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Solomon et al.

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(54) **METHODS FOR DISINFECTING MEDICAL CONNECTORS**

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Related U.S. Application Data

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(51) **Int. Cl.**

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A61M 5/14	(2006.01)
A61M 25/16	(2006.01)
A61M 25/18	(2006.01)
A61M 39/00	(2006.01)
A61M 39/10	(2006.01)

(52) **U.S. Cl.** **604/500**; 604/256; 604/533; 604/905

(58) **Field of Classification Search** 604/905, 604/29, 283, 256, 403, 533

See application file for complete search history.

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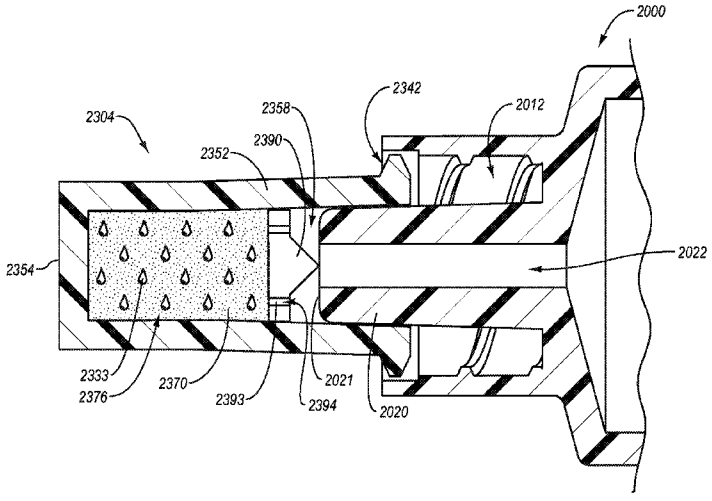
(57) **ABSTRACT**

Caps can be used to cover and sterilize the male luer of a medical connector. Some caps can create a seal with the male luer to prevent antiseptic from entering a lumen of the male luer. A biasing element can aid in creating or maintaining the seal.

10 Claims, 44 Drawing Sheets



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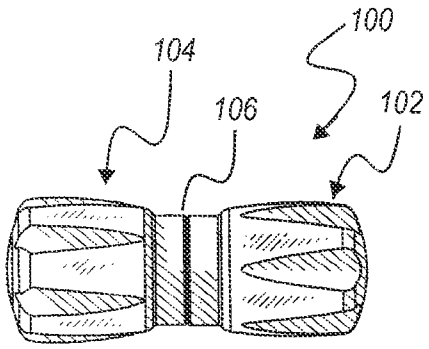

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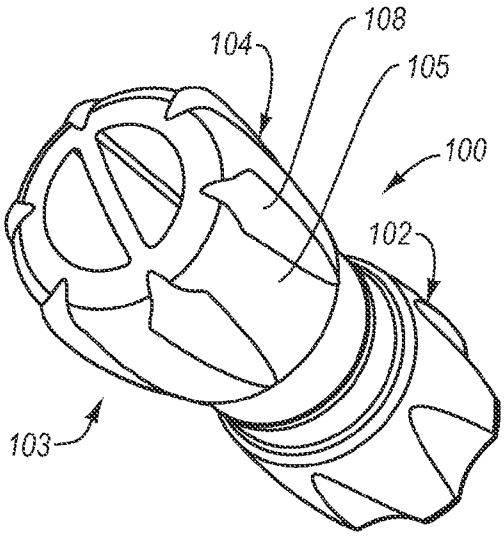

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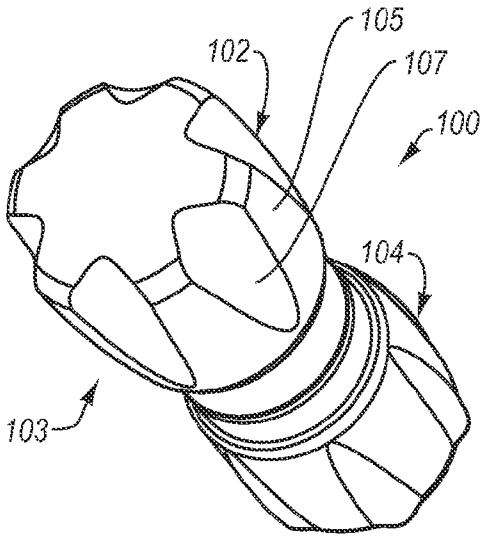

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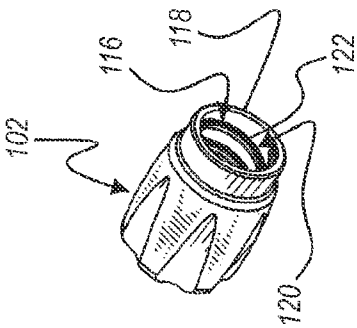

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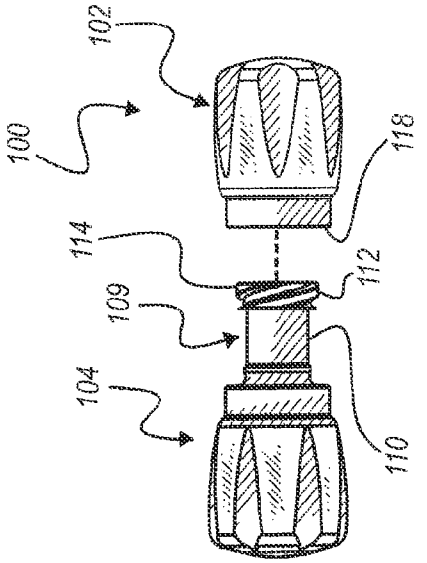

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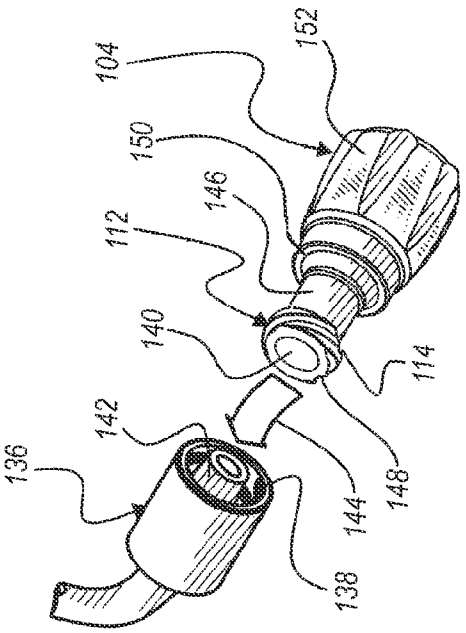

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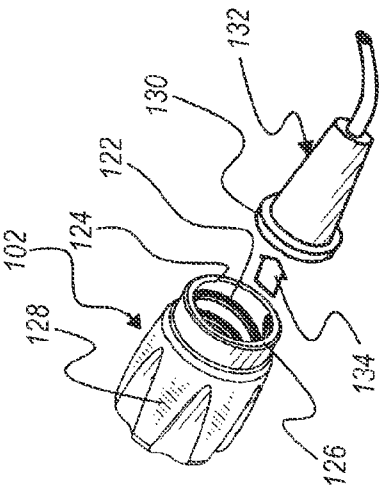

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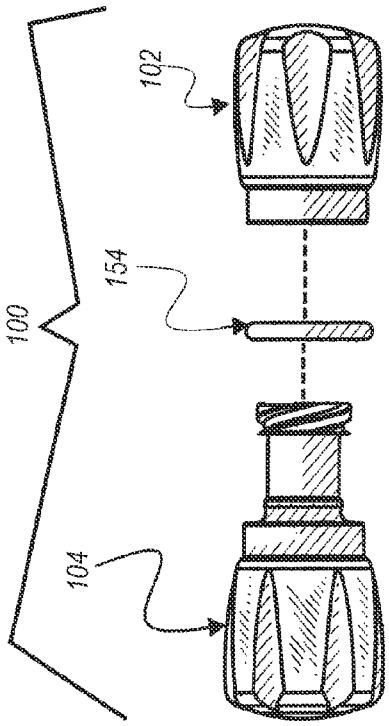

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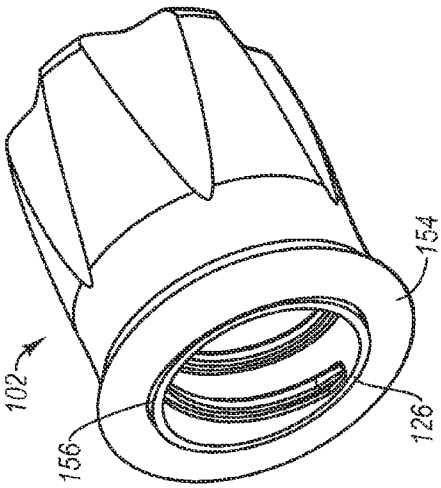

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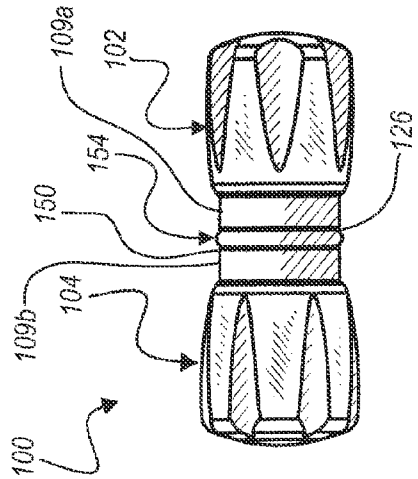

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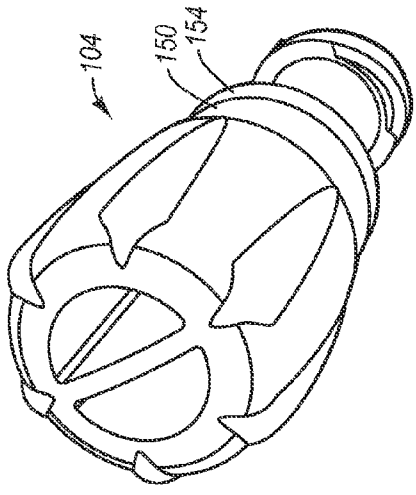

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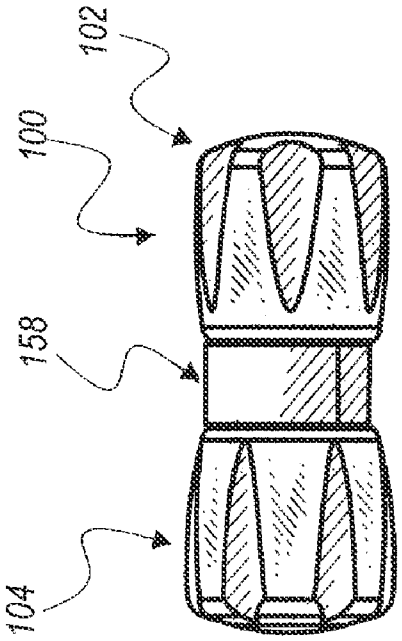

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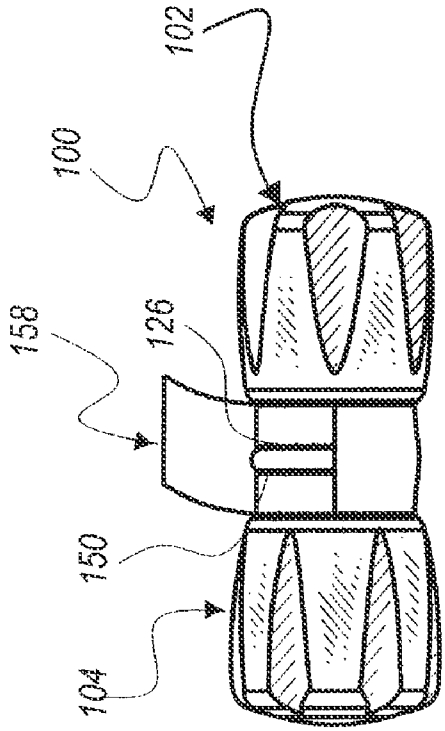

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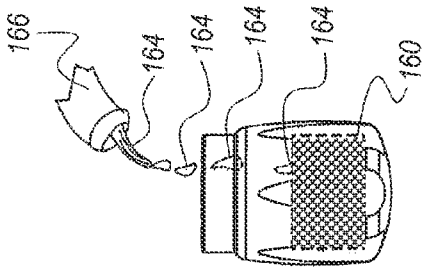

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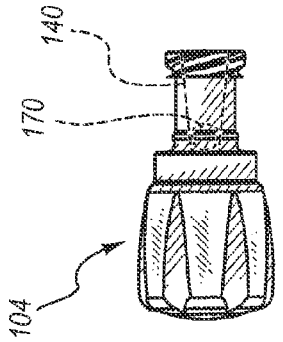

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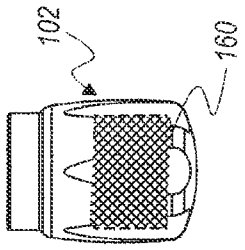

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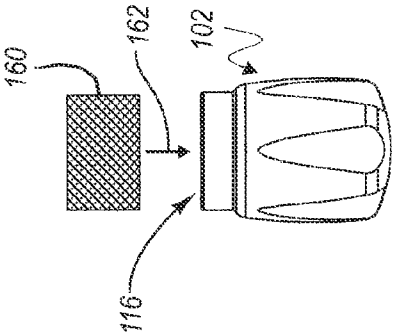
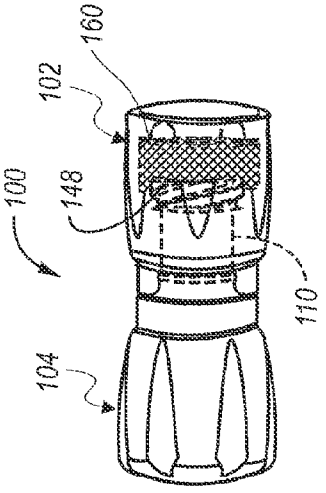


Figure 9A



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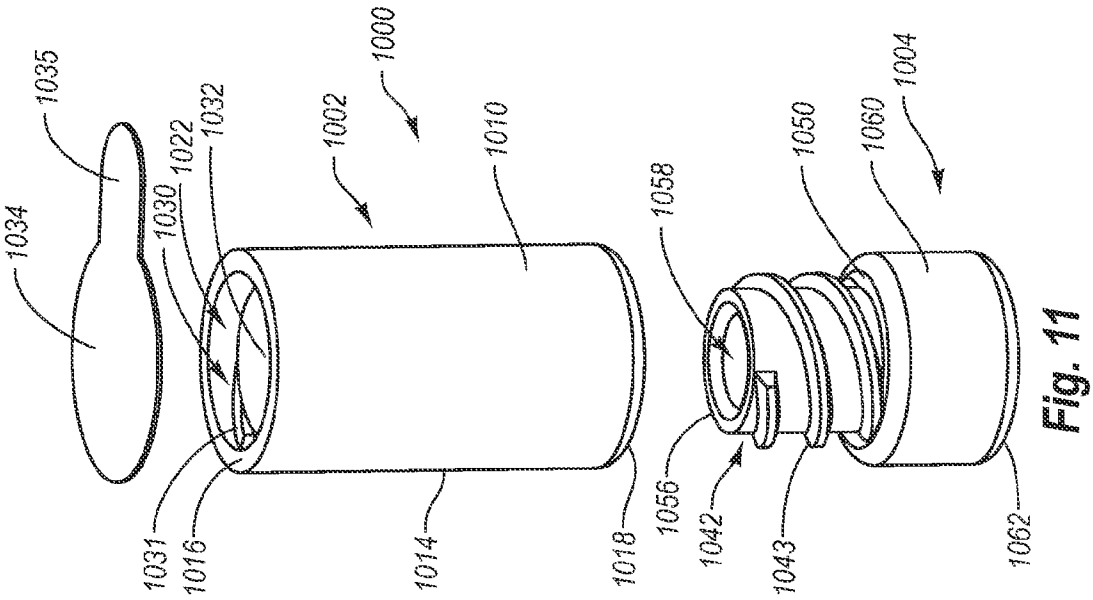
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Fig. 11

