments, the annular ring **1454**A of the enclosure **1454** is attached to the first and second sides **1458**, **1459** of the enclosure **1454** at connection points **1452** via an adhesive or some other means which can provide a hermetic seal between the inner chamber **1455** and the surrounding ambient. In some configurations, the width W**2** of the annular ring **1454**A and the height H of the enclosure **1454** can vary depending on the desired volume displacement in the inner chamber **1455** when the enclosure **1454** expands and/or contracts.

(232) FIG. **25**C illustrates an embodiment of a reservoir **1550** which can be attached to a lumen **1526** of a vial adaptor. As illustrated, the reservoir **1550** includes an enclosure **1554**. In some embodiments, the enclosure **1554** includes a first side **1558** and a second side **1559**. According to some configurations, the first side **1558** and/or second side **1559** of the enclosure **1554** are constructed of a flexible material which can, for example, be crumpled, folded, stretched and/or otherwise deformed. In some embodiments, the first and second sides **1558**, **1559** of the enclosure **1554** are attached to each other via an annular ring **1554**A. In some embodiments, the annular ring **1554**A is constructed of a rigid or semi-rigid material. Furthermore, the enclosure **1554** can include an inner chamber **1555**.

(233) In some embodiments, the first side **1558** of the enclosure **1554** connects with a lumen **1526** of the vial adaptor, such as with an adhesive, pipe clamp, snap ring or otherwise. In certain arrangements, the inner chamber **1555** of the enclosure **1554** is in fluid or non-fluid communication with a regulator channel **1525**, thereby allowing fluid to pass between the regulator channel **1525** and the inner chamber **1555**. In some embodiments, the enclosure **1554** includes an interior filler. The filler can be constructed to inhibit the enclosure **1554** from fully collapsing at ambient pressure. In some embodiments, the filler occupies a portion of or substantially the entire interior volume of the inner chamber **1555**.

(234) According to some embodiments, the annular ring **1554**A of the enclosure **1554** is attached to the first and second sides **1558**, **1559** of the enclosure **1554** at connection points **1552** via an adhesive or some other means which can provide a hermetic seal between the inner chamber **1555** and the surrounding ambient. In some arrangements, the first and second sides **1558**, **1559** of the inner chamber **1555** are configured to stretch, unfold, uncrumple and/or deform in some other manner, so as to increase the volume within the inner chamber **1555** in response to an injection of fluid into a container **10** via an exchange device **40**. In some embodiments, the first and second sides **1558**, **1559** of the inner chamber **1555** are configured to crumple, fold, compress and/or deform in some other manner, so as to decrease the volume within the inner chamber **1555** in response to withdrawal of fluid from the container **10** via an exchange device **40**. According to

some embodiments, the expansion and contraction of the enclosure **1554** can help maintain substantially constant pressure within the container **10**.

(235) FIGS. **25**D-**25**E illustrate an embodiment of a reservoir **1650** which can be attached to a lumen **1626** of a vial adaptor. In certain embodiments, the reservoir **1650** includes an enclosure **1654**. The enclosure **1654** can also include an inner chamber **1655**. In some configurations, the enclosure **1654** includes a plurality of openings, such as are formed by a series of generally concentric rings **1654**A, **1654**B, as illustrated. In some embodiments, the enclosure **1654** includes an aperture **1657** which can connect with the lumen **1626** of the vial adaptor, such as with an adhesive, pipe clamp, snap ring or otherwise. In certain arrangements, the inner chamber **1655** of the enclosure **1654** is in fluid or non-fluid communication with a regulator channel **1625**, thereby allowing fluid to pass between the regulator channel **1625** and the inner chamber **1655**.

(236) In some embodiments, the region between the openings (e.g., the concentric rings **1654**A) is constructed of a rigid or semi-rigid material. Furthermore, in some embodiments, the rings **1654**B are constructed of a flexible material. According to some embodiments, the rings **1654**A are attached to the adjacent rings **1654**B via an adhesive or some other means which can provide a hermetic seal between the inner chamber **1655** and the surrounding ambient. In some configurations, the enclosure **1554** includes an interior filler. The filler can be constructed to inhibit the enclosure **1654** from fully collapsing at ambient pressure. In some embodiments, the filler occupies a portion of or substantially the entire interior volume of the inner chamber **1655**.

(237) According to some configurations, the rings **1654**B are configured to stretch, unfold, uncrumple and/or deform in some other manner, so as to increase the volume within the inner chamber **1655** in response to an injection of fluid into a container **10** via an exchange device **40**. In some embodiments, the rings **1654**B of the inner chamber **1655** are configured to crumple, fold, compress and/or deform in some other manner as to decrease the volume within the inner chamber **1655** in response to withdrawal of fluid from the container **10** via an exchange device **40**. According to some embodiments, the expansion and contraction of the enclosure **1654** can help maintain substantially constant pressure within the container **10**.

(238) FIG. **26**A illustrates an embodiment of an adaptor **1700** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein, and also includes a valve **1770**. The adaptor **1700** is configured to engage with a vial **10**. In some embodiments, the adaptor **1700** includes a regulator assembly **1750**. In some configurations, the regulator assembly **1750** includes a protrusion **1785***a* which can be substantially sealingly attached to (e.g., received within or around the outer perimeter of) a lumen **1726** of the regulator assembly **1750**. The protrusion **2085***a* can facilitate fluid communication between two or more features (e.g., a filter, enclosure, bag and/or valve) of the regulator assembly. In some embodiments, the protrusion **2085***a* can generally define a regulator path. The regulator path can be in fluid communication with the regulator channel a regulator channel **1725** of the regulator assembly **1750**. The longitudinal axis of the protrusion **1785***a* and/or the lumen **1726** can be at least partially, substantially, or wholly perpendicular to the axial centerline of the adaptor **1700**. In some embodiments, the longitudinal axis of the protrusion **1785***a* and/or the lumen **1726** is at least partially, substantially, or wholly parallel to the axial centerline of the adaptor **1700**. In some embodiments, the angle between the longitudinal axis of the protrusion **1785** and the axial centerline of the adaptor **1700** is greater than or equal to about 5° and/or less than or equal to about 85°. In some embodiments, the angle is about 60°. In certain embodiments, the angle between the longitudinal axis of the protrusion **1785** and the axial centerline of the adaptor **1700** can be any angle between 0° and 90° or a variable angle that is selected by the user. Many variations are possible.

(239) In some embodiments, the regulatory assembly includes a filter **1760**. The filter **1760** can include a hydrophobic filter. In some embodiments, the valve **1770** or a portion thereof is located within a lumen **1726** of the adaptor **1700**. In some embodiments, the valve **1770** or a portion

thereof is located outside the lumen **1726** of the adaptor **1700** within the protrusion **1785***a* of the regulator assembly **1750**.

(240) According to some embodiments, the valve **1770** is configured to permit air or other fluid that has passed through the filter **1760** to pass into the container **10**. In some embodiments, the valve **1770** is configured to selectively inhibit fluid from passing through the valve **1770** from the container **10** to the filter **1760**.

(241) In some configurations, the valve **1770** is selectively opened and/or closed depending on the orientation of the adaptor **1700**. For example, the valve **1770** can be configured to allow fluid flow between the container **10** and the filter **1760** without restriction when the adaptor **1700** is positioned above (e.g., further from the floor than) a vial **10** to which the adaptor is attached. In some embodiments, the valve **1770** can be configured to prevent fluid flow from the container **10** to the filter **1760** when the vial **10** is positioned above the adaptor **1700**.

(242) In some embodiments, the valve **1770** can open and/or close in response to the effect of gravity upon the valve **1770**. For example, the valve **1770** can include components that move in response to gravity to open and/or close channels within the valve **1770**. In some embodiments, channels within the valve **1770** can be constructed such that the effect of gravity upon fluid within the adaptor **1700** can prevent or allow the fluid to pass through the channels within the valve **1770**.

(243) For example, the valve **1770** can comprise an orientation-sensitive or orientation-dependent roll-over valve. In some embodiments, a roll-over valve **1770** can comprise a weighted sealing member. In some embodiments, the weighted sealing member can be biased to seal and/or close the valve **1770** when the vial **10** is positioned above the adaptor **1700**. In some embodiments, the sealing member can be biased to seal the valve **1770** by the force of gravity. In some embodiments, the sealing member can be biased to seal the valve **1770** through the use of a compression spring. The sealing member can be constructed such that it can transition to open the valve **1770** when the adaptor **1700** is positioned above the vial **10**. For example, the weight of the sealing member can be high enough that it overcomes the force of the compression spring and moves to an open position when the adaptor **1700** is positioned above the vial **10**.

(244) In some embodiments, the valve **1770** can comprise a swing check valve. In some embodiments, the valve **1770** can comprise a weighted panel rotatably connected to the wall of the regulator channel **1925**. The weighted panel can be oriented such that, when the adaptor **1700** is positioned above the vial **10**, the weighted panel is rotated to an open position wherein the weighted panel does not inhibit the flow of fluid through the regulator channel **1925**. In some embodiments, the weighted panel can be configured to rotate to a closed position wherein the weighted panel inhibits the flow of fluid through the regulator channel **1925** when the vial **10** is positioned above the adaptor **1700**.

(245) According to some configurations, the valve **1770** can be a check valve which can transition between two or more configurations (e.g., an open and closed configuration). In some embodiments, the valve **1770** can change configurations based on user input. For example, the valve **1770** and/or regulator assembly **1750** can include a user interface (e.g., a button, slider, knob, capacitive surface, switch, toggle, keypad, etc.) which the user can manipulate. The user interface can communicate (e.g., mechanically, electronically, and/or electromechanically) with the valve **1770** to move the valve **1770** between an opened configuration and a closed configuration. In some embodiments, the adaptor **1700** and/or regulator assembly **1750** can include a visual indicator to show whether the valve **1770** is in an open or closed configuration.

(246) According to some embodiments, the valve **1770** is configured to act as a two-way valve. In such configurations, the valve **1770** can allow for the passage of fluid through the valve **1770** in a first direction **1770**A at one pressure differential while allowing for the passage of fluid in a second direction **1770**B at a different pressure differential. For example, the pressure differential required for fluid to pass in a first direction **1770**A through the filter **1770** can be substantially higher than the pressure differential required for fluid to pass through the filter **1770** in a second direction

1770B.

(247) FIG. **26**B illustrates an embodiment of an adaptor **1800** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. The adaptor **1800** includes a regulator assembly **1850** which, in some embodiments, can include a valve **1870**. The valve **1870** can be located in a regulator channel **1825** within a lumen **1826** of the adaptor **1800** between a container **10** and a bag or other enclosure **254**. In some embodiments, the valve **1879**, or a portion thereof, is located outside of the lumen **1826** and within a coupling **1852** of the regulator assembly **1850**. In some embodiments, the valve **1870** is configured to permit regulator fluid and/or other fluid to pass from the enclosure **1854** to the container **10**. In some embodiments, the valve **1870** is configured to inhibit or prevent the passage of fluid from the container **10** to the enclosure **1854**.