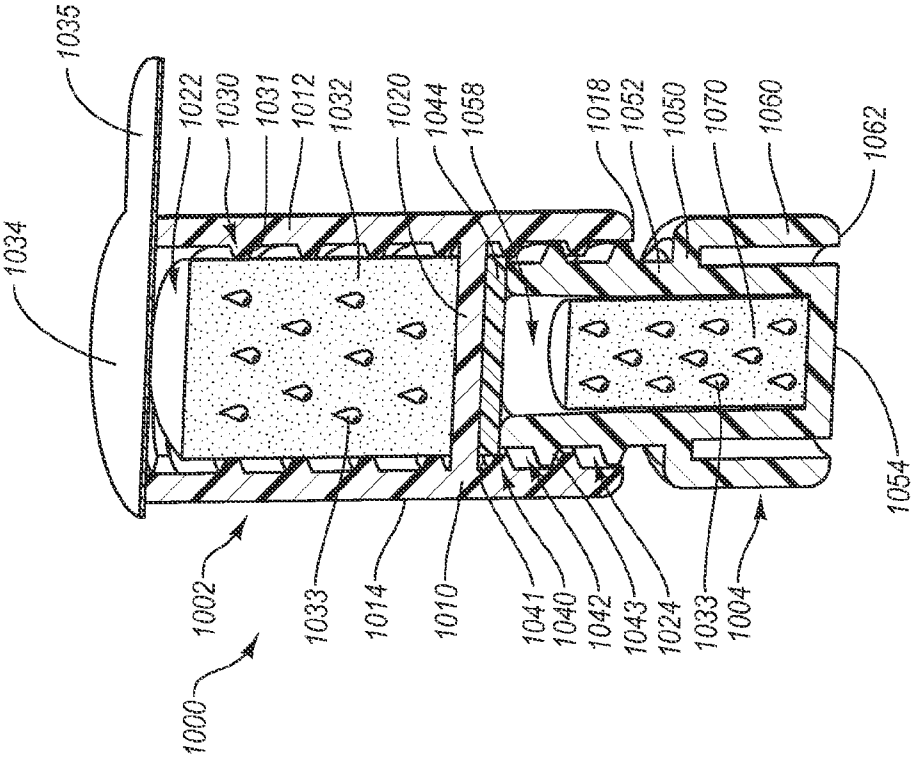
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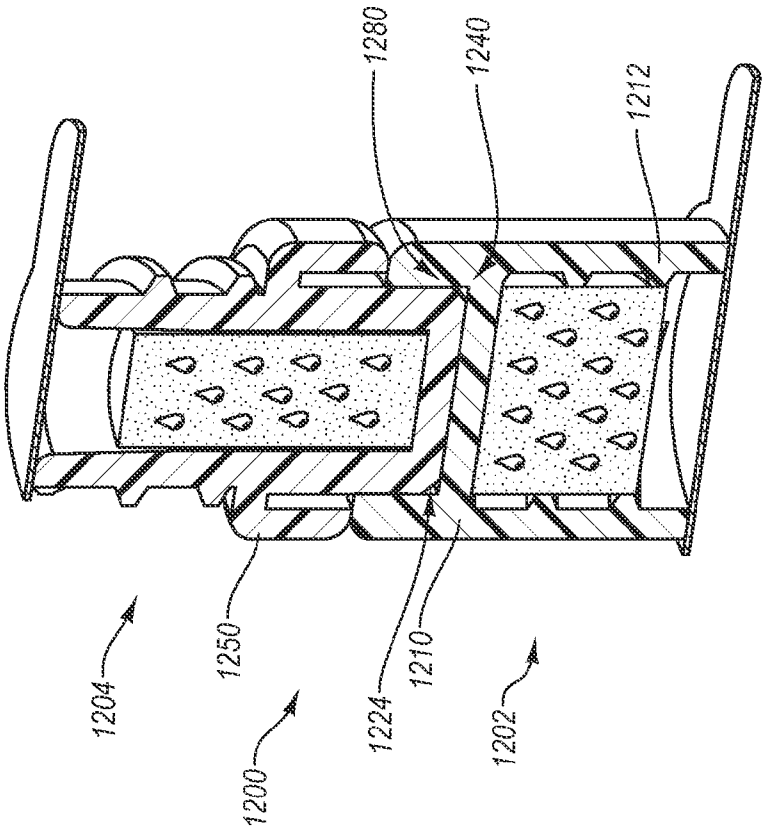
Fig. 10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1202
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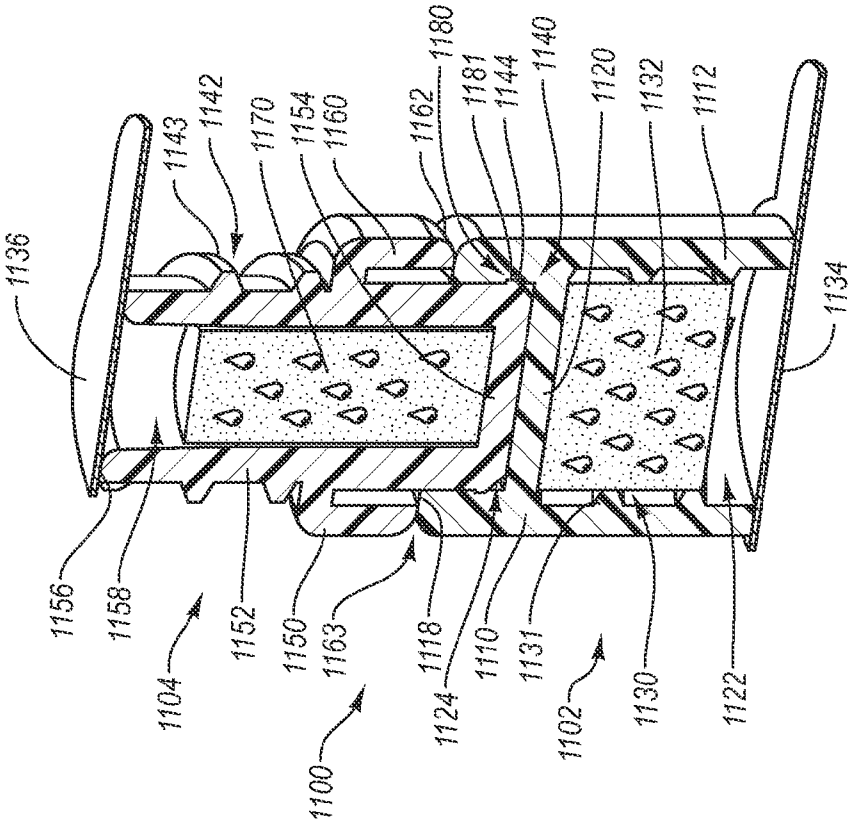
Fig. 13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1102
1100

Fig. 12

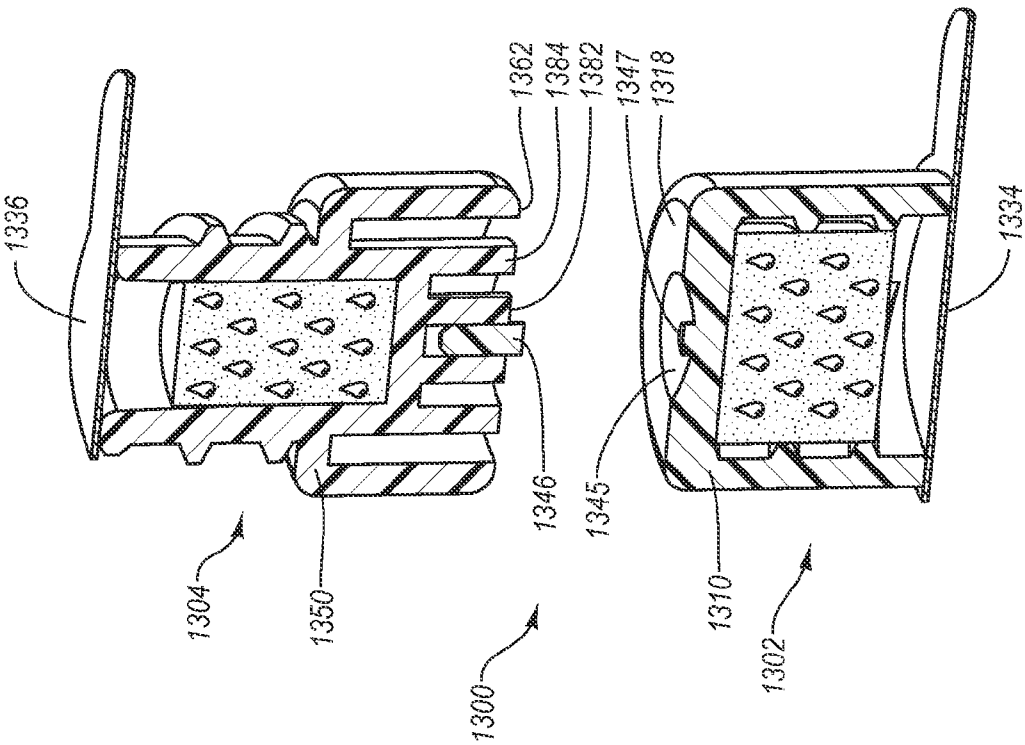
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Fig. 15

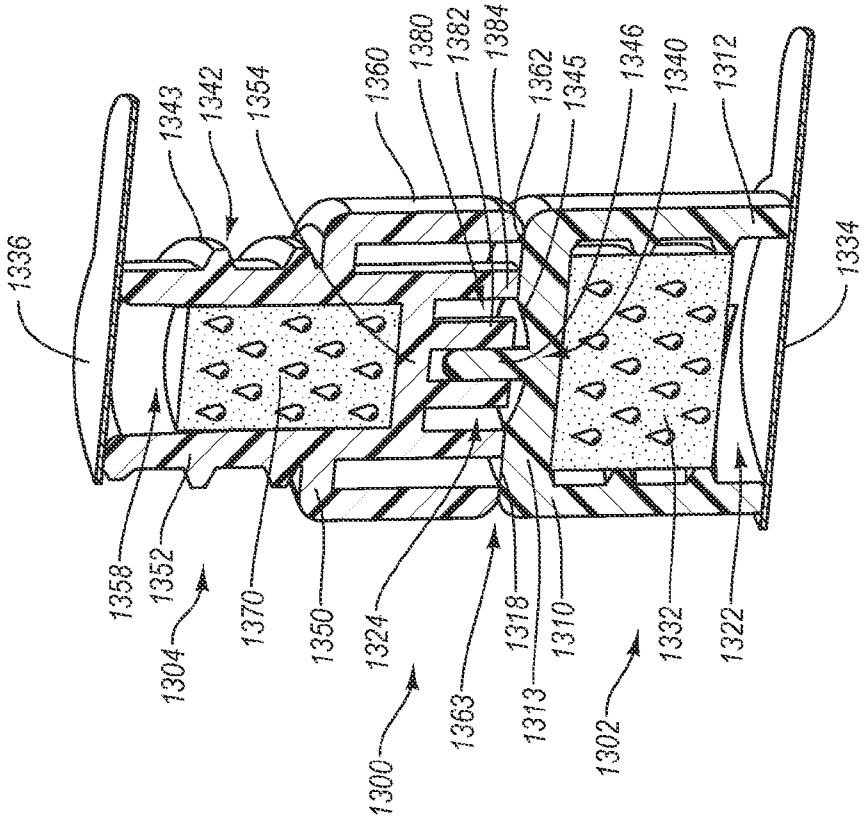
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Fig. 14

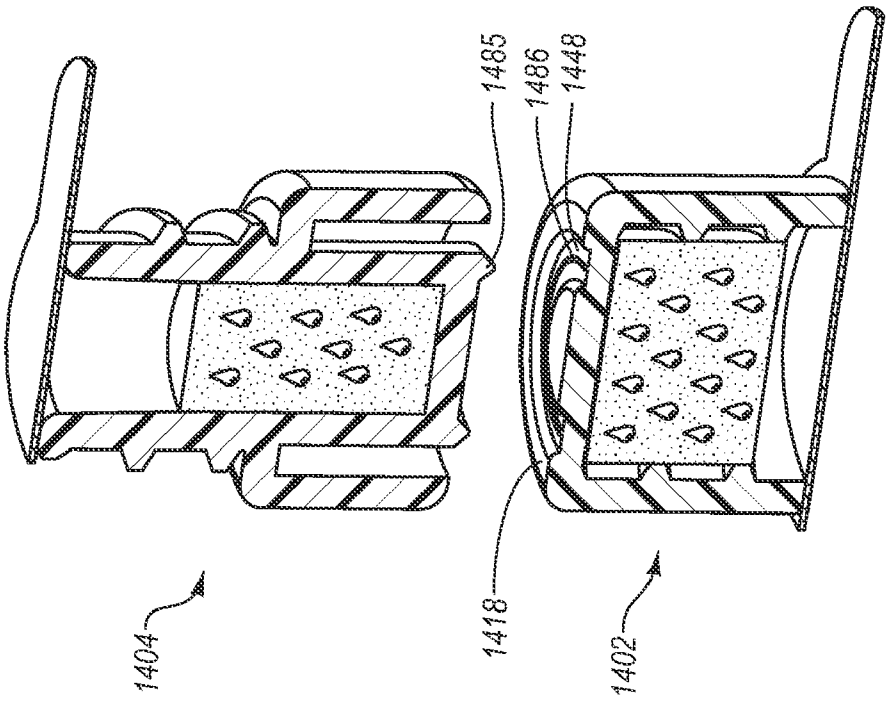
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Fig. 17

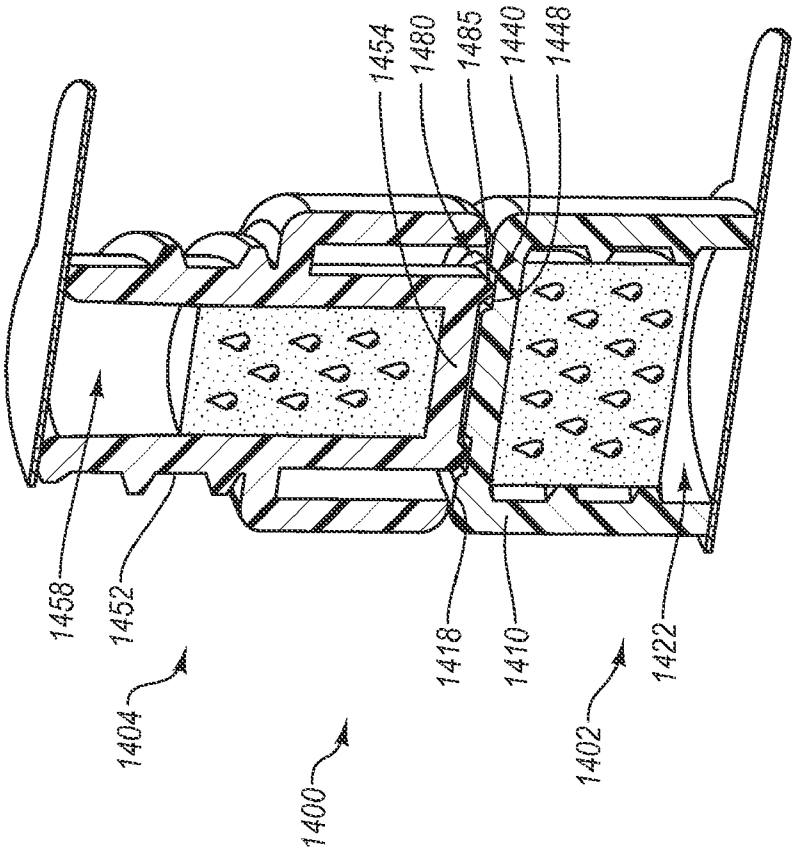
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Fig. 16