(248) In some configurations, the valve **1870** is selectively opened and/or closed depending on the orientation of the adaptor **1800**. For example, the valve **1870** can be configured to allow fluid flow between the container **10** and the enclosure **1854** without restriction when the adaptor **1800** is oriented above a vial **10** to which the adaptor is attached. In some embodiments, the valve **1870** is configured to prevent fluid flow from the container **10** to the enclosure **1854** when the vial **10** is positioned above the adaptor **1800**. Furthermore, in some embodiments, the valve **1870** is configured to act as a two-way valve in substantially the same manner as described above with regard to the valve **1770**.

(249) FIG. **26**C illustrates an embodiment of an adaptor **1900** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. The adaptor **1900** can include a valve **1970** situated in a regulator channel **1925** within a protrusion **1985***a* of a regulator assembly **1950** between a container **10** and a filter **1960**. In some embodiments, the valve **1970**, or some portion thereof, is located in the regulator channel **1925** outside the protrusion **1985***a*. The regulator assembly **1950** can include an enclosure **1954**. In some embodiments, the valve **1970** restricts the flow of fluid through the regulator channel **1925** in substantially the same way as other valves (e.g., **1770**, **1870**) described herein.

(250) FIGS. **27**A-**27**C illustrate an embodiment of a vial adaptor **2000** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. In some embodiments, the vial adaptor **2000** includes a connector interface **2040** and a piercing member **2020** in partial communication with the connector interface **2040**. In some embodiments, the vial adaptor **2000** includes a regulator assembly **2050**.

(251) The regulator assembly **2050** can include an orientation-actuated or orientation-dependent or orientation-sensitive occluder valve, such as a ball check valve **2070**. In some embodiments, the occluder valve can be removably inserted into one or more lumens of the regulator assembly **2050** via an installation path. The installation path can be defined by the axial centerline of the lumen or portion thereof into which the occluder valve is inserted. In some embodiments, the occluder valve is configured to transition between an open configuration and a closed configuration based upon the orientation of the vial adaptor **2000** (e.g., the orientation of the vial adaptor **2000** with respect to the floor). In some such embodiments, the occluder valve is configured to transition from a first configuration corresponding with a first orientation of the vial adaptor **2000** to a second configuration corresponding with a second orientation of the vial adaptor **2000**. The occluder valve can be configured to transition from the first orientation to the second orientation independent of the path of rotation of the vial adaptor **2000**. In some embodiments, the occluder valve can include an occluding member configured to move about within a valve chamber. For example, the occluding member could be configured to engage with and disengage from a valve seat within the valve chamber depending on the configuration of the occluder valve and the orientation of the vial adaptor **2000**. The occluding member can have an ellipsoidal shape, a spherical shape, a generally cylindrical shape with a tapered end, or any other appropriate shape.

(252) In some configurations, the ball check valve **2070** is located in a lumen of the regulator

assembly and/or in a lumen of the connector interface **2040**. For example, the ball check valve **2070** can be located in a regulator channel **2025** within a lumen **2026** of the regulator assembly **2050**. In some embodiments, the ball check valve **2070** is removable from the regulator channel **2025**. In certain variants, the ball check valve **2070** includes a retaining member that prevents or impedes the ball **2073** from falling out of the ball check valve **2070** when it is removed from the regulator channel **2025**. The ball check valve **2070** can be rotatable about its axial centerline within the regulator channel **2025**. In some embodiments, the ball check valve **2070** can be installed in other lumens of the vial adaptor **2000**. In some configurations, the regulator assembly **2050** includes a lumen or appendage or protrusion **2085***a* which can be substantially sealingly attached to (e.g., received within or around the outer perimeter of) the lumen **2026** of the regulator assembly **2050**. The protrusion **2085***a* can facilitate fluid communication between two or more features (e.g., a filter, enclosure, bag and/or valve) of the regulator assembly. According to some configurations, the ball check valve **2070**, or some portion thereof, can be located in the regulator channel **2025** within the protrusion **2085***a*. In some embodiments, the ball check valve **2070** and protrusion **2085***a* form a unitary part. In some embodiments, the ball check valve **2070** and lumen **2026** form a unitary part.

(253) In some embodiments, the ball check valve **2070** includes a first chamber **2074** in fluid communication with the vial **10** via the regulator channel **2025**. The ball check **2070** can include a second chamber **2072** in selective fluid communication with the first chamber **2074**. According to some configurations, the first chamber **2074** has a substantially circular cross section with a diameter or cross-sectional distance DV1 and height H**2**. In some embodiments, the longitudinal axis of the first chamber **2074** is parallel to the axial centerline of the vial adaptor **2000**. In some embodiments, the longitudinal axis of the first chamber **2074** is positioned at an angle away from the axial centerline of the vial adaptor **2000**. The angle between the longitudinal axis of the first chamber **2074** and the axial centerline of the vial adaptor **2000** can be greater than or equal to about 15° and/or less than or equal to about 60°. In some embodiments, the angle between the longitudinal axis of the first chamber **2074** and the axial centerline of the vial adaptor **2000** is approximately 45°. Many variations are possible. In some embodiments, the second chamber **2072** also has a substantially circular cross section with a diameter or cross-sectional distance DV2. Many other variations in the structure of the first and second chambers are possible. For example, other cross-sectional shapes may be suitable.

(254) In some embodiments, the ball check valve **2070** can include a shoulder **2078** between the first chamber **2074** and second chamber **2072**. The shoulder **2078** can comprise a sloped or tapering surface configured to urge a ball **2073** to move toward an occluding position under the influence of gravity when the vial adaptor is oriented such that the vial is above the vial adaptor. In some embodiments, the angle θ between the shoulder **2078** and the wall of the first chamber **2074** is less than or equal to about 90°. In some embodiments the angle θ is less than or equal to about 75° and/or greater than or equal to about 30°. In some embodiments, the second chamber **2072** is in fluid communication with the first chamber **2074** when the ball check valve **2070** is in an open configuration. In some embodiments, the inner wall of the first chamber **2074** can gradually taper into the inside wall of the second chamber **2072** such that the first and second chambers **2074**, **2072** constitute a single generally frustoconical chamber.

(255) In some embodiments, the ball **2073** can rest on a circular seat when in the occluding position. In some embodiments, the circular seat is formed by the shoulder **2078**. In some embodiments, the longitudinal axis of the circular seat is parallel to the longitudinal axis of the first chamber **2074**. In some embodiments, the longitudinal axis of the first chamber **2074** can define a general movement path for the ball **2073** or other occluding member (e.g., the ball **2073** can generally move to and/or from the occluding position in a direction generally parallel to the longitudinal axis of the first chamber **2074**). In some embodiments, the movement path of the occluding member is not substantially parallel to the installation path of the ball check valve **2070**.

For example, the movement path of the occluding member can be substantially perpendicular to the installation path of the ball check valve **2070**. In certain variations, the longitudinal axis of the circular seat forms an angle with the respect to the longitudinal axis of the first chamber **2074**. The angle formed between the longitudinal axis of the circular seat and the longitudinal axis of the first chamber **2074** can be greater than or equal to about 5° and/or less than or equal to about 30°. In some embodiments, the angle is approximately 10°. Many variations are possible. In some embodiments, the longitudinal axes of the first chamber **2074** and the circular seat are parallel to the axial centerline of the adaptor **2000**. Such a configuration can reduce the likelihood that the ball **2073** will “stick to” the circular seat or to the inner walls of the first chamber **2074** when the ball check valve **2070** is transitioned between the opened and closed configurations, as will be explained below.

(256) In certain configurations, the longitudinal axis of the first chamber **2074** can be substantially parallel to the axial centerline of the ball check valve **2070**. In some embodiments, the longitudinal axis of the first chamber **2074** can define the movement path of the ball **2073**. As illustrated in FIG. **27**C, the longitudinal axis of the first chamber **2074** can be perpendicular to the axial centerline of the ball check valve **2070**. In some embodiments, the angle between the longitudinal axis of the first chamber **2074** and the axial centerline of the ball check valve **2070** is greater than or equal to about 5° and/or less than or equal to about 90°. In some embodiments, the angle is about 60°. Many variations are possible. In some embodiments, the angle between the longitudinal axis of the first chamber **2074** and axial centerline of the ball check valve **2070** is the same as the angle between the axial centerline of the ball check valve **2070** and the axial centerline of the vial adaptor **2000**. In some such embodiments, the longitudinal axis of the first chamber **2074** can be aligned with the axial centerline of the vial adaptor **2000**.

(257) The ball check valve **2070** can also include a valve channel **2071**. According to some embodiments, the valve channel **2071** is in fluid communication with the second chamber **2072**. In some embodiments, the valve channel **2071** generally defines a flow path between the second chamber **2072** and a portion of the regulator channel **2025** opposite the second chamber **2072** from the first chamber **2074**. As illustrated in FIGS. **27**A-**27**C, the ball check valve **2070** can include one or more sealing portions **2079**. The one or more sealing portions **2079** can resist movement of the ball check valve **2070** within the regulator channel **2025**. In some embodiments, the one or more sealing portions **2079** inhibit fluid from flowing around and bypassing the ball check valve **2070**. In some embodiments, the one or more sealing portions **2079** include one or more annular protrusions that extend from the valve channel **2071**. Many variations are possible.

(258) As illustrated in FIG. **27**A, the ball check valve **2070** has a distal opening **2075***a*. In some embodiments, the ball check valve **2070** has a plurality of distal openings. The distal opening **2075***a* defines the fluid boundary (e.g., the interface) between the first chamber **2074** and the regulator channel **2025**. In some embodiments, the ball check valve **2070** includes a first valve channel in fluid communication with both the regulator channel **205** and the first chamber **2074**. In such embodiments, the distal opening **2075***a* defines the fluid boundary (e.g., the interface) between the first valve channel and the regulator channel **2025**. The ball check valve **2070** further includes a proximal opening **2075***b* that defines the fluid boundary (e.g., the interface) between the valve channel **2071** and the regulator channel **2025**.