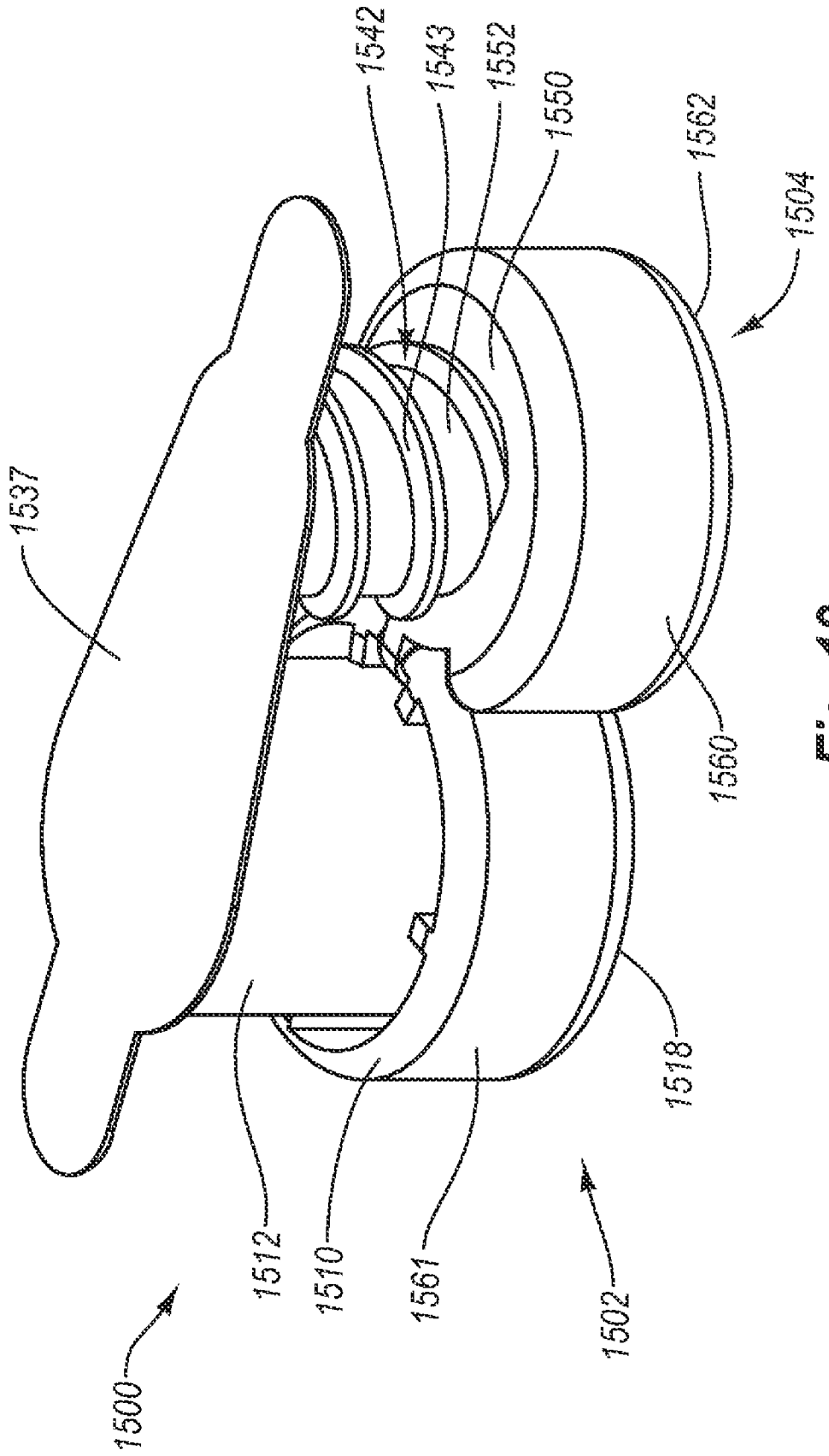
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Fig. 18

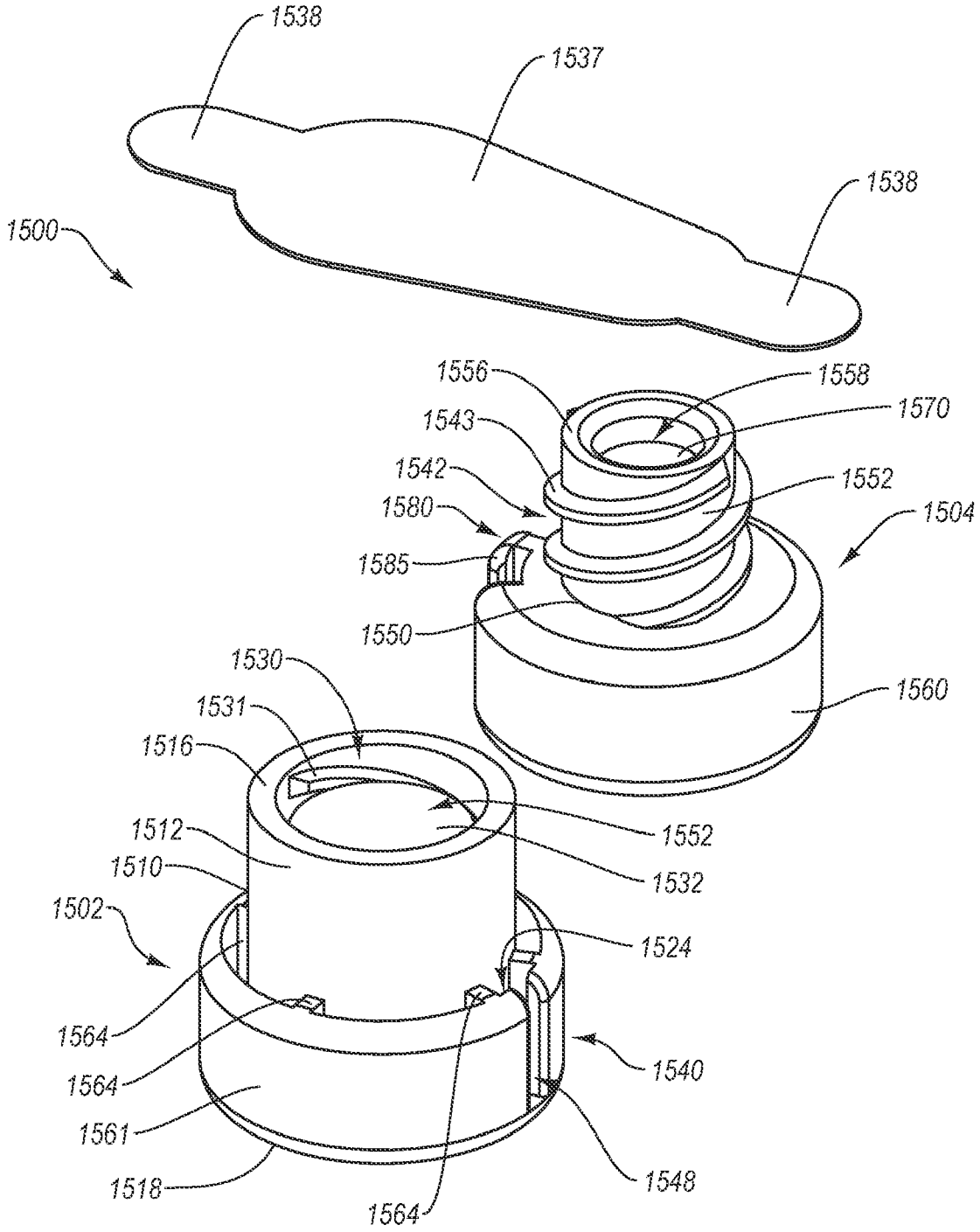
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Fig. 19

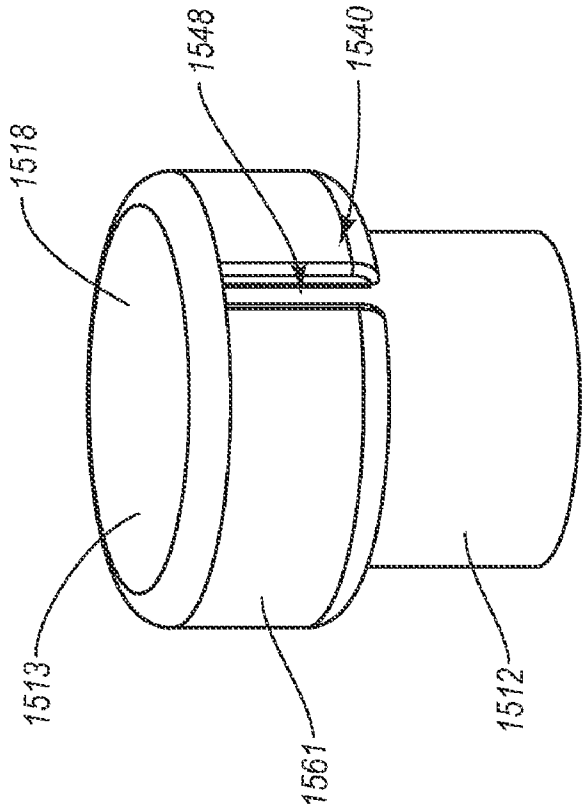
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Fig. 21

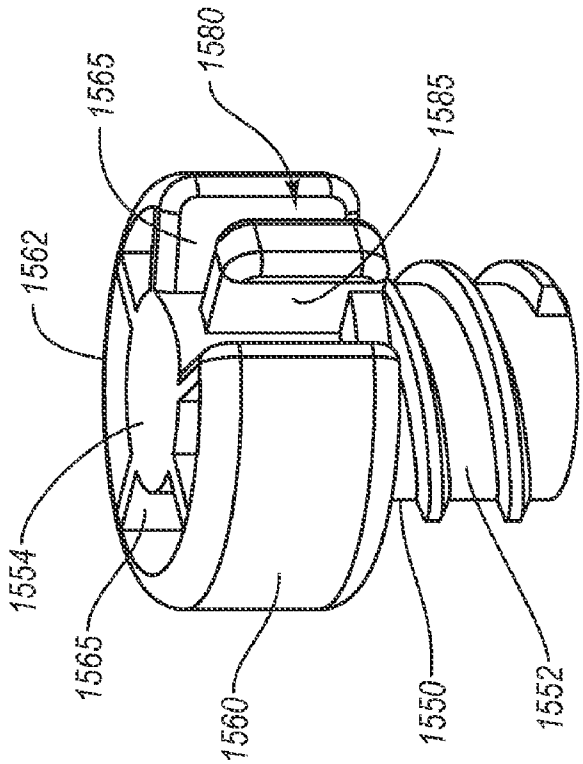
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Fig. 20

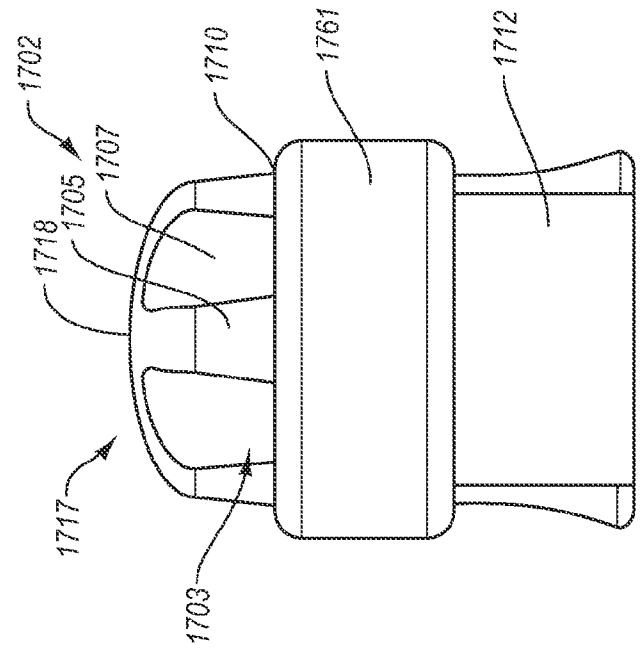
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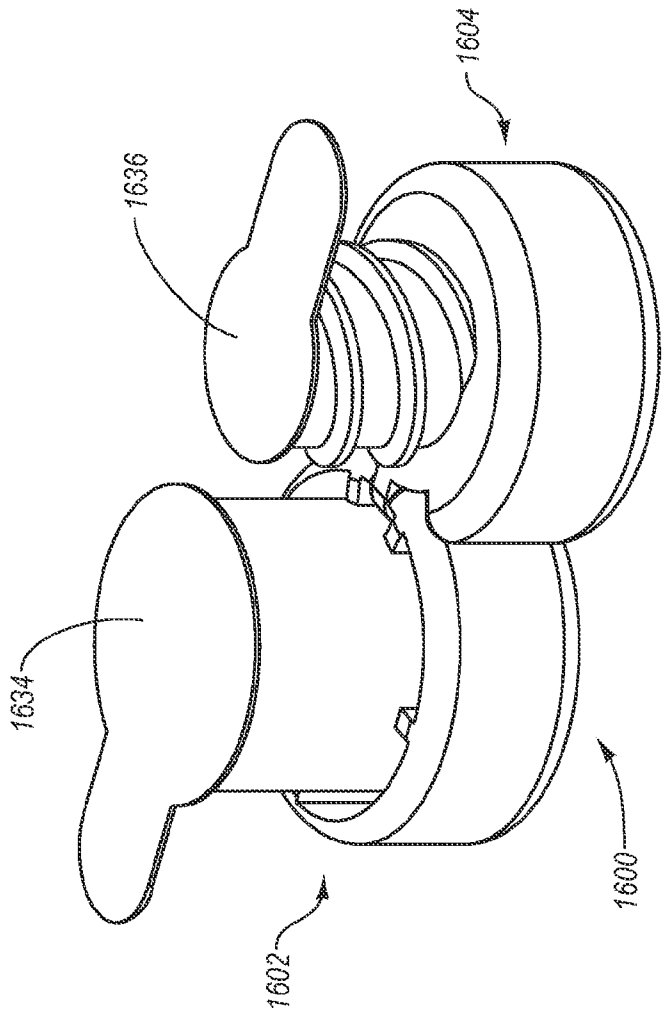
Fig. 23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1634
1602
1600

Fig. 22

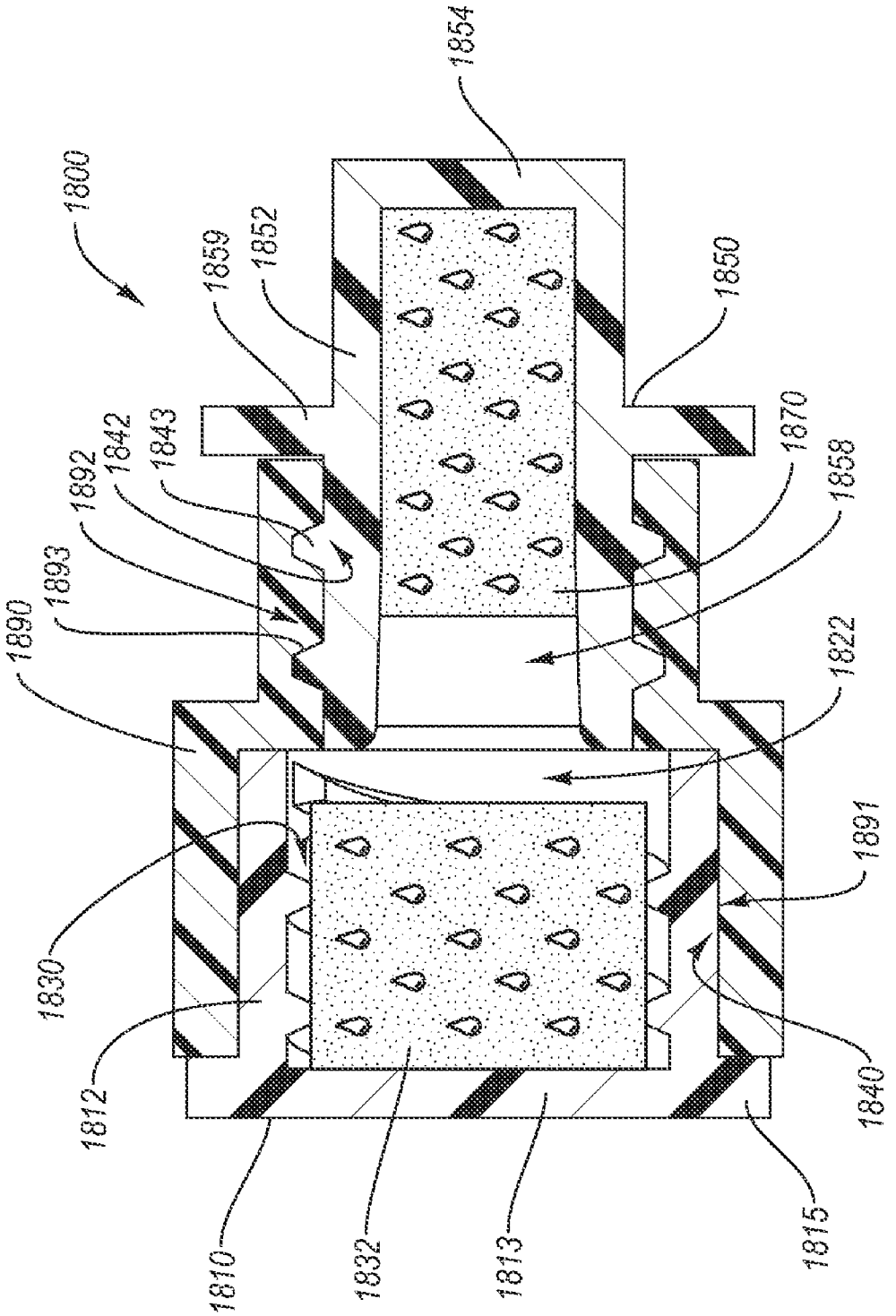
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Fig. 24

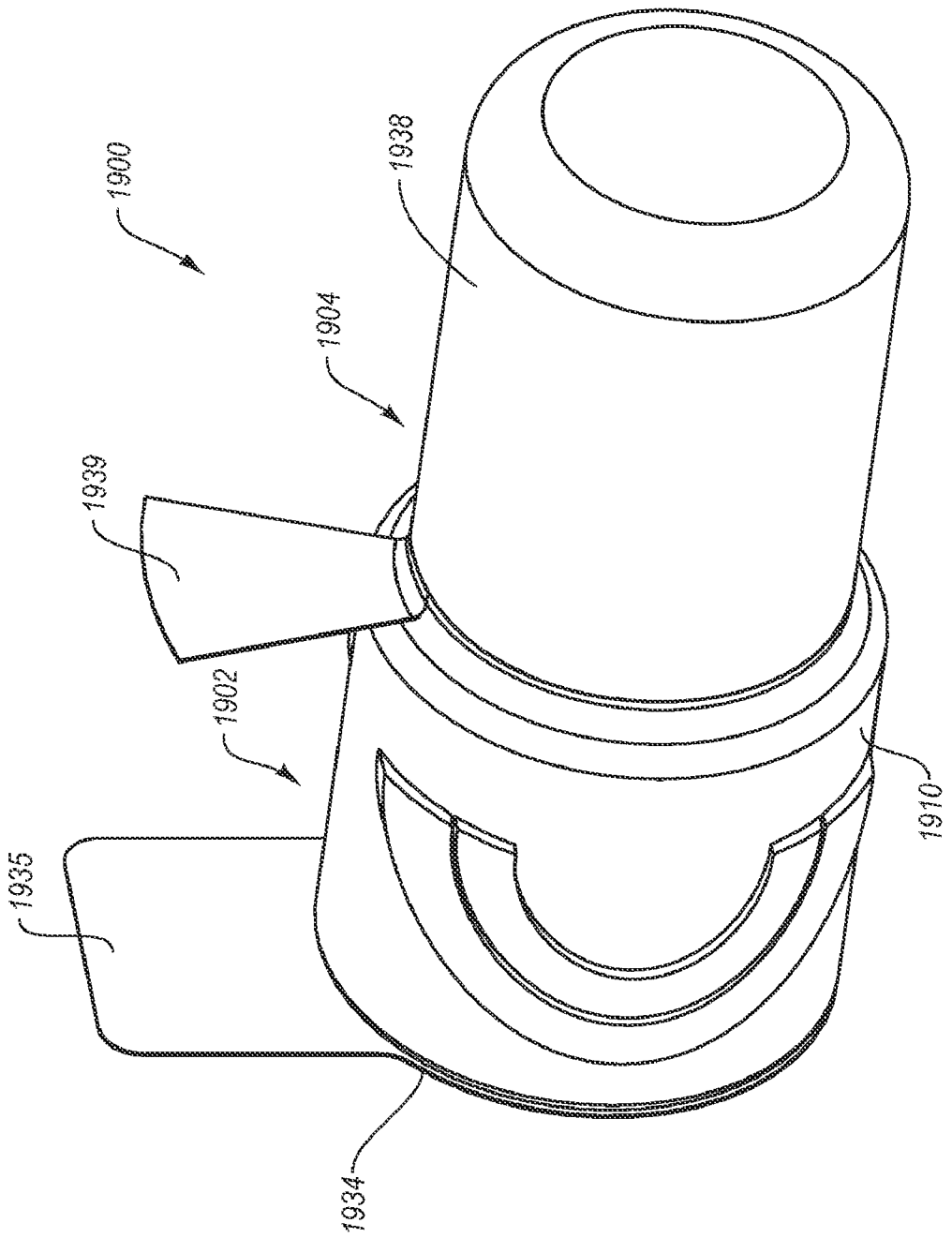
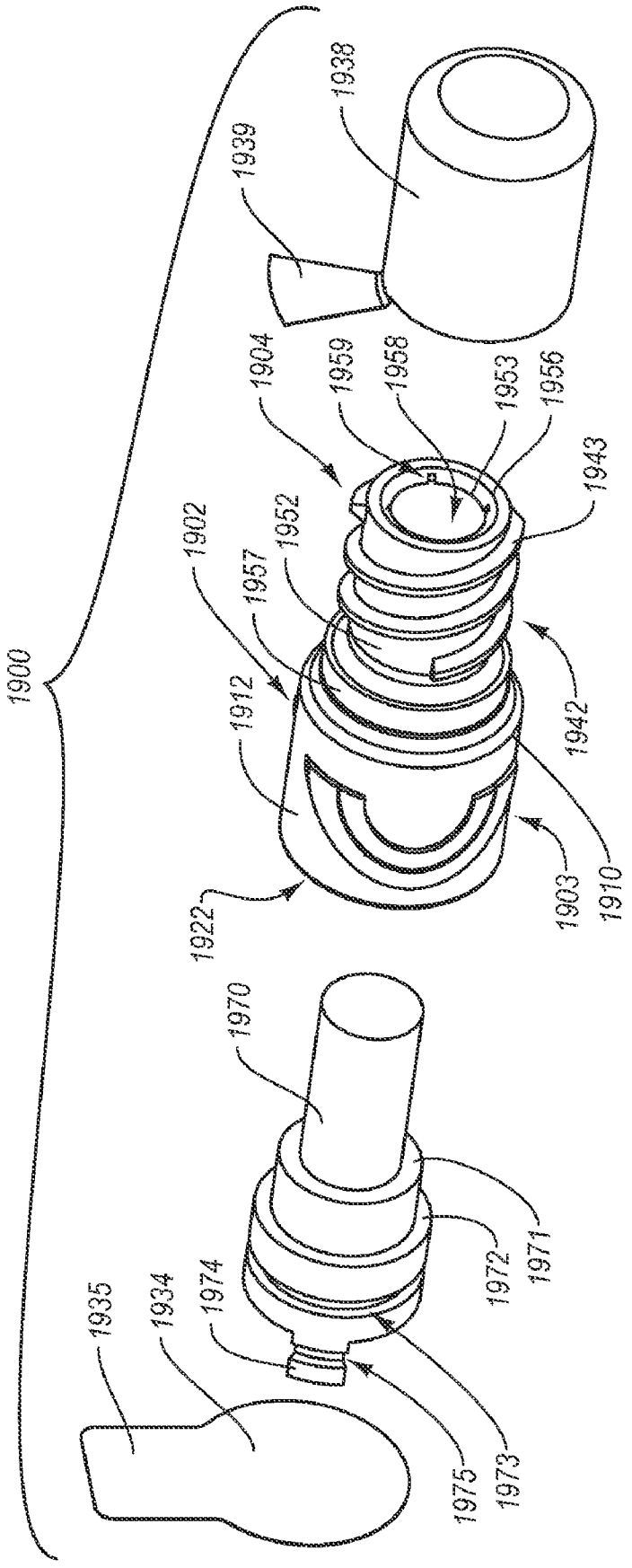


Fig. 25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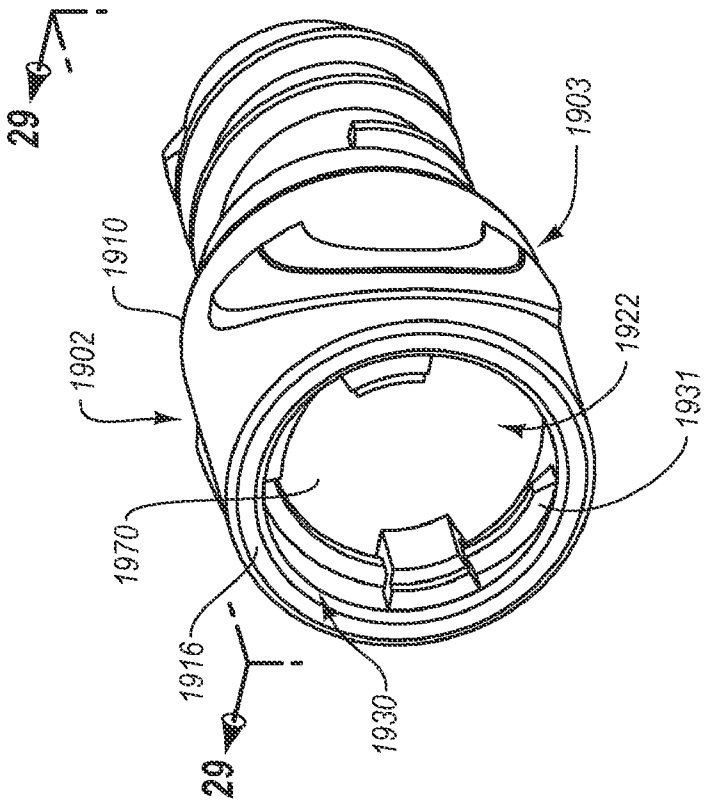
1973

Fig. 26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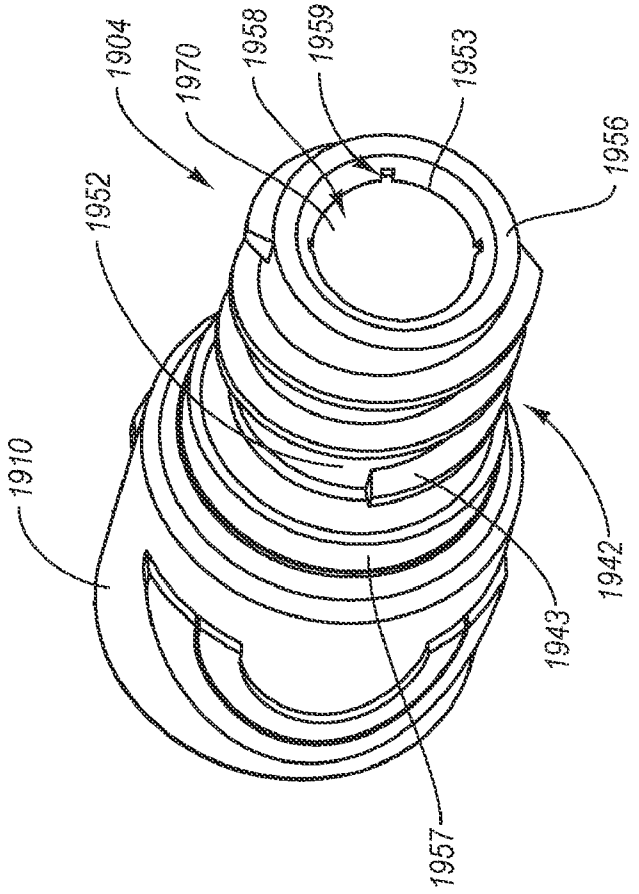
1922
1931
1970
1916
1930
29

Fig. 28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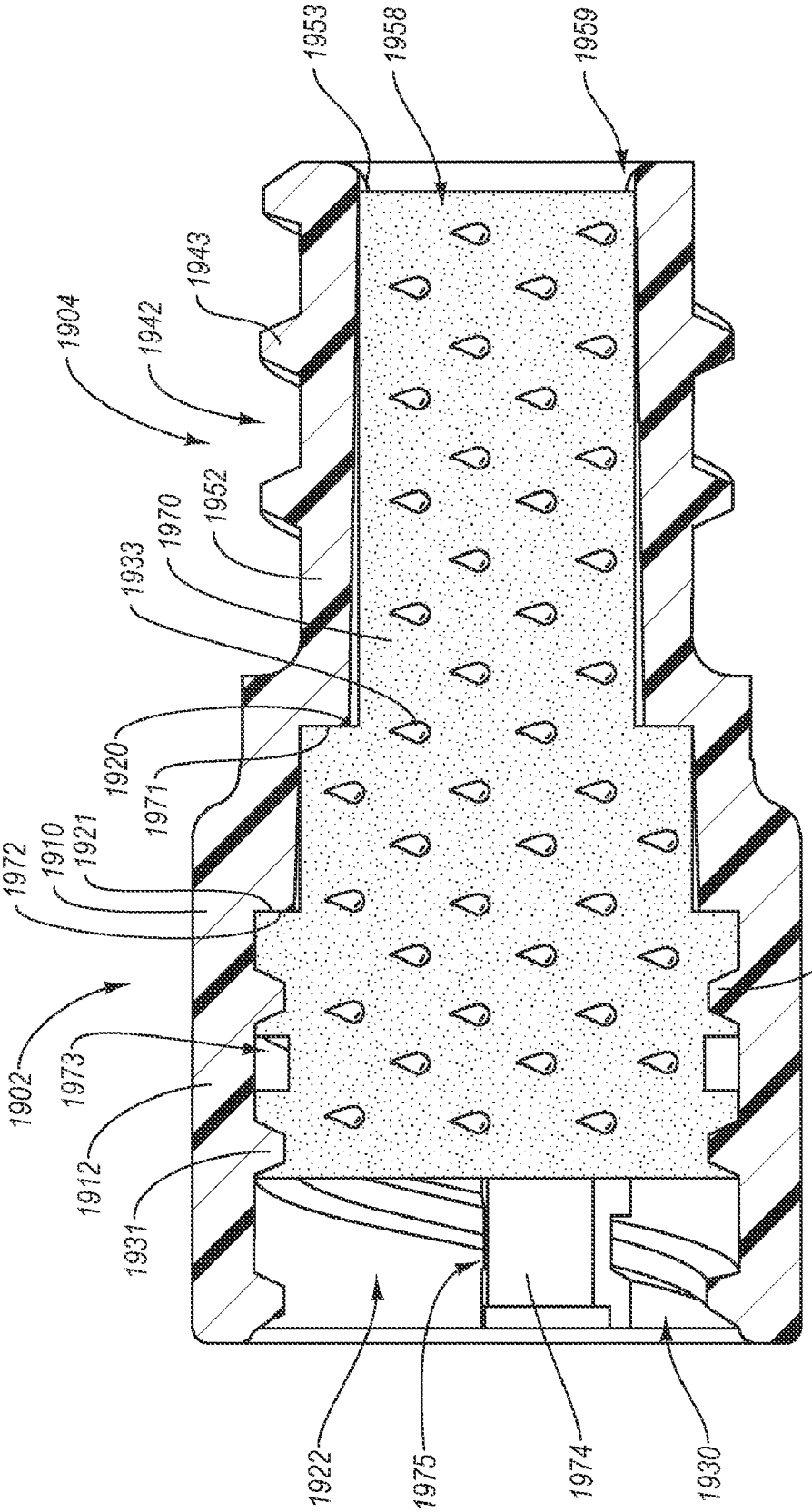
1957