(259) The ball check valve **2070** can be configured such that fluids that enter and exit the ball check valve **2070** through the distal opening **2075***a* and the proximal opening **2075***b* flow through the interfaces defined by each opening in a direction generally perpendicular to the interfaces. For example, as illustrated in FIG. **27**B, regulator fluid FR that enters and/or exits the ball check valve **2070** through the proximal opening **2075***b* has a flow direction (horizontal with respect to FIG. **27**B) that is generally perpendicular to the interface (vertical with respect to FIG. **27**B) defined by the proximal opening **2075***b*. Similarly, the flow of liquid into and out of the ball check valve **2070** through the distal opening **2075***a* is in a direction generally perpendicular to the interface defined

by the proximal opening **2075***a*. In some embodiments, the direction of flow through one or more of the distal opening **2075***a* and the proximal opening **2075***b* is oblique or perpendicular to the movement path of the ball **2073** or other occluding member. The angle formed between either interface and the movement path of the ball **2073** can be the same as the angle formed between the same interface and the insertion axis of the adaptor **2000**.

(260) According to some embodiments, the occluder valve **2070** includes a moveable occluder, such as a ball **2073**. All references herein to a ball can apply to an occluder of any other shape, such as a generally cubic occluder, a generally cylindrical occluder, a generally conical occluder, combinations of these shapes, etc. In some embodiments, the ball **2073** is generally spherical or has another suitable shape. The ball **2073** can be constructed of a material with a higher density than the liquid L or other fluid within the vial **10**. The ball **2073** can have a diameter DB. In some configurations, the diameter DB of the ball **2073** is less than the diameter DV1 and height H**2** of the first chamber **2074**. For example, in some embodiments the ratio of the diameter DB of the ball **2073** to the diameter DV1 of the first chamber **2074** is less than or equal to about 9:10 and/or greater than or equal to about 7:10. In some configurations, the diameter DB of the ball **2073** is greater than the diameter DV2 of the second chamber **2072**. For example, in some embodiments the ratio of the diameter DV2 of the second chamber **2072** to the diameter DB of the ball **2073** is less than or equal to about 9:10 and/or greater than or equal to about 7:10. In some embodiments, the ball **2073** is can move between at least two positions within the first chamber **2074**. For example, movement of the ball **2073** can be governed by gravity, external forces on the vial adapter, fluids within the regulator channel, other forces, or a combination of forces.

(261) As illustrated in FIGS. **27**A-**27**C, the ball **2073** in the ball check valve **2070** can be configured to rest upon the shoulder **2078** at the opening of the second chamber **2072** when the adaptor **2000** and vial **10** are oriented such that the force of gravity is influencing the fluid contained within the vial to be urged toward the vial adaptor (e.g., when at least some portion of the vial **10** is above the connector interface **2040**). The ball check valve **2070** can be oriented such that the longitudinal axis of the first chamber **2074** and the longitudinal axis of the circular seat are substantially parallel to the axial centerline of the vial adaptor **2000**. In such embodiments, the ball **2073** can be configured to transition to the occluding position (e.g., resting on the circular seat) in a substantially consistent manner independent of the direction of rotation of the vial **10** and the connector interface **2040**. For example, in such embodiments, the manner in which the ball **2073** moves toward the shoulder **2078** or circular seat when the vial **10** is rotated from below connector interface **2040** to above the connector interface **2040** would be substantially consistent and independent of whether the vial **10** and connector interface **2040** were rotated about the longitudinal axis of the lumen **2026**, about an axis perpendicular to the longitudinal axis of the lumen **2026** and to the axial centerline of the vial adaptor **2000**, or about any other axis of rotation therebetween. Furthermore, in such embodiments, parallel alignment between the longitudinal axis of the first chamber **2074** and the axial centerline of the adaptor **2000** can assist the user of the adaptor **2000** in visualizing the alignment of the ball check valve **2070**. In some configurations, the contact between the ball **2073** and the shoulder **2078** can form a seal **2076**. The seal **2076** can put the ball check valve **2070** in a closed configuration and inhibit passage of liquid L and/or other fluid from the vial **10** through the ball check valve **2070** when the vial **10** is oriented above the connector interface **2040**.

(262) In some embodiments, the ball **2073** can be configured to move away from the shoulder **2078** when the adaptor **2000** and vial **10** are oriented such that fluid within the vial is urged away from the vial adaptor under the force of gravity (e.g., when at least a portion of the connector interface **2040** is positioned above the vial **10**). In some embodiments (such as, for example, embodiments in which the longitudinal axes of the first chamber **2074** and the circular seat are parallel to the axial centerline of the vial adaptor **2000**), the ball **2073** can be configured to move away from the shoulder **2078** in a substantially consistent manner independent of the direction of rotation of the

vial **10** and the connector interface **2040**. For example, in such embodiments, the manner in which the ball **2073** moves away from the shoulder **2078** when the vial **10** is rotated from above connector interface **2040** to below the connector interface **2040** would be substantially consistent and independent of whether the vial **10** and connector interface **2040** were rotated about the longitudinal axis of the lumen **2026**, about an axis perpendicular to the longitudinal axis of the lumen **2026** and to the axial centerline of the vial adaptor **2000**, or about any other axis of rotation therebetween. Movement of the ball **2073** away from the shoulder **2078** can open or break the seal **2076** and put the ball check valve **2070** in an open configuration such that the first chamber **2074** and second chamber **2072** are in fluid communication. In some embodiments, the ball check valve **2070** includes a resilient biasing member which can bias the ball **2073** toward the shoulder **2078** and thus bias the ball check valve **2070** to a closed configuration. In some configurations, the biasing member can be a spring. In some configurations, the biasing member can be a flexible member. In some embodiments, the biasing force provided by the resilient biasing member can be less than the weight of the ball **2073**.

(263) In some embodiments, the ball **2073** can move about the first chamber **2074** under the influence of gravity. In some configurations, gravity can cause the ball **2073** to move toward the second chamber **2072** and rest upon the shoulder **2078** at the opening of the second chamber **2072**. As explained above, the resting of the ball **2073** upon the shoulder **2078** can create a seal **2076** which can put the ball check valve **2070** in a closed configuration and inhibit passage of liquid L and/or other fluid from the vial **10** through the ball check valve **2070**. In some configurations, gravity can cause the ball **2073** to move away from the shoulder **2078**. Movement of the ball **2073** away from the shoulder **2078** under the influence of gravity can open or break the seal **2076** and put the ball check valve **2070** in an open configuration such that the first chamber **2074** and second chamber **2072** are in fluid communication. Since the diameter or cross-section of the first chamber DV1 is greater than the diameter or cross-section DB of the ball **2073**, fluid can flow through the first chamber, around the outside surface of the ball **2073**.

(264) Certain aspects of the operation of the ball check valve **2070** while the ball check valve **2070** is in a closed configuration will now be described. For example, in some embodiments when no fluid is being introduced to or withdrawn from the vial **10** via the access channel **2045**, the pressure within the vial **10** is substantially the same as the pressure in the valve channel **2071**. In such a situation, the pressure in the first chamber **2074** can be substantially the same as the pressure in the second chamber **2072**. In some embodiments, positioning of the vial **10** above the connector interface **2040** can cause liquid L or other fluid to move from the vial **10** to the first chamber **2074**. In some embodiments, the ball **2073** will remain at rest on the shoulder **1078** and create a seal **2076** when there is equilibrium in the pressure between the first chamber **2074** and the second chamber **2072**. The seal **2076** can inhibit passage of liquid L and/or other fluid from the vial **10** through the ball check valve **2070**.

(265) In some embodiments, withdrawal of fluid from the vial **10** through the access channel **2045** can create lower pressure in the vial **10** and first chamber **2074** than the pressure within the second chamber **2072**. The pressure differential can cause the ball **2073** to move away from the shoulder **2078** into the first chamber **2074**. The movement of the ball **2073** away from the shoulder **2078** can break the seal **2076** and permit regulator fluid FR to pass from through the second chamber **2072** and around the ball **2073**. The regulator fluid FR can then pass through the first chamber **2074** and through the regulator channel **2025** into the vial **10**. In some embodiments, the regulator fluid FR is fluid which has passed through a filter in the regulator assembly **2050**. In some embodiments, the regulator fluid FR is a fluid contained in the inner volume of an enclosure of the regulator assembly **2050**. Passage of regulator fluid FR into the vial **10** can offset, reduce, substantially eliminate, or eliminate the pressure differential between the first chamber **2074** and the second chamber **2072** and allow the ball **2073** to return to a resting position on the shoulder **2078**. In some embodiments, the passage of regulator fluid FR into the vial **10** helps to maintain equilibrium between the interior

of the vial **10** and the interior of the regulator assembly **2050**. The return of the ball **2073** to a resting position on the shoulder **2078** can recreate or produce the seal **2076** and prevent passage of liquid L or other fluid from the vial **10** through the ball check valve **2070**.

(266) In some embodiments, introduction of fluid to the vial **10** through the access channel **2045** (e.g., when diluents, mixing fluids, or overdrawn fluids are injected into the vial **10** via an exchange device **40**) can create higher pressure in the vial **10** and first chamber **2074** than the pressure within the second chamber **2072**. This difference in pressure can cause the ball **2073** to be pushed onto the shoulder **2078** and thus tighten the seal **2076**. Tightening of the seal **2076** can inhibit the passage through the ball check valve **2070** of fluid L from the vial **10**. In some embodiments, the tightening of the seal **2076** can cause the internal pressure within the vial **10** and first chamber **2074** to continue to increase as more fluid is introduced into the vial **10** via the access channel **2045**. In some embodiments, a continual increase in pressure within the vial **10** and first chamber **2074** can dramatically increase the force required to introduce more fluid to a prohibitive level, and eventually increase the likelihood of fluid leaks from the vial **10** and adaptor **2000** or between these components. It can therefore be desirable for the ball check valve **2070** to be in an open position when fluids are injected into the vial **10**.

(267) Movement of the ball **2073** away from the shoulder **2078** can open or break the seal **2076** and put the ball check valve **2070** in an open configuration. Certain aspects of the operation of the ball check valve **2070** while the ball check valve **2070** is in an open configuration will now be described. For example, in some embodiments when no fluid is being introduced to or withdrawn from the vial **10** via the access channel **2045**, the pressure within the vial **10** remains substantially constant. In some embodiments, the vial **10** is in fluid communication with and has the same substantially constant internal pressure as the first and second chambers **2074**, **2072** and valve channel **2071** of the ball check valve **2070**.

(268) In some embodiments, withdrawal of fluid from the vial **10** through the access channel **2045** can lower the pressure in the vial **10** and subsequently lower the pressure in the first chamber **2074**. This lowering of pressure in the vial **10** and first chamber **2074** can create a pressure differential between the first chamber **2074** and second chamber **2072** of the ball check valve **2070**. The pressure differential can cause regulator fluid FR to pass through the first chamber **2074** and through the regulator channel **2025** into the vial **10**. In some embodiments, the regulator fluid FR is fluid which has passed through a filter in the regulator assembly **2050**. In some embodiments, the regulator fluid FR is a fluid contained in the inner volume of an enclosure of the regulator assembly **2050**. Passage of regulator fluid FR into the vial **10** can offset, reduce, substantially eliminate, or eliminate the pressure differential between the first chamber **2074** and the second chamber **2072**. In some embodiments, the passage of regulator fluid FR into the vial **10** helps to maintain equilibrium between the interior of the vial **10** and the interior of the regulator assembly **2050**.