Fig. 27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1930

Fig. 29

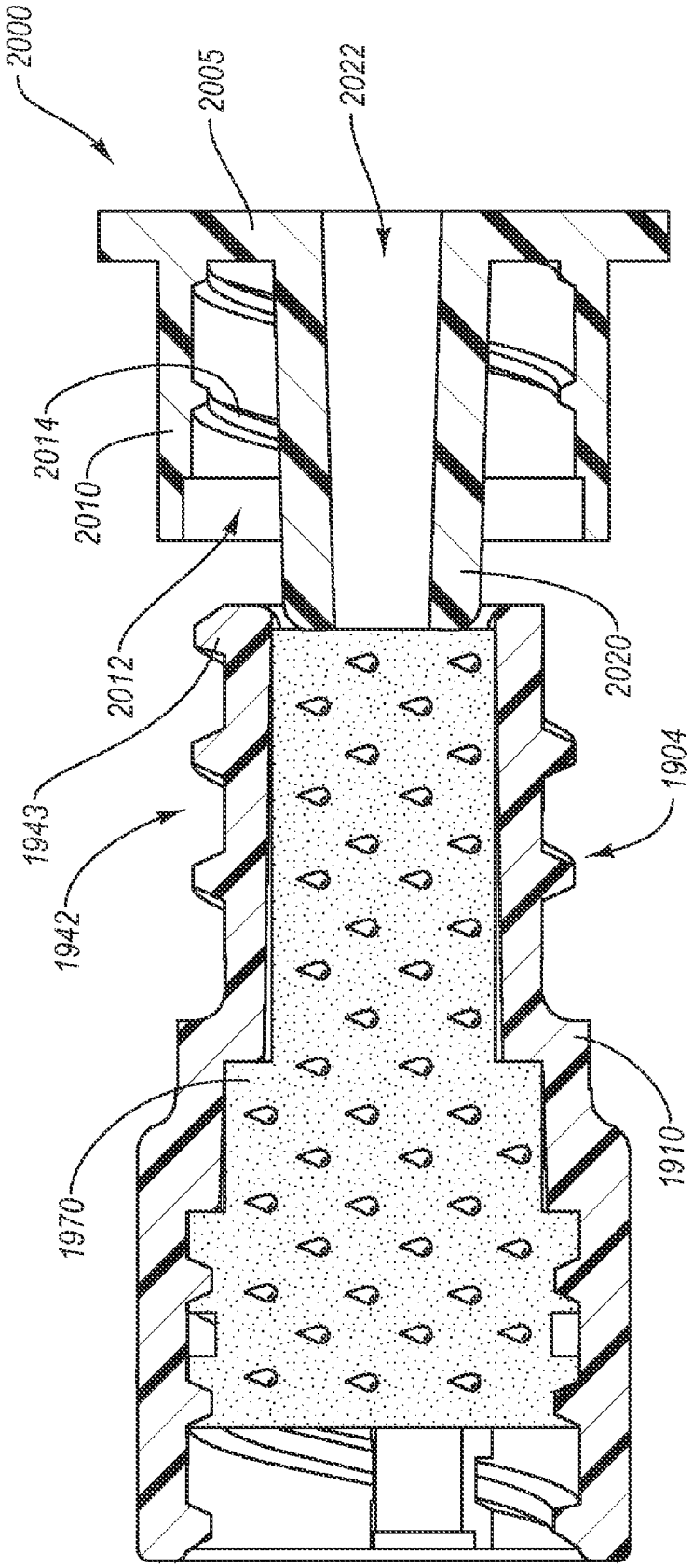
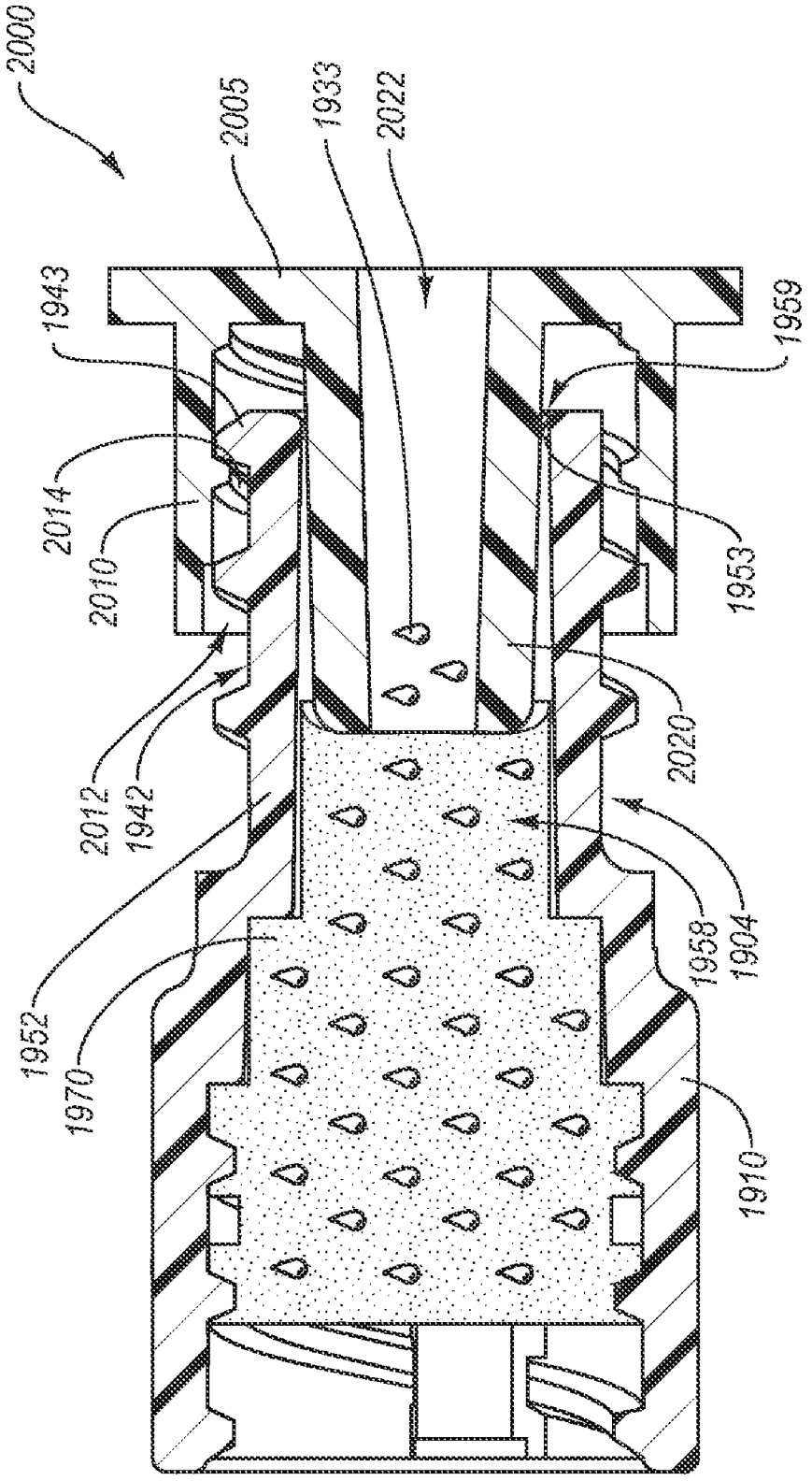