(269) In some embodiments, introduction of fluid to the vial **10** through the access channel **2045** (e.g., when diluents, mixing fluids, or overdrawn fluids are injected into the vial **10** via an exchange device **40**) can create higher pressure in the vial **10** and first chamber **2074** than the pressure within the second chamber **2072**. This differential in pressure can cause fluid from the vial **10** to pass from the vial **10**, through the ball check valve **2070** and into the regulator assembly **2050**. In some embodiments, the fluid from the vial **10** can pass through the check valve **2070** and through a filter. In some embodiments, the fluid from the vial **10** passes through the check valve **2070** and into a bag or other enclosure. Passage of fluid from the vial **10** through the ball check valve **2070** can lower the pressure within the vial **10** and maintain equilibrium between the interior of the vial **10** and the interior of the regulator assembly **2050**. In some embodiments, regulator fluid FR is ambient air or sterilized gas, or filtered air or gas.

(270) In some embodiments, especially those in which portions of the vial adaptor are modular or interchangeable, the internal and/or external cross section of the lumen **2026** can include one or more alignment features. For example, the internal and/or external cross section of the lumen can

be keyed or otherwise specially shaped. Some examples of potential shapes and their benefits are illustrated in FIGS. **20**A-**20**F and discussed above. The protrusion **2085***a* and/or ball check valve **2070** can include a corresponding alignment feature (e.g. corresponding keying or other special shaping). Such a configuration can be useful to signal, control, or restrict the regulatory assembly **2050** that can be connected with, or made integral with, the adaptor **2000**. For example, keying of or shaping of the ball check valve **2070** and/or the channel in which it is placed could provide a user of the adaptor **2000** with confirmation that the ball check valve **2070** is properly aligned (e.g., aligning the first chamber **2074** on the side of the vial **10**) within the regulator assembly **2050**. This alignment of ball check valve **2070** can allow for proper and/or predictable functioning of the regulatory assembly **2050**.

(271) In some embodiments, the exterior of the regulator assembly **2050** can include one or more visual indicators to show the alignment of the ball check valve **2070**. In some embodiments, the visual indicators include notches, words (e.g., top and/or bottom), arrows or other indicators of alignment. In some embodiments, the protrusion **2085***a*, lumen **2026**, and/or body of the valve **2070** are constructed of a substantially transparent material to provide the user of the adaptor **2000** with visual confirmation of the configuration of the valve (e.g., to permit viewing the position of the ball to indicate whether the valve is in an open or closed configuration).

(272) In some embodiments, the regulator assembly **2050** can include one or more indicators (e.g., visual or audible) to indicate when the ball **2073** is in the occluding position. For example, the regulator assembly **2050** could include one or more light sources (e.g., LED lights, chemiluminescent lights, etc.) that can be configured to emit light when the ball **2073** is in the occluding position. In some embodiments, the adaptor **2000** can include a power source (e.g., one or more batteries, AC input, DC input, photovoltaic cells, etc.) configured to supply power to at least one of the one or more indicators. In some embodiments, the ball **2073** is constructed of an electrically conductive material. In such embodiments, the ball check valve **2070** can be configured such that the ball **2073** completes a circuit between the power source and the light source when the ball **2073** is in the occluding position. In some embodiments, the adaptor **2000** can include a gyroscopic sensor configured to sense when the ball **2073** is in the occluding position. In certain such embodiments, a controller to which the sensor is connected can direct power to activate the one or more indicators when the vial **10** is held above the adaptor **2000**.

(273) FIG. **28** illustrates an embodiment of an adaptor **2100** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. In some embodiments, a ball check valve **2170** includes a first valve channel **2171**A in fluid communication with both a regulator channel **2125** and a first chamber **2174** of the ball check valve **2170**. The ball check valve **2100** can include a second valve channel **2171**B in fluid communication with a second chamber **2172** of the ball check valve **2170**. In some embodiments, the ball check valve **2170**, or some portion thereof, is positioned in the regulator channel **2125** within a protrusion **2185***a*. In some embodiments, the ball check valve **2170**, or some portion thereof, is positioned in the regulator channel **2125** within a lumen **2126** of the adaptor **2100**. In some embodiments, the ball check valve **2170**, or some portion thereof, is positioned in the regulator channel **2125** outside a protrusion **2185***a*. In some embodiments, the ball check valve **2170**, or some portion thereof, is positioned in the regulator channel **2125** outside a lumen **2126** of the adaptor **2100**. In some embodiments, the ball check valve **2170** and protrusion **2185***a* form a unitary part. In some embodiments, the ball check valve **2170** and lumen **2126** form a unitary part.

(274) FIG. **29** illustrates an embodiment of an adaptor **2200** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. In some embodiments, a regulator assembly **2250** includes a flexible valve, such as a domed valve **2270**. The domed valve **2270** can include a domed portion **2273**. The domed portion **2273** can include a concave side **2275**B and a convex side **2275**A. In some embodiments, the domed valve **2270** can include an annular flange **2278** attached to the domed portion **2273**. In some

embodiments, the annular flange **2278** and domed portion **2273** constitute a unitary part. The domed portion **2273** can have a wall thickness T3. The wall thickness T3 can be substantially constant throughout the domed portion **2273**. In some embodiments, the thickness T3 of the domed portion **2273** can vary across the domed valve **2270**.

(275) In some embodiments, the domed valve **2270**, or some portion thereof, is positioned in a regulator channel **2225** within a lumen **2226** of the adaptor **2200**. In some embodiments, the domed valve **2270**, or some portion thereof, is positioned in the regulator channel **2225** outside a protrusion **2285***a*. In some embodiments, the domed valve **2270**, or some portion thereof, is positioned in the regulator channel **2225** outside a lumen **2226** of the adaptor **2200**. In some embodiments, the domed valve **2270** is fixed within the regulator channel **2225**. The domed valve **2270** can be fixed within the regulator channel **2225** via, for example, adhesives, welding, fitted channels within the regulator channel **2225** or otherwise.

(276) In some embodiments, the domed portion **2273** includes one or more slits **2274** or some other opening. In some embodiments, the one or more slits **2274** are biased to a closed position by the domed portion **2273** and/or annular flange **2278**. The domed valve **2270** can inhibit and/or prevent the passage of fluid through the regulator channel **2225** when the one or more slits **2274** are in a closed position. In some embodiments, the one or more slits **2274** are configured to open in response to one or more cracking pressures and allow fluid to flow through the one or more slits **2274**. In some embodiments, the geometry and/or material of the domed valve **2270** can cause the cracking pressure required to allow fluid to flow through the one or more slits **2274** in a first direction F**1** to be substantially higher than the cracking pressure required to allow fluid to flow through the one or more slits **2274** in a second direction F**2**.

(277) Certain aspects of the operation of the domed valve **2270** will now be described. For example, in some embodiments when no fluid is being introduced to or withdrawn from a vial **10** via an access channel **2245** of the adaptor **2200**, the pressure within the vial **10** remains substantially constant. In some embodiments, the vial **10** is in fluid communication with and has the same substantially constant internal pressure as the pressure P**1** in the regulator channel **2225** in the region of the convex side **2275**A of the domed valve **2270**. In some embodiments, the pressure P**2** in the region of the concave side **2275**B of the domed valve **2270** is substantially the same as the pressure P**1** when no fluid is being introduced to or withdrawn from the vial **10**. In such a configuration, the one or more slits **2274** of the domed valve **2270** can be biased closed by the domed portion **2273** of the domed valve **2270**.

(278) In some embodiments, withdrawal of fluid from the vial **10** through the access channel **2045** can lower the pressure in the vial **10** and subsequently lower the pressure P**1** in the region of the convex side **2275**A. This lowering of the pressure P**1** can create a pressure differential between the convex side **2275**A and concave side of **2275**B of the domed valve **2270**. In some embodiments, withdrawal of fluid from the vial **10** can create a pressure differential across the domed valve **2270** high enough to overcome the cracking pressure of the domed valve **2270** and open the one or more slits **2274** to allow fluid to flow in a second direction F**2** through the domed valve **2270**. In some configurations, regulator fluid FR flows in a second direction F**2** through the domed valve **2270** when the one or more slits **2274** are opened and the pressure P**2** on the concave side **2275**B of the valve **2270** is higher than the pressure P**1** on the convex side **2275**A of the valve **2270**. Passage of regulator fluid FR through the domed valve **2270** and/or into the vial **10** can raise the pressure within the vial **10**. Raising of the pressure within the vial **10** can raise the pressure P**1** in the region of the convex surface **2275**A of the domed valve **2270**. Raising of the pressure P**1** in the region of the convex surface **2275**A can lower the pressure differential across the valve **2270** below the cracking pressure and cause the one or more slits **2274** to shut. In some embodiments, the passage of regulator fluid FR in a second direction F**2** through domed valve **2270** helps maintain equilibrium between the interior of the vial **10** and interior of the regulator assembly **2050** when fluid is withdrawn from the vial **10** via the access channel **2245**. In some embodiments, the

regulator fluid FR is fluid which has passed through a filter in the regulator assembly **2250**. In some embodiments, the regulator fluid FR is a fluid contained in the inner volume of an enclosure of the regulator assembly **2250**.

(279) In some embodiments, introduction of fluid to the vial **10** through the access channel **2245** (e.g., when diluents, mixing fluids, or overdrawn fluids are injected into the vial **10** via an exchange device **40**) can raise the pressure in the vial **10**. Raising the pressure within the vial **10** can raise the pressure P**1** in the region of the convex surface **2275**A of the domed valve **2273**. Raising of the pressure P**1** in the region of the convex surface **2275**A can create a pressure differential across the domed valve **2273**. In some embodiments, introduction of fluid into the vial **10** can create a pressure differential across the domed valve **2270** high enough to overcome the cracking pressure of the domed valve **2270** and open the one or more slits **2274** to allow fluid to flow in a first direction F**1** through the domed valve **2270**. In some configurations, as explained above, the cracking pressure required to permit fluid to flow in the first direction F**1** is substantially higher than the cracking pressure required to permit fluid to flow in a second direction F**2** through the domed valve **2270**. In some embodiments, flow of fluid from the vial **10** through the domed valve **2270** in a first direction F**1** can lower the pressure in the vial **10**. Lowering of the pressure within the vial **10** can lower the pressure P**1** in the region of the convex surface **2275**A and can lower the pressure differential across the valve **2270** below the cracking pressure and cause the one or more slits **2274** to shut. In some embodiments, passage of fluid through the domed valve **2270** in a first direction F**1** helps maintain equilibrium between the interior of the vial **10** and the interior of the regulator assembly **2250**.