Fig. 30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1910

Fig. 31

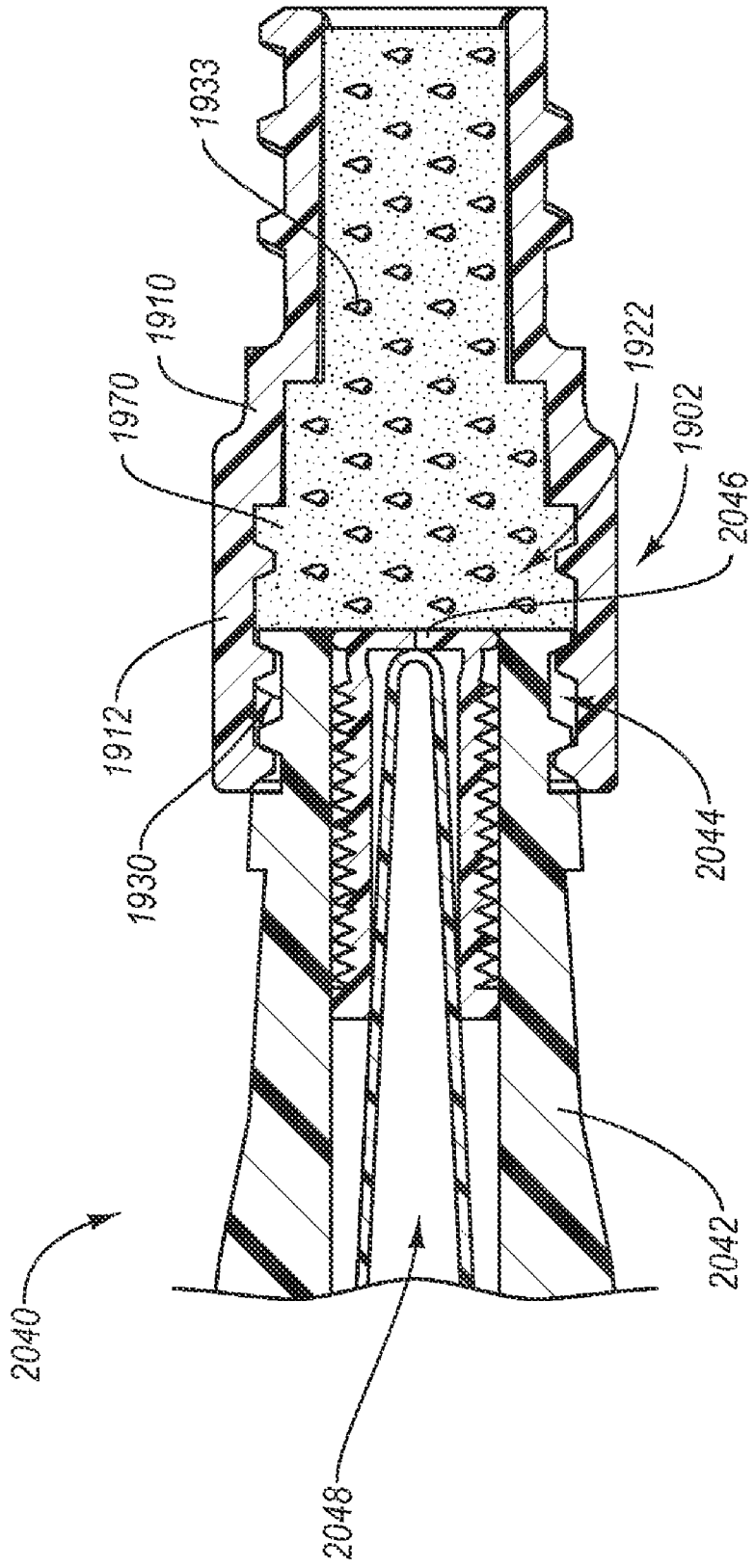


Fig. 32

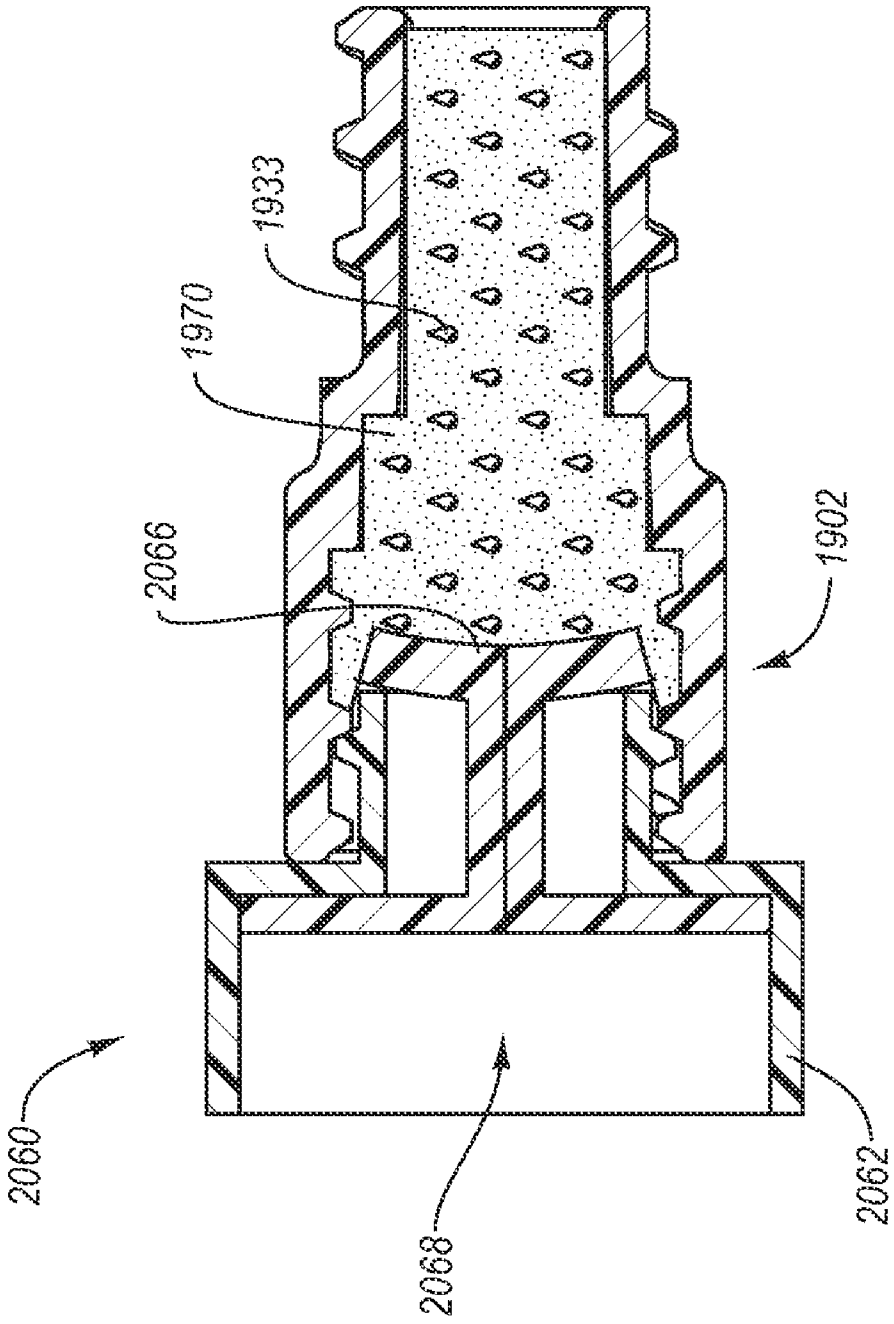


Fig. 33

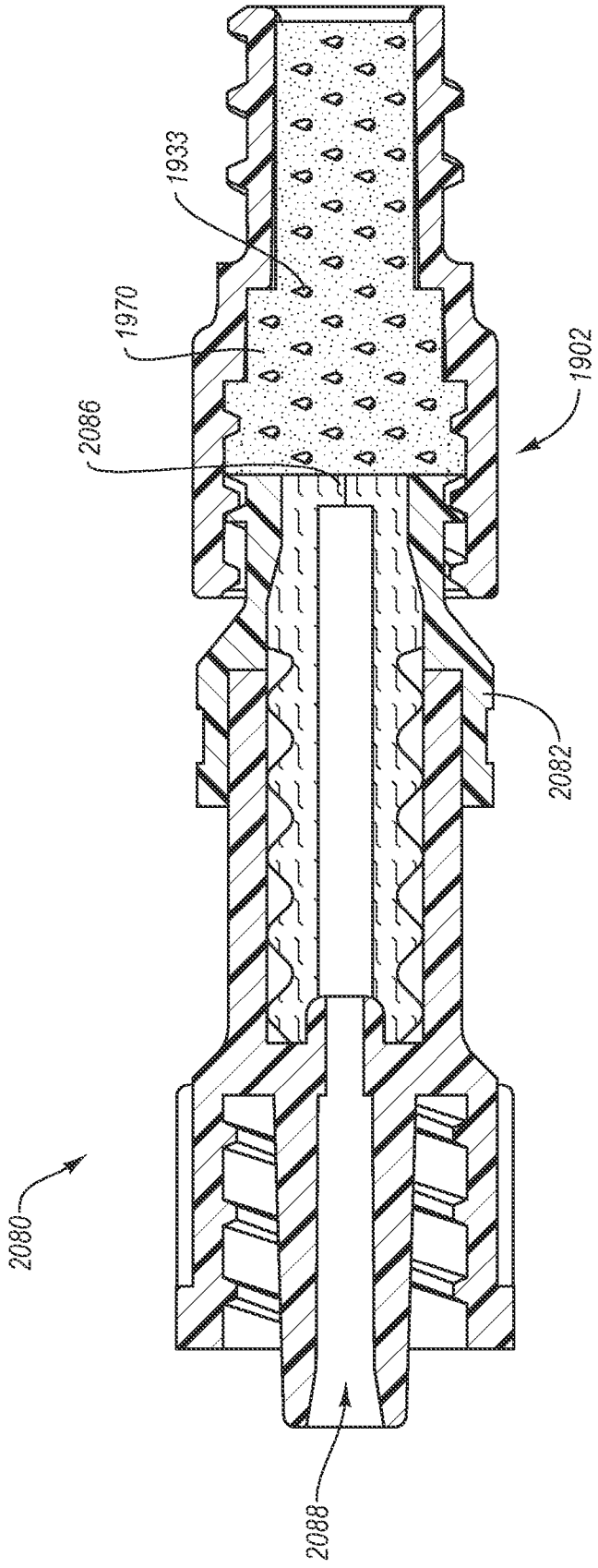


Fig. 34

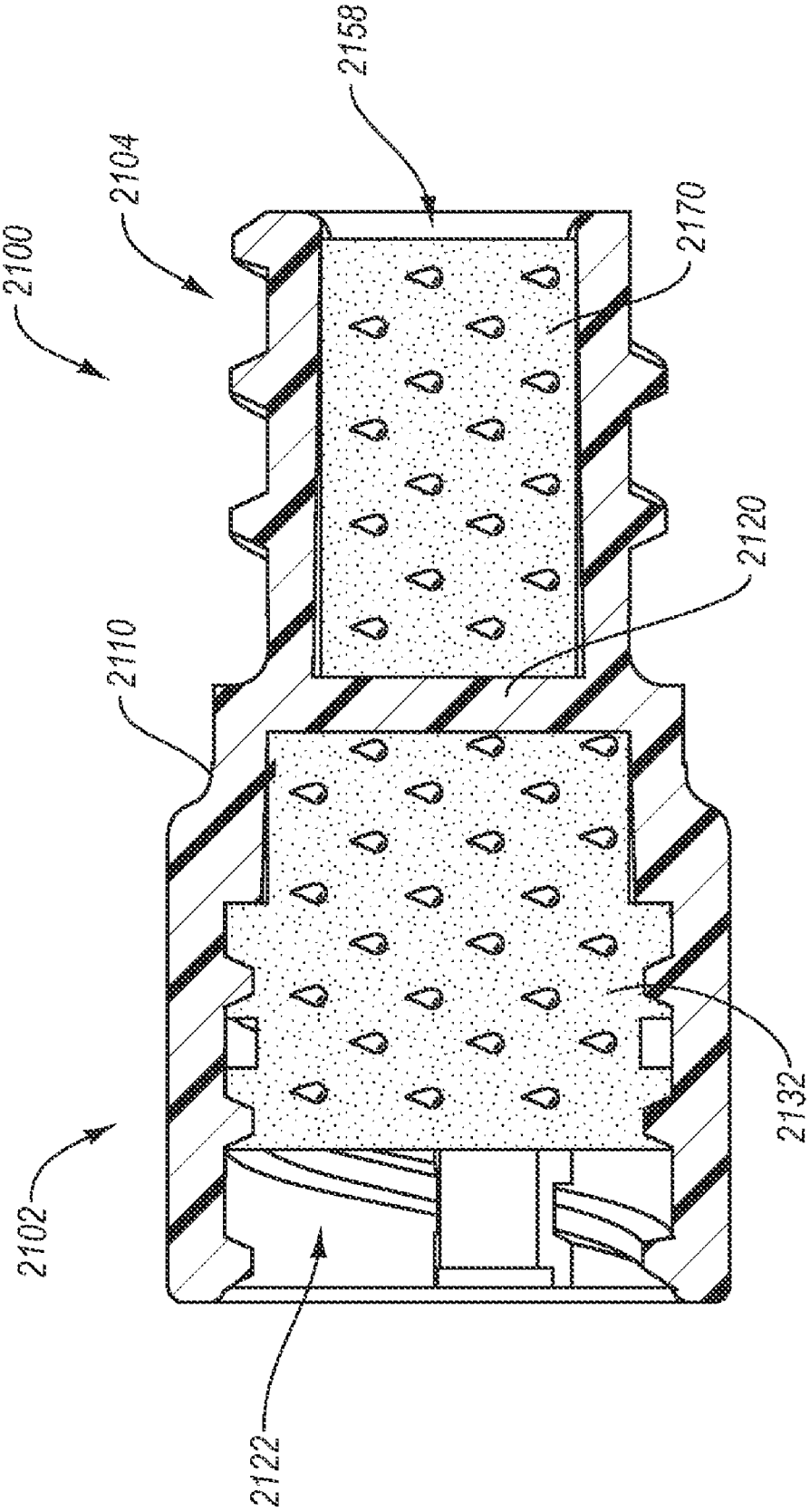
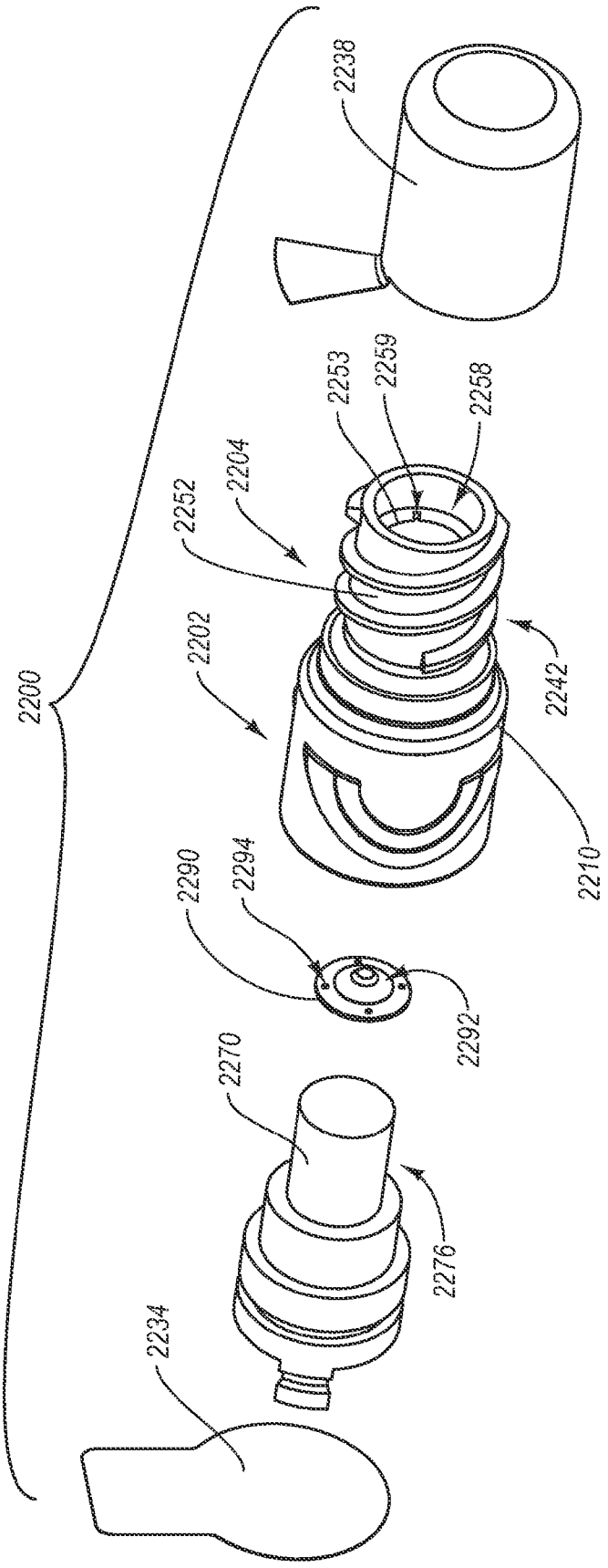


Fig. 35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2234

Fig. 36

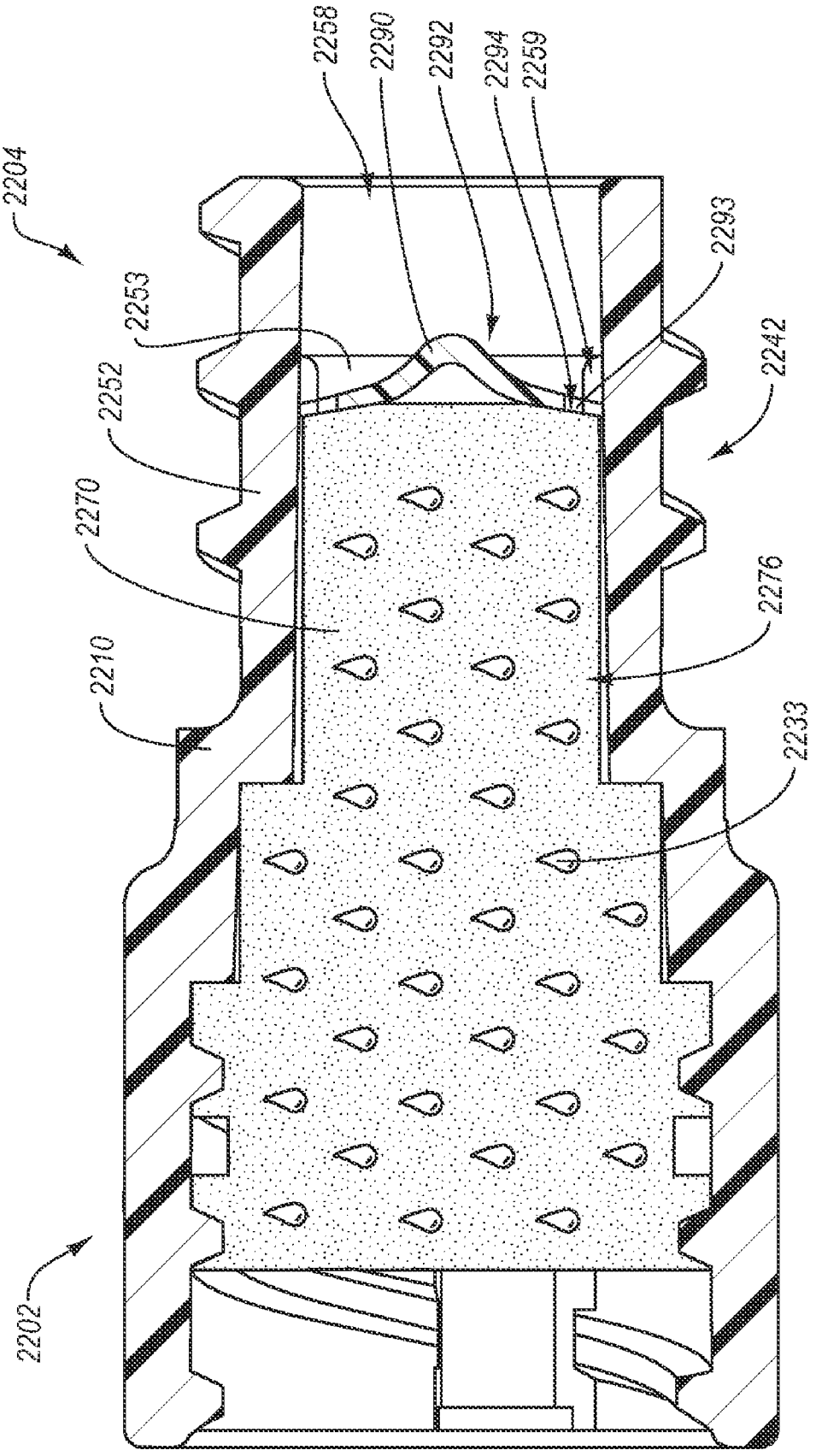
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Fig. 37