(280) FIGS. **30**A-**30**B illustrate an embodiment of an adaptor **2300** and a valve with multiple openings, such as a showerhead domed valve **2370**. The adaptor **2300** can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. The showerhead domed valve **2370** can include a domed portion **2373**. The domed portion **2373** can include a concave side **2375**B and a convex side **2375**A. In some embodiments, the showerhead domed valve **2370** can include an annular flange **2378** attached to the domed portion **2373**. In some embodiments, the annular flange **2378** and domed portion **2373** constitute a unitary part. The domed portion **2373** can have a wall thickness T4. The wall thickness T4 can be substantially constant throughout the domed portion **2373**. In some embodiments, the thickness T4 of the domed portion **2373** can vary across the showerhead domed valve **2370**.

(281) In some embodiments, the showerhead domed valve **2370**, or some portion thereof, is positioned in a regulator channel **2325** within a lumen **2326** of the adaptor **2300**. In some embodiments, the showerhead domed valve **2370**, or some portion thereof, is positioned in the regulator channel **2325** outside a protrusion **2385***a*. In some embodiments, the showerhead domed valve **2370**, or some portion thereof, is positioned in the regulator channel **2325** outside a lumen **2326** of the adaptor **2300**. In some embodiments, the showerhead domed valve **2370** is fixed within the regulator channel **2325**. The showerhead domed valve **2370** can be fixed within the regulator channel **2325** via, for example, adhesives, welding, fitted channels within the regulator channel **2325** or otherwise.

(282) In some embodiments, the domed portion **2373** includes one or more openings or central slits **2374**. In some embodiments, the one or more central slits **2374** are arranged in a generally crisscross configuration. In some embodiments, the one or more central slits **2374** are generally parallel to each other. In some embodiments, the domed portion **2373** includes one or more outer slits **2374**A. In some embodiments the number of outer slits **2374**A is less than or equal to about 30 and/or greater than or equal to about 4.

(283) In some embodiments, the one or more central slits **2374** and/or outer slits **2374**A are biased to a closed position by the domed portion **2373** and/or annular flange **2378**. The showerhead domed valve **2370** can inhibit and/or prevent the passage of fluid through the regulator channel **2325** when the slits **2374**, **2374**A are in a closed position. In some embodiments, the slits **2374**, **2374**A are

configured to open in response to one or more cracking pressures and allow fluid to flow through the slits **2374**, **2374**A. In some embodiments, the geometry and/or material of the showerhead domed valve **2370** can cause the cracking pressure required to allow fluid to flow through the slits **2374**, **2374**A in a first direction F**1** to be substantially higher than the cracking pressure required to allow fluid to flow through the slits **2374**, **2374**A in a second direction F**2**. In some embodiments, the cracking pressures required to allow fluid to flow through the showerhead domed valve **2370** in a first direction F**1** and second direction F**2** are less than the cracking pressures required to allow fluid to flow through the domed valve **2270** in a first direction F**1** and second direction F**2**, respectively. In some embodiments, the showerhead domed valve **2370** functions in substantially the same way as the domed valve **2270** when fluid is introduced to or removed from the vial **10** via the access channel **2345**.

(284) FIGS. **31**A-**31**B illustrate an embodiment of an adaptor **2400** that can have components or portions that are the same as or similar to the components or portions of other vial adaptors disclosed herein. In some embodiments, a regulator assembly **1450** includes an opening and closing occluder valve **2470**, such as a flap check valve **2470**, with a portion of the occluding component remaining affixed to structure within the vial adaptor **2400** as the occluder valve **2470** transitions between the open and closed states. The flap check valve **2470** can include a sealing portion **2479**. The sealing portion **2479** can comprise, for example, a hollow stopper shaped to fit snugly in a regulator channel **2425** of a regulator assembly **2450**, one or more annular protrusion or some other feature suitable for fixing the flap check valve **2470** in place within the regulator channel **2425**. In some embodiments, flap check valve **2470**, or some portion thereof, is positioned in a regulator channel **2425** within a lumen **2426** of the adaptor **2400**. In some embodiments, the flap check valve **2470**, or some portion thereof, is positioned in the regulator channel **2425** outside a protrusion **2485***a*. In some embodiments, the flap check valve **2470**, or some portion thereof, is positioned in the regulator channel **2425** outside a lumen **2426** of the adaptor **2400**. In some embodiments, the flap check valve **2470** is fixed within the regulator channel **2425**.

(285) According to some configurations, the flap check valve **2470** can include a seat portion **2477** attached to the sealing portion **2479**. In some embodiments, the seat portion **2477** and sealing portion **2479** form a unitary part. In some embodiments, the seat portion **2477** and sealing portion **2479** are separate parts. The flap check valve **2470** can include a flap **2473**. The flap **2473** can have a first end **2473**A and a second end **2473**B. The first end **2473**A of the flap **2473** can be rotatably attached to the sealing portion **2479** and/or seat portion **2477**.

(286) In some embodiments, the flap **2473** can be configured to rest upon the seat portion **2477** when the adaptor **2400** and vial **10** are oriented such that the vial **10** is above the connector interface of the adaptor **2400**. In some configurations, contact between the flap **2437** and the seat portion **2477** can form a seal **2476** between the interior **2472** and the exterior **2474** of the flap check valve **2470**. The seal **2476** can put the flap check valve **2470** in a closed configuration and inhibit passage of liquid L and/or other fluid from the vial **10** through the flap check valve **2470**. In some embodiments, the flap **2473** can be configured to rotate away from the seat portion **2477** when the adaptor **2400** and vial **10** are oriented such that the connector interface of the adaptor **2400** is above the vial **10**. Movement of the flap **2473** away from the seat member **2477** can eliminate the seal **2476** and put the flap check valve **2470** in an open configuration such that the interior **2472** and exterior **2474** of the flap check valve **2470** are in fluid communication.

(287) In some embodiments, the flap **2473** can move toward and away from the seat portion **2477** under the influence of gravity. As explained above, contact between the flap **2473** and the seat portion **2477** can form a seal **2476** between the interior **2472** and exterior **2474** of the flap check valve **2470**, putting the flap check valve **2470** in a closed configuration and inhibiting passage of liquid L and/or other fluid from the vial **10** through the flap check valve **2470**. In some configurations, gravity can cause the flap **2473** to move away from the seat portion **2477** and break the seal **2476**. Movement of the flap **2473** away from the seat portion **2477** under the influence of

gravity can eliminate the seal **2476** and put the flap check valve **2470** in an open configuration such that the exterior **2474** and interior **2472** are in fluid communication. In some embodiments, the flap **2473** is biased to the closed position. The biasing force can be provided by, for example, one or more torsion springs, or another feature suitable for biasing the flap **2473** toward the seat portion **2477** (e.g., tensile force, memory materials, magnets, etc.). In some embodiments, the biasing torque upon the flap **2473** at the first end **2473**A is less than the torque created at the first end **2437**A when the weight of flap **2473** is pulled away from the seat portion **2477** due to the force of gravity (e.g., when the seat portion **2477** is positioned above the flap **2473**).

(288) Certain aspects of the operation of the flap check valve **2470** while the flap check valve **2470** is in a closed configuration will now be described. For example, in some embodiments when no fluid is being introduced to or withdrawn from the vial **10** via an access channel **2445**, the pressure within the vial **10** is substantially the same as the pressure in the interior **2472** of the flap check valve **2470**. In such a situation, the pressure P**2** in the interior **2472** of the flap check valve **2470** can be substantially the same as the pressure P**1** in the exterior **2474** of the flap check valve **2470**. In some embodiments, positioning of the vial **10** above the flap check valve **2470** can cause liquid L or other fluid to move from the vial **10** to the exterior **2474** of the flap check valve **2470**. In some embodiments, the flap **2473** will remain at rest on the seat portion **2477** and create a seal **2476** when there is equilibrium in the pressure between the exterior **2474** and interior **2472** of the flap check valve. The seal **2476** can inhibit passage of liquid L and/or other fluid from the vial **10** through the flap check valve **2470**.

(289) In some embodiments, withdrawal of fluid from the vial **10** through the access channel **2445** can create lower pressure in the vial **10** and exterior **2474** of the flap check valve **2470** than the pressure in the interior **2472** of the flap check valve **2470**. The pressure differential can cause the flap **2473** to move away from the seat portion **2477**. The movement of the flap **2473** away from the seat portion **2477** can break the seal **2476** and permit regulator fluid FR to pass from through the interior **2472** of the flap check valve **2470** to the exterior **2474** of the flap check valve **2470**. The regulator fluid FR can then pass through the regulator channel **2425** into the vial **10**. In some embodiments, the regulator fluid FR is fluid which has passed through a filter in the regulator assembly **2450**. In some embodiments, the regulator fluid FR is a fluid contained in the inner volume of an enclosure of the regulator assembly **2450**. Passage of regulator fluid FR into the vial **10** can offset, reduce, substantially eliminate, or eliminate the pressure differential between the first exterior **2474** and interior **2472** of the flap check valve **2470** and allow the flap **2473** to return to a resting position on the seat portion **2477**. In some embodiments, the passage of regulator fluid FR into the vial **10** helps to maintain equilibrium between the interior of the vial **10** and the interior of the regulator assembly **2450**. The return of the flap **2473** to a resting position on the seat portion **2477** can recreate the seal **2476** and prevent passage of liquid L or other fluid from the vial **10** through the flap check valve **2470**.

(290) In some embodiments, introduction of fluid to the vial **10** through the access channel **2445** (e.g., when diluents, mixing fluids, or overdrawn fluids are injected into the vial **10** via an exchange device **40**) can create higher pressure in the vial **10** and exterior **2474** of the flap check valve **2470** than the pressure within the interior **2472** of the flap check valve **2470**. This difference in pressure can cause the flap **2473** to be pushed onto the seat portion **2477** and thus tighten the seal **2476**. Tightening of the seal **2476** can inhibit the passage through the flap check valve **2470** of fluid L from the vial **10**. In some embodiments, the tightening of the seal **2476** can cause the internal pressure within the vial **10** and the pressure P**1** in the region of the exterior **2474** of the flap check valve **2470** to continue to increase as more fluid is introduced into the vial **10** via the access channel **2445**. In some embodiments, a continual increase in pressure within the vial **10** can dramatically increase the force required to introduce more fluid to a prohibitive level, and eventually increase the likelihood of fluid leaks from the vial **10** and adaptor **2400** or between these components. It can therefore be desirable for the flap check valve **2470** to be in an open position

when fluids are injected into the vial **10**.