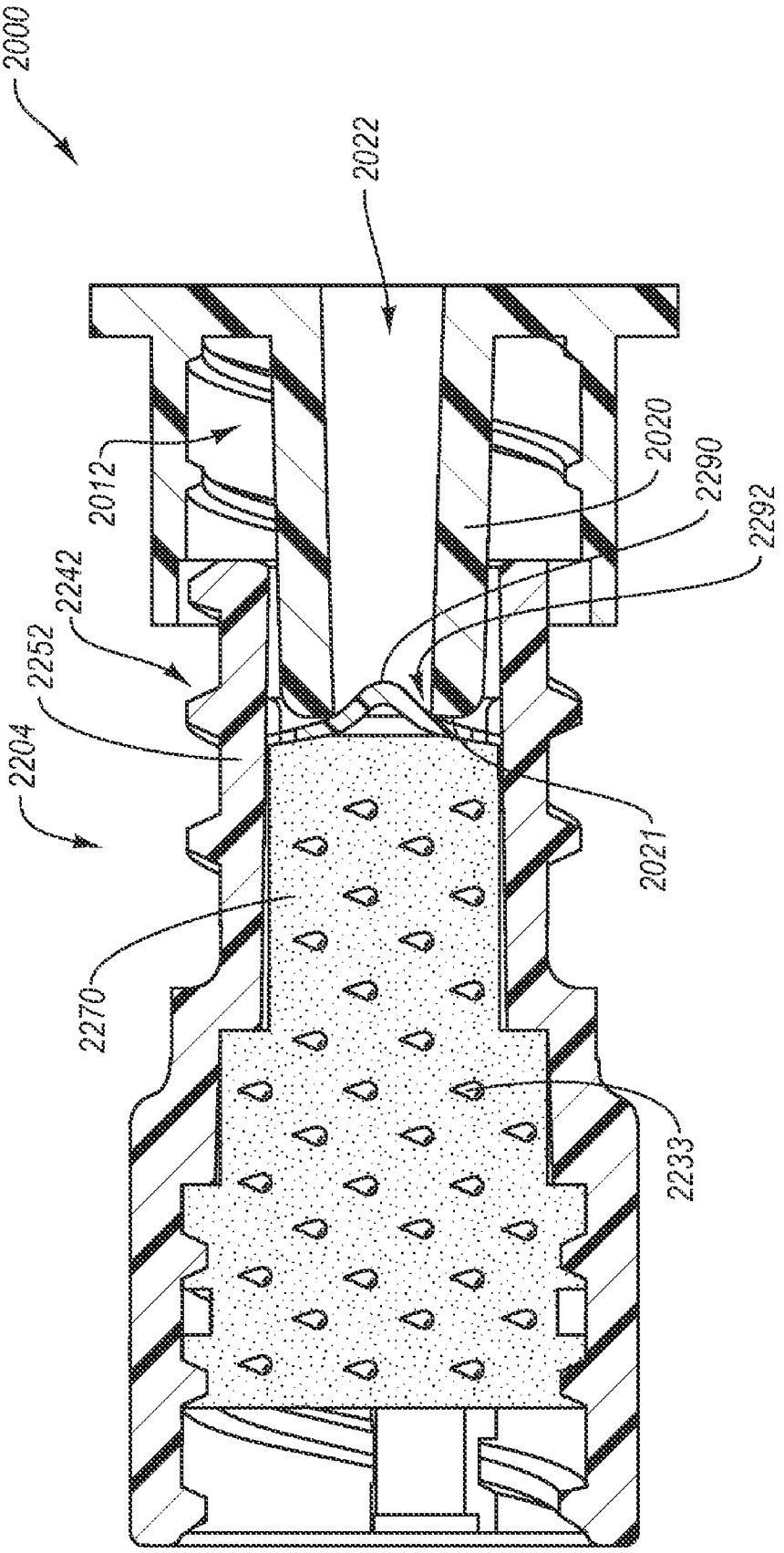
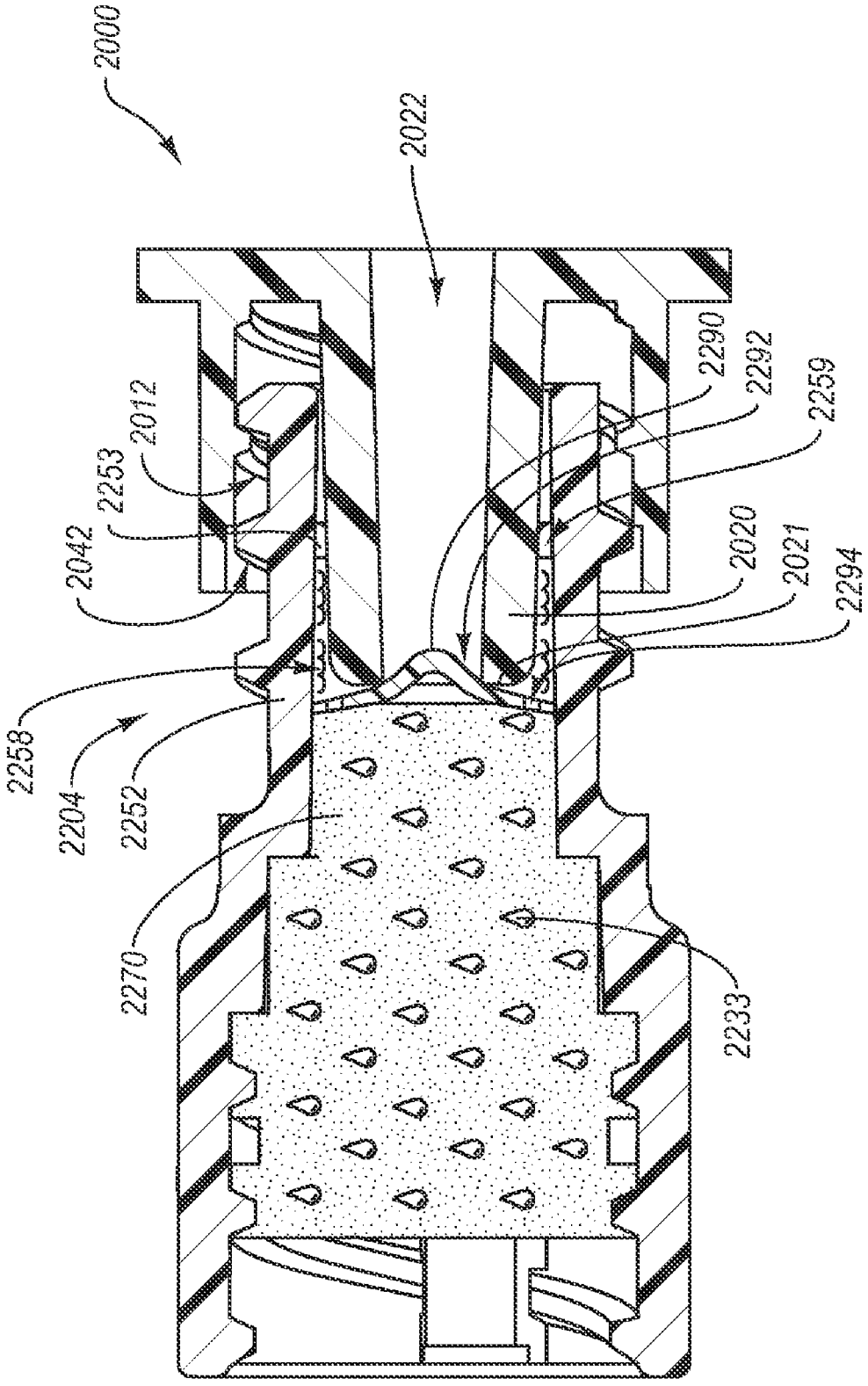


Fig. 38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2270
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Fig. 39

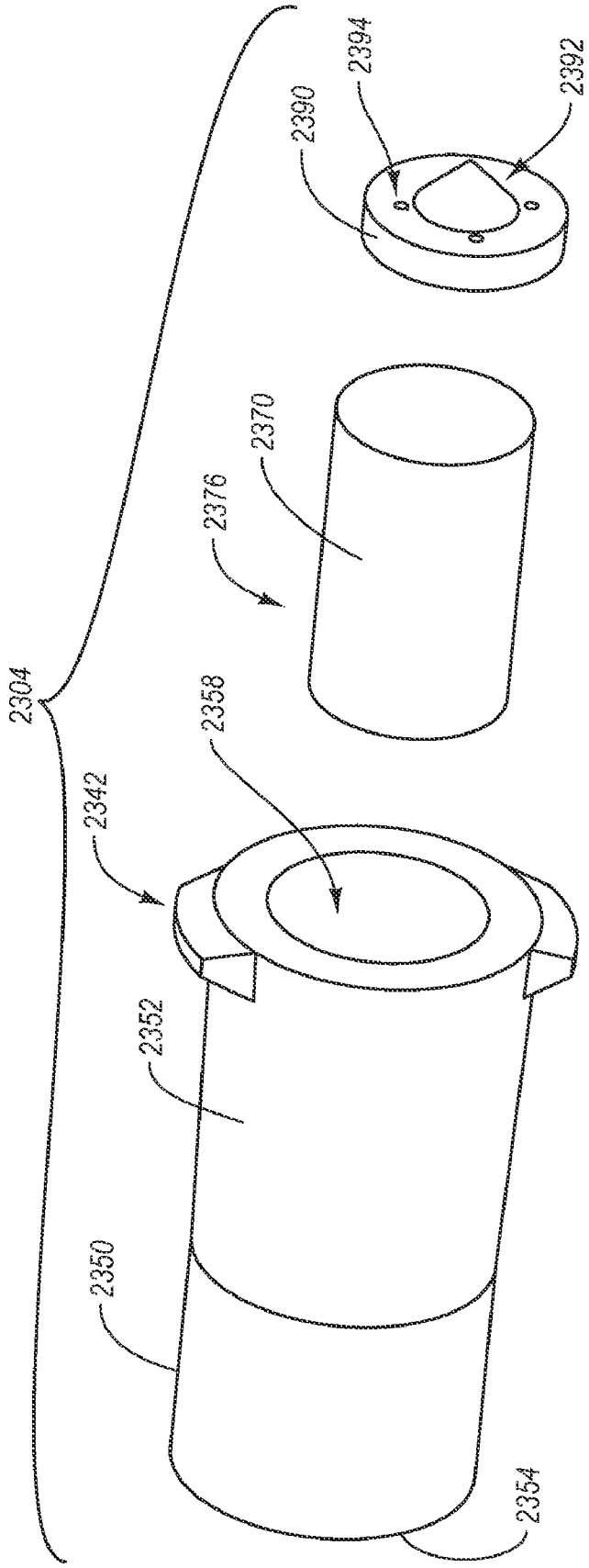

Fig. 40

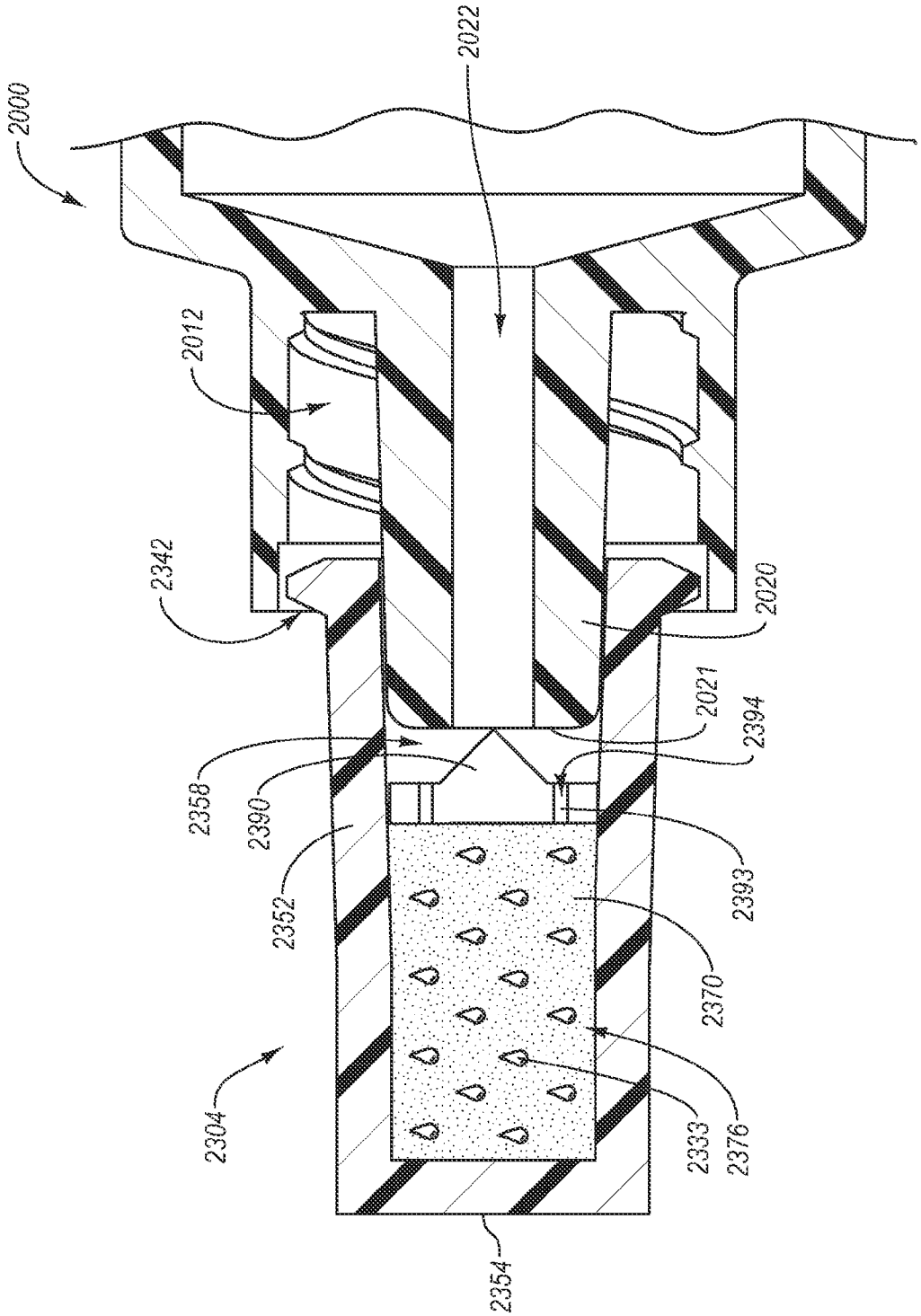
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Fig. 41

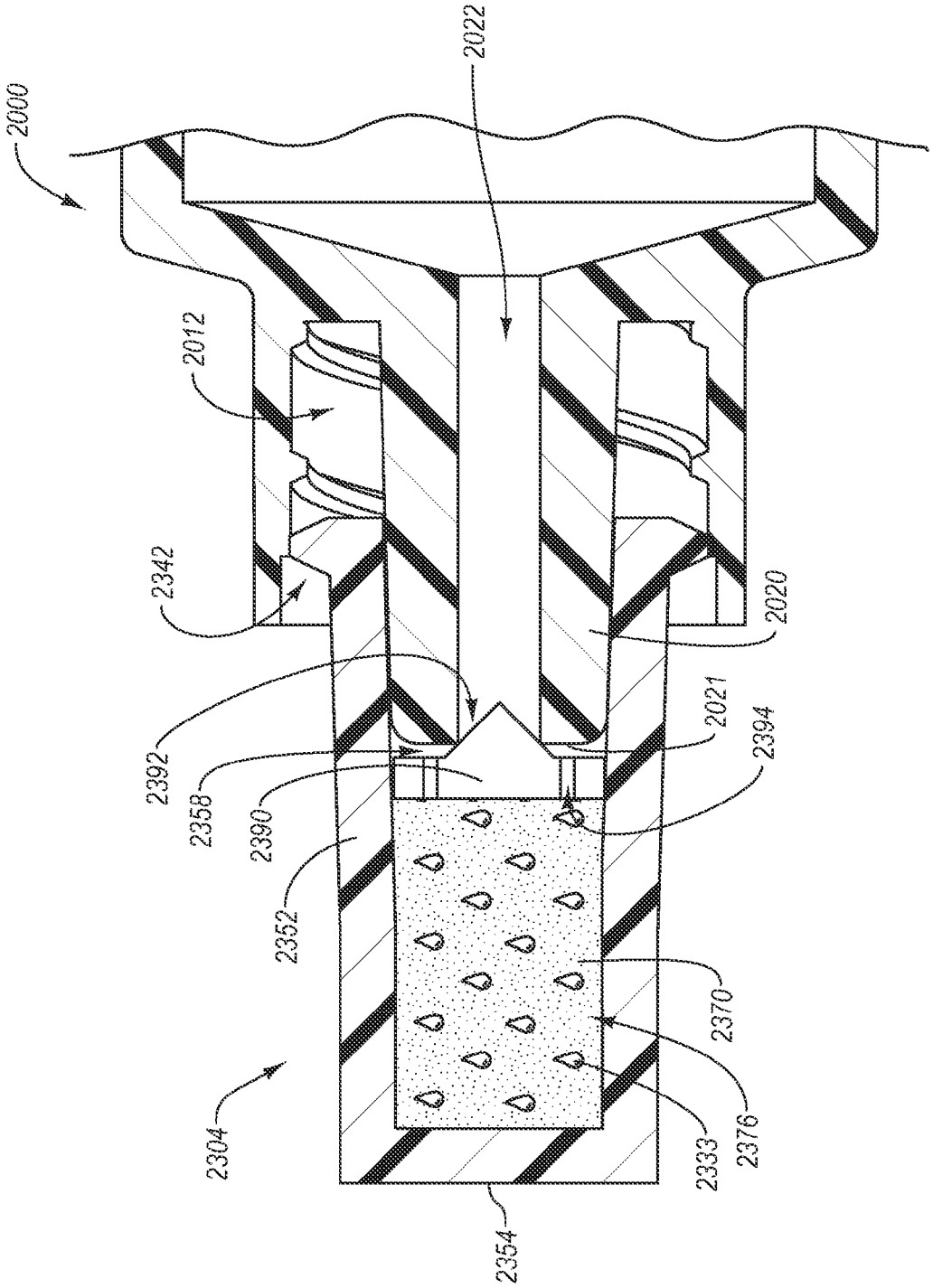
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Fig. 42