(291) Movement of the flap **2473** away from the seat portion **2477** can eliminate the seal **2476** and put the flap check valve **2470** in an open configuration. In some embodiments, the opened flap check valve **2470** functions in much the same way as the opened ball check valve **2070** described above with regard to the passage of fluids through the flap check valve **2470** upon the introduction of fluid to or withdrawal of fluid from the vial **10** via the access channel **2445**. In some embodiments, the regulator assembly **2450** can have many of the same keying, shaping, and/or alignment features described above with respect to the ball check valve **2070** (e.g., transparent materials, visual alignment indicators, shaped channels and/or a shaped valve).

(292) FIG. **32** illustrates an embodiment of an adaptor **2500**. The adaptor **2500** can include a piercing member **2520**. In some embodiments, the piercing member **2520** is disposed within a vial **10**. The piercing member **2520** can include an access channel **2545** in communication with an exchange device **40**. In some embodiments, the piercing member **2530** includes a regulator channel **2525** which includes a gravity or orientation occluder valve, such as a ball check valve **2520**. The ball check valve **2570** can include a first channel **2574** with a substantially circular cross section and a diameter D**1** in fluid communication with the vial **10**. In some embodiments, the ball check valve **2570** includes a second channel **2572** with a substantially circular cross section and diameter D**2** in selective fluid communication with the first channel **2574**. Many other variations in the structure of the first and second chambers are possible. For example, other cross-sectional shapes may be suitable.

(293) The ball check valve **2570** can include a shoulder **2578** between the first channel **2574** and second channel **2572**. In some embodiments, the angle θ**2** between the shoulder **2578** and the wall of the first channel **2574** can be about 90°. In some embodiments, the angle θ**2** can be less than or greater than 90°. For example, in some embodiments the angle θ**2** is less than or equal to about 75° and/or greater than or equal to about 30°. In some embodiments, the second channel **2572** is in fluid communication with the first channel **2574** when the ball check valve **2570** is in an open configuration. In some embodiments, the inner wall of the first channel **2574** can gradually taper into the inside wall of the second channel **2572** such that the first and second channels **2574**, **2572** constitute a single frustoconical channel.

(294) The occluder valve can include an occluder, such as a ball **2573**. In some embodiments, the ball **2573** is constructed of a material which has a higher density than the liquid L and/or other fluids within the vial **10**. The ball **2573** can be spherical or some other suitable shape. In some embodiments, the ball **2573** has a diameter DB2. The diameter DB2 could be less than the diameter D**1** of the first channel **2574** and more than the diameter D**2** of the second channel **2572**. For example, in some embodiments the ratio of the diameter DB2 of the ball **2573** to the diameter D**1** of the first channel **2574** is less than or equal to about 9:10 and/or greater than or equal to about 7:10. In some embodiments the ratio of the diameter D**2** of the second channel **2572** to the diameter DB2 of the ball **2573** is less than or equal to about 9:10 and/or greater than or equal to about 7:10. In some embodiments, the ball check valve **2570** can include a capture member **2577**. The capture member **2577** can inhibit the ball **2570** from moving out of the first channel **2574**.

(295) In some configurations, the ball **2573** can behave in much the same way as the ball **2073** of the ball check valve **2070**. For example, the ball **2573** can move within the first channel **2574** under the influence of forces in much the same way the ball **2073** can move around the first chamber **2074** of the ball check valve **2070**. Resting of the ball **2573** against the shoulder **2578** of the ball check valve **2570** can create a seal **2560** which can inhibit the passage of liquid L and/or other fluids within the vial into the regulator channel **2525**. In many respects, the ball check valve **2570** behaves in the same or substantially the same manner as the ball check valve **2070** under the influence of gravity, alignment of the adaptor **2570** and/or other forces.

(296) The following list has example embodiments that are within the scope of this disclosure. The example embodiments that are listed should in no way be interpreted as limiting the scope of the

embodiments. Various features of the example embodiments that are listed can be removed, added, or combined to form additional embodiments, which are part of this disclosure: 1. An adaptor configured to couple with a sealed vial, the adaptor comprising: a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; a regulator enclosure in fluid communication with the regulator channel, wherein the regulator enclosure is configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when a fluid is withdrawn from the sealed vial via the extractor channel; and a filler disposed within the regulator enclosure, the filler configured to ensure an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture. 2. The adaptor of embodiment 1, wherein the adaptor is configured such that the regulator enclosure is outside the sealed vial when the adaptor is coupled with the sealed vial. 3. The adaptor of embodiment 1, wherein at least a substantial portion of the regulator enclosure is not within a rigid housing. 4. The adaptor of embodiment 1, wherein the housing apparatus comprises a medical connector interface in fluid communication with the extractor channel and configured to couple with a syringe configured to hold a defined volume of fluid within a barrel, and wherein the filler is configured to ensure that the initial volume of regulator fluid is greater than or equal to the defined volume of fluid. 5. The adaptor of embodiment 4, wherein the initial volume of regulator fluid within the regulator enclosure is greater than or equal to about 60 mL. 6. The adaptor of embodiment 1, wherein the regulator enclosure is configured to hold a maximum volume of regulator fluid when the regulator enclosure is fully expanded or unfolded, and wherein the maximum volume is greater than or equal to about 180 mL. 7. The adaptor of embodiment 1, wherein the regulator enclosure is constructed from a material system including a polyethylene terephthalate film. 8. The adaptor of embodiment 7, wherein the polyethylene terephthalate film includes a metalized coating. 9. The adaptor of embodiment 8, wherein the metalized coating comprises aluminum. 10. The adaptor of embodiment 1, wherein the pressure regulating vial adaptor comprises a piercing member connected to the housing apparatus, and the enclosure is at least partially disposed within the piercing member. 11. The adaptor of embodiment 1, wherein the pressure within the sealed vial is regulated by permitting the regulator enclosure to contract or fold in order to substantially equilibrate pressure on opposite sides of the regulator enclosure as the medicinal fluid is withdrawn from the sealed vial. 12. The adaptor of embodiment 1, wherein the regulator enclosure comprises a layer that is substantially impermeable to a medicinal fluid disposed within the vial, thereby impeding the passage of the medicinal fluid between an outer surface and an inner surface of the regulator enclosure. 13. The adaptor of embodiment 1, further comprising a hydrophobic filter disposed between the regulator enclosure and a distal regulator aperture configured to permit regulator fluid to flow between the regulator enclosure and the vial when the adaptor is coupled with the vial. 14. The adaptor of embodiment 13, wherein the hydrophobic filter is disposed within the regulator channel. 15. The adaptor of embodiment 1, wherein the filler comprises a foamed material. 16. The adaptor of embodiment 15, wherein the filler comprises a polyurethane-ether foam. 17. A method of withdrawing fluid from a sealed vial, the method comprising: connecting a pressure regulating vial adaptor to the sealed vial, wherein the pressure regulating vial adaptor comprises: a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; a regulator enclosure in fluid communication with the regulator channel, wherein the regulator enclosure is configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when a fluid is withdrawn from the sealed vial via the extractor channel; and a filler disposed within the regulator enclosure, the filler configured to ensure an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture; and withdrawing fluid from the sealed vial through the pressure regulating vial adaptor. 18. A method of manufacturing an adaptor for coupling with a sealed vial, the method comprising: providing a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; disposing a filler within a regulator enclosure, the filler configured to ensure an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture; and placing the regulator enclosure in fluid communication with the regulator channel, such that the regulator enclosure is configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when a fluid is withdrawn from the sealed vial via the extractor channel. 19. The method of embodiment 18, wherein disposing a filler within a regulator enclosure comprises: forming a fill opening in the regulator enclosure configured to allow the filler to pass therethrough; filling the regulator enclosure with the filler through the fill opening; and closing the fill opening. 20. The method of embodiment 18, wherein placing the regulator enclosure in fluid communication with the regulator channel comprises: aligning an enclosure opening in the regulator enclosure with a proximal regulator aperture of the housing apparatus; and fastening the regulator enclosure to the housing apparatus. 21. An adaptor configured to couple with a sealed vial, the adaptor comprising: a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; and a regulator enclosure in fluid communication with the regulator channel, wherein the regulator enclosure is configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when a fluid is withdrawn from the sealed vial via the extractor channel; wherein a rigid housing does not contain a substantial volume of the regulator enclosure. 22. The adaptor of embodiment 21, wherein the regulator enclosure comprises a first side and a second side opposite the first side, and wherein each of the first and second sides is configured to expand, contract, fold, or unfold as regulator fluid flows between the regulator channel and the regulator enclosure. 23. The adaptor of embodiment 22, wherein the second side is configured to move away from the housing apparatus or towards the housing apparatus when regulator fluid passes through the regulator channel. 24. The adaptor of embodiment 22, wherein the first side comprises an inner surface forming a portion of the regulator enclosure interior and an outer surface forming a portion of the regulator enclosure exterior, and wherein the outer surface of the first side is oriented towards the housing apparatus. 25. The adaptor of embodiment 21, wherein pressure within the sealed vial is regulated by allowing the regulator enclosure to contract or fold in order to substantially equilibrate pressure on opposite sides of the regulator enclosure as the medicinal fluid is withdrawn from the sealed vial. 26. The adaptor of embodiment 21, wherein the regulator enclosure comprises a layer that is substantially impermeable to a medicinal fluid disposed within the vial, thereby impeding the passage of the medicinal fluid between an outer surface and an inner surface of the enclosure. 27. The adaptor of embodiment 21, further comprising a hydrophobic filter disposed between the regulator enclosure and a distal regulator aperture configured to permit regulator fluid to flow between the regulator enclosure and the vial when the adaptor is coupled with the vial. 28. The adaptor of embodiment 21, further comprising a filler disposed within the regulator enclosure, the filler configured to ensure an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture. 29. A vial adaptor configured to couple with a sealed vial, the vial adaptor comprising: a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; a regulator enclosure in fluid communication with the regulator channel, wherein the regulator enclosure is configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when a fluid is withdrawn from the sealed vial via the extractor channel; and wherein the regulator enclosure has a first side and a second side opposite the first side, wherein the first side comprises an inner surface forming a portion of the regulator enclosure interior and an outer surface forming a portion of the regulator enclosure exterior, and wherein the outer surface of the first side is oriented towards the housing apparatus; wherein each of the first and second sides is configured to expand, contract, fold, or unfold when regulator fluid passes through the regulator channel; wherein the second side is configured to move away from the housing apparatus or towards the housing apparatus when regulator fluid passes through the regulator channel; and wherein the regulator enclosure is not entirely contained within a rigid housing. 30. A vial adaptor configured to couple with a sealed vial, the vial adaptor comprising: a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; a regulator enclosure in fluid communication with the regulator channel and configured to receive a volume of regulating fluid, wherein the regulator enclosure is configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when a fluid is withdrawn from the sealed vial via the extractor channel; and wherein the regulator enclosure has a first layer connected with a second layer opposite the first layer, the first and second layers being configured to receive the volume of regulating fluid therebetween; wherein each of the first and second sides is configured to expand, contract, fold, or unfold when regulator fluid passes through the regulator channel; wherein the second side is configured to move away from the housing apparatus or towards the housing apparatus when regulator fluid passes through the regulator channel; and wherein the regulator enclosure is not entirely contained within a rigid housing. 31. The vial adaptor of embodiment 30, wherein the first layer is made of a first sheet of material, and the second layer is made of a second sheet of material. 32. The vial adaptor of embodiment 30, wherein the first and second layers are connected at a periphery of the first and second layers. 33. The vial adaptor of embodiment 30, wherein the first and second layers each comprise a central portion, and the first and second layers are not connected at the central portions. 34. A modular vial adaptor configured to couple with a sealed vial, the vial adaptor comprising: a pressure regulating vial adaptor module comprising: a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; and a proximal regulator aperture in fluid communication with the regulator channel, wherein the proximal regulator aperture is configured to permit ingress or egress of regulator fluid therethrough when the vial adaptor module is coupled with the sealed vial and fluid is withdrawn from the vial; and a regulator fluid module configured to couple with the proximal regulator aperture, the regulator fluid module comprising: a regulator enclosure configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when regulator fluid passes through an enclosure opening in the regulator enclosure; and a fastener configured to couple the regulator enclosure with the proximal regulator aperture; wherein the regulator enclosure is not entirely contained within a rigid housing. 35. The adaptor of embodiment 34, wherein the fastener comprises a bonding member having first and second surfaces coated with adhesive. 36. The adaptor of embodiment 35, wherein the bonding member is constructed from a material system comprising resilient material. 37. A method of manufacturing a vial adaptor configured to couple with a sealed vial, the method comprising: providing a pressure regulating vial adaptor module comprising: a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; and a proximal regulator aperture in fluid communication with the regulator channel, wherein the proximal regulator aperture is configured to permit ingress or egress of regulator fluid therethrough when the vial adaptor module is coupled with the sealed vial and fluid is withdrawn from the vial; providing a regulator fluid module configured to couple with the proximal regulator aperture, the regulator fluid module comprising: a regulator enclosure configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when regulator fluid passes through an enclosure opening in the regulator enclosure; and a fastener configured to couple the regulator enclosure with the proximal regulator aperture; wherein the regulator enclosure is not entirely contained within a rigid housing; aligning the enclosure opening of the regulator enclosure with the proximal regulator aperture of the pressure regulating vial adaptor module; and fastening the regulator fluid module to the pressure regulating vial adaptor module. 38. The method of embodiment 37, wherein the fastener comprises a bonding member having first and second surfaces coated with adhesive. 39. The method of embodiment 38, wherein the bonding member is constructed from a material system comprising resilient material. 40. The method of embodiment 39, wherein the bonding member has a thickness greater than or equal to about 0.01 inches and less than or equal to about 0.03 inches. 41. A regulator fluid module configured to fasten to a pressure regulating vial adaptor module to form a vial adaptor for coupling with a sealed vial, the pressure regulating vial adaptor module comprising a housing apparatus including a distal extractor aperture configured to permit withdrawal of fluid from the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an extractor channel and at least a portion of a regulator channel pass through the housing apparatus; and a proximal regulator aperture in fluid communication with the regulator channel, wherein the proximal regulator aperture is configured to permit ingress or egress of regulator fluid therethrough when the vial adaptor module is coupled with a sealed vial and fluid is withdrawn from the vial, the regulator fluid module comprising: a regulator enclosure configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when regulator fluid passes through an enclosure opening in the regulator enclosure; a filler within the regulator enclosure, the filler configured to ensure an initial volume of regulator fluid within the regulator enclosure, thereby permitting the adaptor to supply regulator fluid to the sealed vial from the regulator enclosure when fluid is withdrawn from the sealed vial via the extractor aperture; and a fastener configured to couple the regulator enclosure with the proximal regulator aperture such that the regulator fluid module is permitted to move small distances with respect to the pressure regulating vial adaptor module without causing the fastener to become ripped, torn, or otherwise damaged during routine manipulation of the vial adaptor; wherein the regulator enclosure is not entirely contained within a rigid housing. 42. A method of manufacturing a modular adaptor for coupling with and regulating the pressure in a sealed vial, the method comprising: forming a housing apparatus including a distal access aperture configured to permit transfer of fluid between a medical device and the sealed vial when the adaptor is coupled to the sealed vial, wherein at least a portion of an access channel and at least a portion of a regulator channel pass through the housing apparatus, the regulator channel being in fluid communication with the sealed vial when the adaptor is coupled to the sealed vial; connecting a coupling assembly such that the coupling assembly is in fluid communication with the regulator channel, the coupling assembly including a membrane and a cover, the cover including an aperture, the coupling assembly configured to allow a flow of regulating fluid between the aperture and the regulator channel, the flow of regulating fluid passing through the membrane; and providing a regulator enclosure configured to be positioned in fluid communication with the aperture, such that the regulator enclosure is configured to move between a first orientation in which at least a portion of the regulator enclosure is at least partially expanded or unfolded and a second orientation in which at least a portion of the regulator enclosure is at least partially unexpanded or folded when a regulator fluid passes through an opening in the regulator enclosure. 43. The method of embodiment 42, further comprising selecting the regulator enclosure from a variety of sizes of regulator enclosures, the selection being based on the volume of the medicinal fluid to be withdrawn from the sealed vial. 44. The method of embodiment 42, wherein the flow of regulating fluid passes between the aperture and the sealed vial when the medicinal fluid is withdrawn from the sealed vial via the access channel. 45. The method of embodiment 42, wherein the aperture is in fluid communication with ambient air prior to the regulator enclosure being positioned in fluid communication with the aperture. 46. A vial adaptor having an insertion axis, the vial adaptor configured to be used in an area with a floor and configured to couple with a sealed vial, the vial adaptor comprising: a housing assembly comprising a piercing member capable of piercing a septum of a sealed vial when the piercing member is urged against the septum of the vial; an extractor channel, wherein the extractor channel extends between a proximal extractor aperture and a distal extractor aperture and is configured to permit withdrawal of fluid from the sealed vial when the vial adaptor is coupled to the sealed vial, and wherein at least a portion of the extractor channel passes through at least a portion the housing assembly; a regulator channel, wherein the regulator channel extends between a proximal regulator aperture and a distal regulator aperture, and wherein at least a portion of the regulator channel passes through at least a portion of the housing assembly; and an occluder valve housed in the regulator channel and configured to transition between a closed configuration and an opened configuration in response to rotation of the vial adaptor about an axis of rotation between an upright position and an upside down position, wherein the proximal extractor aperture is further from the floor than the distal extractor aperture when the vial adaptor is in the upright position and the proximal extractor aperture is closer to the floor than the distal extractor aperture when the vial adaptor is in the upside down position; wherein the occluder valve inhibits passage of fluid past the occluder valve toward the proximal regulator aperture when the occluder valve is in the closed configuration and wherein the axis of rotation is perpendicular to the insertion axis of the vial adaptor and the occluder valve consistently transitions between the closed configuration and the opened configuration substantially independent of the axis of rotation about which the vial adaptor is rotated. 47. The vial adaptor of embodiment 46, wherein occluder valve transitions to the closed configuration when the vial adaptor is rotated to the upside down position. 48. The vial adaptor of embodiment 46, wherein the occluder valve transitions to the opened configuration when the vial adaptor is rotated to the upright position. 49. The vial adaptor of embodiment 46, wherein the occluder valve comprises a valve chamber in fluid communication with the regulator channel, an occluding member within the valve chamber, and a valve seat, wherein the occluder valve is configured to transition to the closed configuration upon engagement between the occluding member and the valve seat, and wherein the occluder valve is configured to transition to the opened configuration upon disengagement of the occluding member from the valve seat. 50. The vial adaptor of embodiment 49, wherein the occluding member moves within the valve chamber under the influence of gravity. 51. The vial adaptor of embodiment 49, wherein the occluding member is a spherical ball. 52. The vial adaptor of embodiment 49, wherein the occluding member has a cylindrical body with a tapered end. 53. The vial adaptor of embodiment 49, wherein the occluding member has an ellipsoidal shape. 54. The vial adaptor of embodiment 46, wherein the occluder valve has a generally cylindrical shape and an axial centerline. 55. The vial adaptor of embodiment 54, wherein the occluder valve is rotatable about the axial centerline of the occluder valve with respect to the regulator channel. 56. The vial adaptor of embodiment 46, wherein the vial adaptor further comprises a filter positioned in the regulator channel between the occluder valve and the proximal regulator aperture. 57. The vial adaptor of embodiment 56, wherein the filter is a hydrophobic filter. 58. A vial adaptor configured to couple with a sealed vial, the vial adaptor having an insertion axis and comprising: a housing assembly comprising a piercing member capable of piercing a septum of a sealed vial when the piercing member is urged against the septum of the vial; an extractor channel, wherein at least a portion of the extractor channel passes through at least a portion of the housing assembly; a regulator channel, wherein the regulator channel defines a regulator fluid flow path and extends between a proximal regulator aperture and a distal regulator aperture, and wherein at least a portion of the regulator channel passes through at least a portion of the housing assembly; and an occluder valve located in at least a portion of the regulator channel and having a proximal opening nearest the proximal regulator aperture and a distal opening nearest the distal regulator aperture, the occluder valve further configured to transition between a closed configuration and an opened configuration, wherein the occluder valve comprises: a valve chamber in fluid communication with the regulator channel and the regulator fluid flow path, the valve chamber having an occluding member, a movement path for the occluding member, and a valve seat; a valve channel in fluid communication with the valve chamber and the regulator channel and the regulator fluid flow path; a proximal interface defining the fluid boundary between the proximal opening and the regulator channel; and a distal interface defining the fluid boundary between the distal opening and the regulator channel; wherein the occluder valve is configured to transition to the closed configuration when the occluding member is engaged with the valve seat, the occluder valve is configured to transition to the opened configuration when the occluding member is disengaged from the valve seat, and wherein an angle formed between the movement path for the occluding member and the regulator fluid flow path at one or more of the proximal interface and the distal interface is oblique or perpendicular. 59. The vial adaptor of embodiment 58, wherein the movement path for the occluding member is oblique or perpendicular to an installation path of the occluder valve. 60. The vial adaptor of embodiment 59, wherein the angle formed between the movement path and the installation path is greater than about 45° and less than about 135°. 61. The vial adaptor of embodiment 58, wherein the occluding member is a spherical ball. 62. The vial adaptor of embodiment 58, wherein the occluding member has a cylindrical body with one tapered end. 63. The vial adaptor of embodiment 58, wherein the occluding member has an ellipsoidal shape. 64. The vial adaptor of embodiment 60, wherein the angle formed between the movement path and the installation path is about 90°. 65. The vial adaptor of embodiment 58, wherein the angle formed between the movement path and the installation path is substantially the same as the angle formed between the insertion axis of the vial adaptor and the installation path. 66. The vial adaptor of embodiment 58, wherein the movement path is substantially parallel to the insertion axis of the vial adaptor. 67. The vial adaptor of embodiment 58, wherein the vial adaptor further comprises a filter in the regulator channel between the occluder valve and the proximal regulator aperture. 68. The vial adaptor of embodiment 67, wherein the filter is a hydrophobic filter. 69. A method of manufacturing a modular vial adaptor configured to couple with a sealed vial, the method comprising: selecting a connector interface having an insertion axis, the connector interface comprising: a housing assembly comprising a piercing member capable of piercing a septum of a sealed vial when the piercing member is urged against the septum of the vial; an extractor channel, wherein at least a portion of the extractor channel passes through at least a portion of the housing assembly; a regulator channel, wherein the regulator channel extends between a proximal regulator aperture and a distal regulator aperture, and wherein at least a portion of the regulator channel passes through at least a portion of the housing assembly; and coupling a regulator assembly with the proximal regulator aperture of the connector interface, wherein the regulator assembly comprises a regulator path configured to be in fluid communication with the regulator channel when the regulator assembly is coupled with the connector interface and the regulator channel and regulator path define a regulator fluid flow path, and wherein the regulator assembly further comprises an occluder valve installed at least partially within one or more of the regulator channel and the regulator path via an installation path and having a proximal opening nearest the proximal regulator aperture and a distal opening nearest the distal regulator aperture, the occluder valve configured to transition between a closed configuration and an opened configuration, wherein the occluder valve comprises: a valve chamber in fluid communication with the regulator fluid flow path, the valve chamber having an occluding member, a movement path for the occluding member, and a valve seat; a valve channel in fluid communication with the valve chamber and the regulator fluid flow path, the valve channel having a flow path; a proximal interface defining the fluid boundary between the proximal opening and the regulator channel; and a distal interface defining the fluid boundary between the distal opening and the regulator channel; wherein the occluder valve is configured to transition to the closed configuration when the occluding member is engaged with the valve seat, the occluder valve is configured to transition to the opened configuration when the occluding member is disengaged from the valve seat, and wherein an angle formed between the movement path for the occluding member and the regulator fluid flow path at one or more of the proximal interface and the distal interface is oblique or perpendicular. 70. The method of embodiment 69, wherein the method further comprises installing the occluder valve at least partially into one or more of the regulator channel and the regulator path via an installation path. 71. The method of embodiment 70, wherein the method further includes selecting an occluder valve wherein the angle between the movement path in the occluder valve and the installation path of the occluder valve is substantially the same as the angle between the installation path and the insertion axis of the coupling interface. 72. The method of embodiment 69, wherein the method further comprises selecting an occluder valve wherein the movement path in the occluder valve is substantially parallel to insertion axis of the coupling interface. 73. The method of embodiment 69, wherein the method further includes matching a protrusion of the regulator assembly with the proximal regulator aperture of the connector interface, wherein the protrusion and proximal regulator aperture are keyed. 74. The method of embodiment 73, method further includes matching an alignment feature on the occluder valve with an alignment feature of the regulator channel. 75. The method of embodiment 74, wherein the matching the alignment feature of the occluder valve with the alignment feature of the regulator channel orients the occluder valve such that the movement path is substantially parallel to the insertion axis of the connector interface when the regulator assembly is coupled to the connector interface and the occluder valve is at least partially installed in one or more of the regulator channel and the regulator path.

(297) Although the vial adaptor has been disclosed in the context of certain embodiments and examples, it will be understood by those skilled in the art that the vial adaptor extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses of the embodiments and certain modifications and equivalents thereof. For example, some embodiments are configured to use a regulating fluid that is a liquid (such as water or saline), rather than a gas. As another example, in certain embodiments the bag comprises a bellows. It should be understood

that various features and aspects of the disclosed embodiments can be combined with or substituted for one another in order to form varying modes of the vial adaptor. For example, the annular bag shape of FIG. **24** can be incorporated into the embodiment of FIGS. **13-15**. Accordingly, it is intended that the scope of the vial adaptor herein-disclosed should not be limited by the particular disclosed embodiments described above, but should be determined only by a fair reading of the claims that follow.

Claims

1. A pressure-regulating vial adapter comprising: a housing configured to couple with a vial having a septum, the housing comprising a piercing member that is configured to be inserted through the septum of the vial in a distal direction, the piercing member having a distal tip; a rigid enclosure comprising an internal space; and a reservoir comprising a first flexible side and a second flexible side, the reservoir configured to inflate in the distal direction from a deflated state to an inflated state in response to regulating fluid being received between the first and second flexible sides, the reservoir substantially centered with respect to an axial center of the pressure-regulating vial adaptor; wherein, in the deflated state and with the housing coupled with the vial, the entirety of the reservoir is positioned in the internal space of the rigid enclosure and outside of the vial; and wherein, during inflation from the deflated state to the inflated state, a portion of the reservoir expands out of the rigid enclosure, such that some of the reservoir is in the rigid enclosure and some of the reservoir is not in the rigid enclosure.
2. The pressure-regulating vial adapter of claim 1, wherein the reservoir is annular.
3. The pressure-regulating vial adapter of claim 1, wherein the reservoir comprises a bag.
4. The pressure-regulating vial adapter of claim 1, wherein, in response to regulating fluid being withdrawn from between the first and second flexible sides, the reservoir crumples.
5. The pressure-regulating vial adapter of claim 1, wherein the first flexible side is made of a first sheet of material and the second flexible side is made of a second sheet of material, the first and second sheets connected at a peripheral edge.
6. The pressure-regulating vial adapter of claim 1, wherein the reservoir comprises an annular ring.
7. The pressure-regulating vial adapter of claim 6, wherein the annular ring is rigid.
8. The pressure-regulating vial adapter of claim 1, wherein the reservoir comprises a peripheral portion connecting the first flexible side and the second flexible side.
9. The pressure-regulating vial adapter of claim 8, wherein the peripheral portion is rigid.
10. The pressure-regulating vial adapter of claim 9, wherein the peripheral portion is annular.
11. The pressure-regulating vial adapter of claim 1, wherein the first flexible side and the second flexible side are configured to unfold to increase the volume of the reservoir and to crumple to decrease the volume of the reservoir.
12. The pressure-regulating vial adapter of claim 1, wherein, during inflation from the deflated state to the inflated state, a bottommost end of the reservoir expands toward the vial.
13. The pressure-regulating vial adapter of claim 1, wherein, in the deflated state and with the housing coupled with the vial, a bottom of the reservoir is above a top of the vial.
14. The pressure-regulating vial adapter of claim 1, wherein the piercing member comprises a regulating channel configured to convey the regulating fluid and an access channel configured to convey a medicinal liquid.
15. A pressure-regulating vial adapter comprising: a housing configured to couple with a vial having a septum, the housing comprising a piercing member that is configured to be inserted through the septum of the vial in a distal direction, the piercing member having a distal tip; a rigid enclosure comprising an internal space; and an annular reservoir comprising a first flexible side and a second flexible side, the reservoir configured to inflate in the distal direction from a deflated state to an inflated state in response to regulating fluid being received between the first and second

flexible sides; wherein, in the deflated state and with the housing coupled with the vial, the entirety of the reservoir is positioned in the internal space of the rigid enclosure and outside of the vial; and wherein, during inflation from the deflated state to the inflated state, a portion of the reservoir expands out of the rigid enclosure, such that some of the reservoir is in the rigid enclosure and some of the reservoir is not in the rigid enclosure.

16. The pressure-regulating vial adapter of claim 15, wherein, in response to regulating fluid being withdrawn from between the first and second flexible sides, the reservoir crumples.

17. The pressure-regulating vial adapter of claim 15, wherein the first flexible side is made of a first sheet of material and the second flexible side is made of a second sheet of material, the first and second sheets connected at a peripheral edge.

18. The pressure-regulating vial adapter of claim 15, wherein the first flexible side and the second flexible side are configured to unfold to increase the volume of the reservoir and to crumple to decrease the volume of the reservoir.

19. The pressure-regulating vial adapter of claim 15, wherein, during inflation from the deflated state to the inflated state, a bottom end of the reservoir expands toward the vial.

20. The pressure-regulating vial adapter of claim 15, wherein the reservoir is substantially centered with respect to an axial center of the pressure-regulating vial adaptor.

21. The pressure-regulating vial adapter of claim 15, wherein, in the deflated state and with the housing coupled with the vial, a bottom of the reservoir is above a top of the vial.

22. The pressure-regulating vial adapter of claim 15, wherein the piercing member comprises a regulating channel configured to convey the regulating fluid and an access channel configured to convey a medicinal liquid.

23. A pressure-regulating vial adapter comprising: a housing configured to couple with a vial having a septum, the housing comprising a piercing member that is configured to be inserted through the septum of the vial in a distal direction, the piercing member having a distal tip; a rigid enclosure comprising an internal space; and a reservoir comprising a first flexible side made of a first sheet of material and a second flexible side made of a second sheet of material, the first and second sheets connected at a peripheral edge, the reservoir configured to inflate in the distal direction from a deflated state to an inflated state in response to regulating fluid being received between the first and second flexible sides; wherein, in the deflated state and with the housing coupled with the vial, the entirety of the reservoir is positioned in the internal space of the rigid enclosure and outside of the vial; and wherein, during inflation from the deflated state to the inflated state, a portion of the reservoir expands out of the rigid enclosure, such that some of the reservoir is in the rigid enclosure and some of the reservoir is not in the rigid enclosure.

24. The pressure-regulating vial adapter of claim 23, wherein the first flexible side and the second flexible side are configured to unfold to increase the volume of the reservoir and to crumple to decrease the volume of the reservoir.

25. The pressure-regulating vial adapter of claim 23, wherein, during inflation from the deflated state to the inflated state, a bottom end of the reservoir expands toward the vial.

26. The pressure-regulating vial adapter of claim 23, wherein the reservoir is substantially centered with respect to an axial center of the pressure-regulating vial adaptor.

27. The pressure-regulating vial adapter of claim 23, wherein, in the deflated state and with the housing coupled with the vial, a bottom of the reservoir is above a top of the vial.

28. The pressure-regulating vial adapter of claim 23, wherein the piercing member comprises a regulating channel configured to convey the regulating fluid and an access channel configured to convey a medicinal liquid.