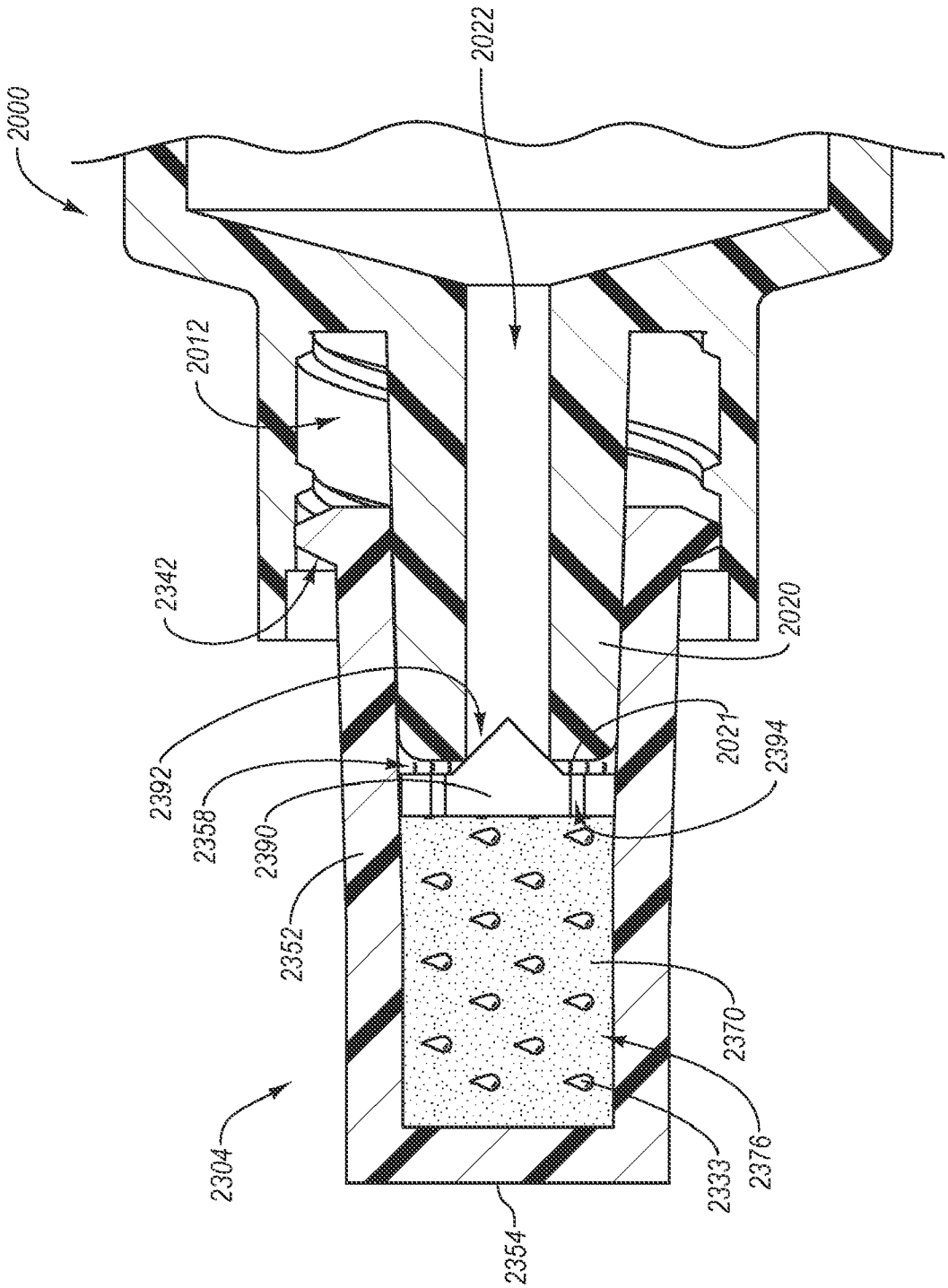
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Fig. 43

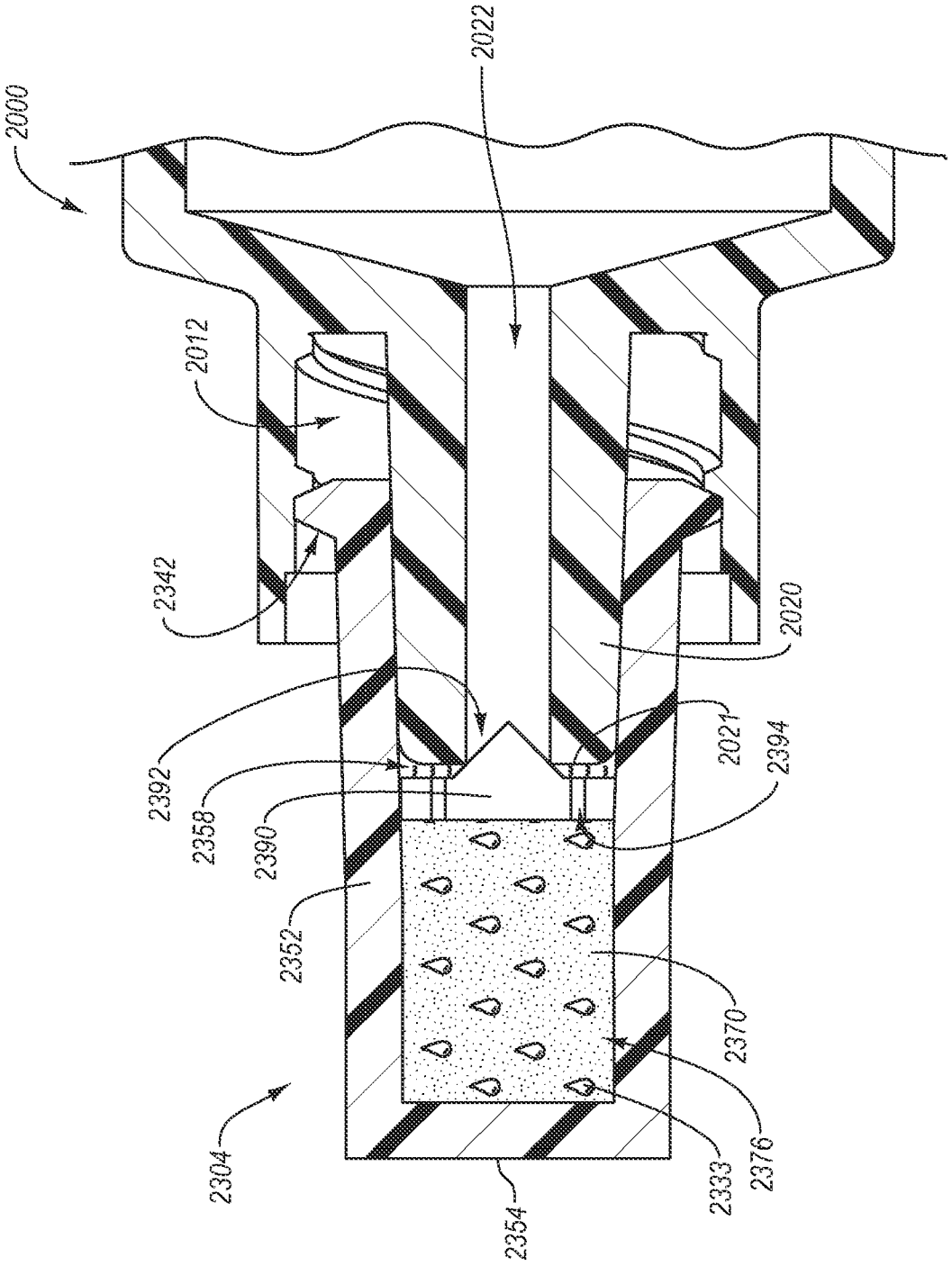
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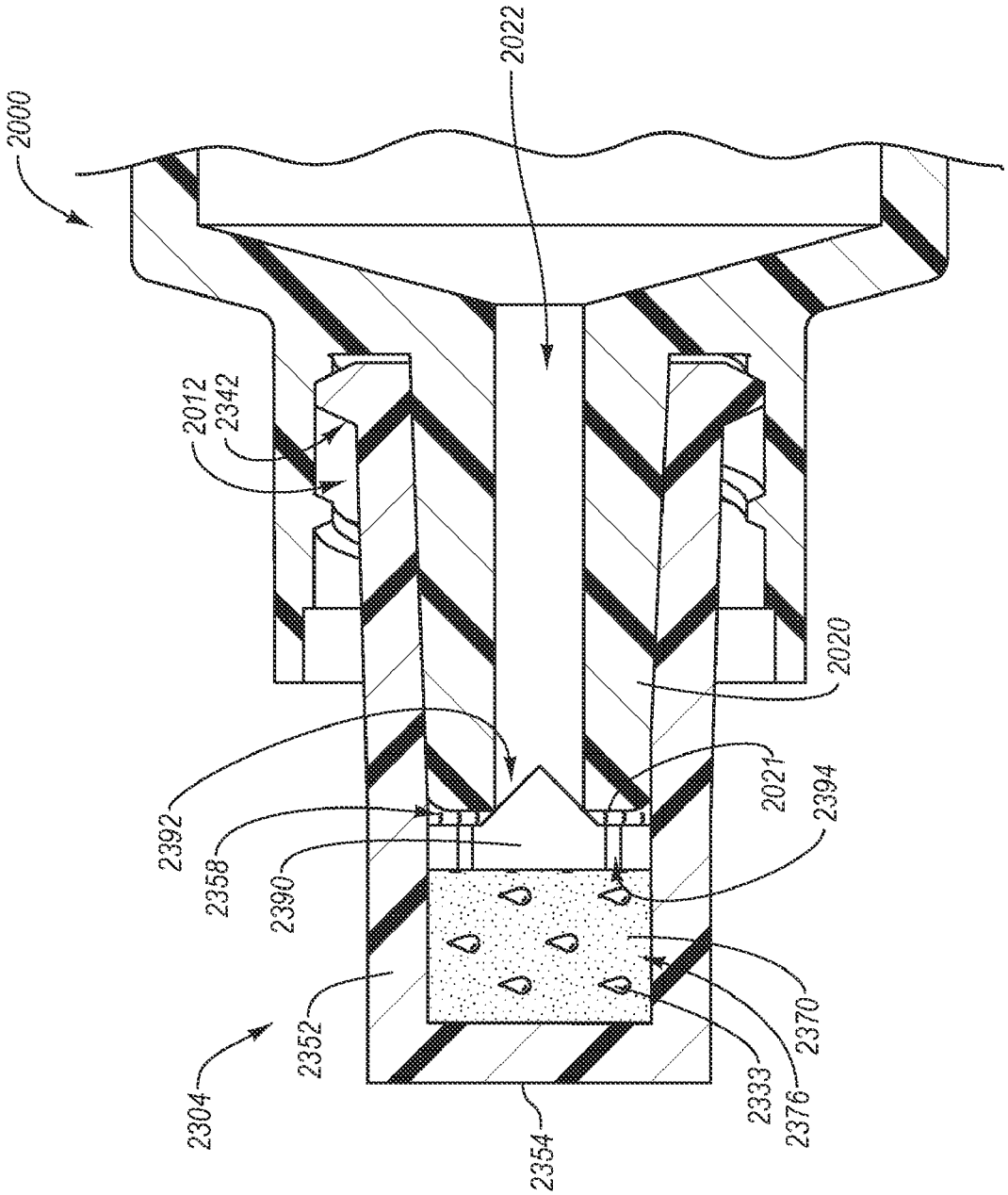
Fig. 44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2304
2354

Fig. 45

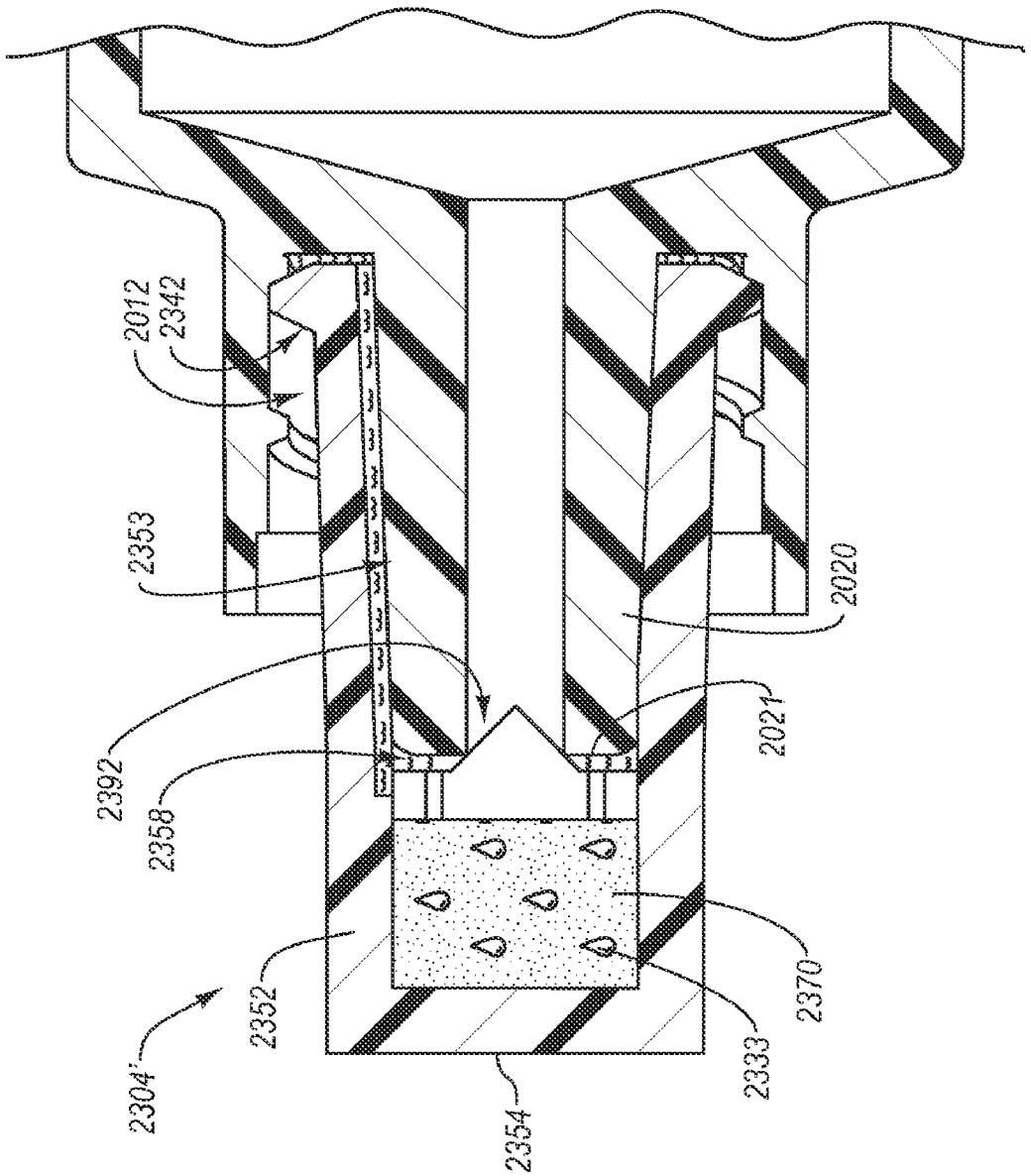
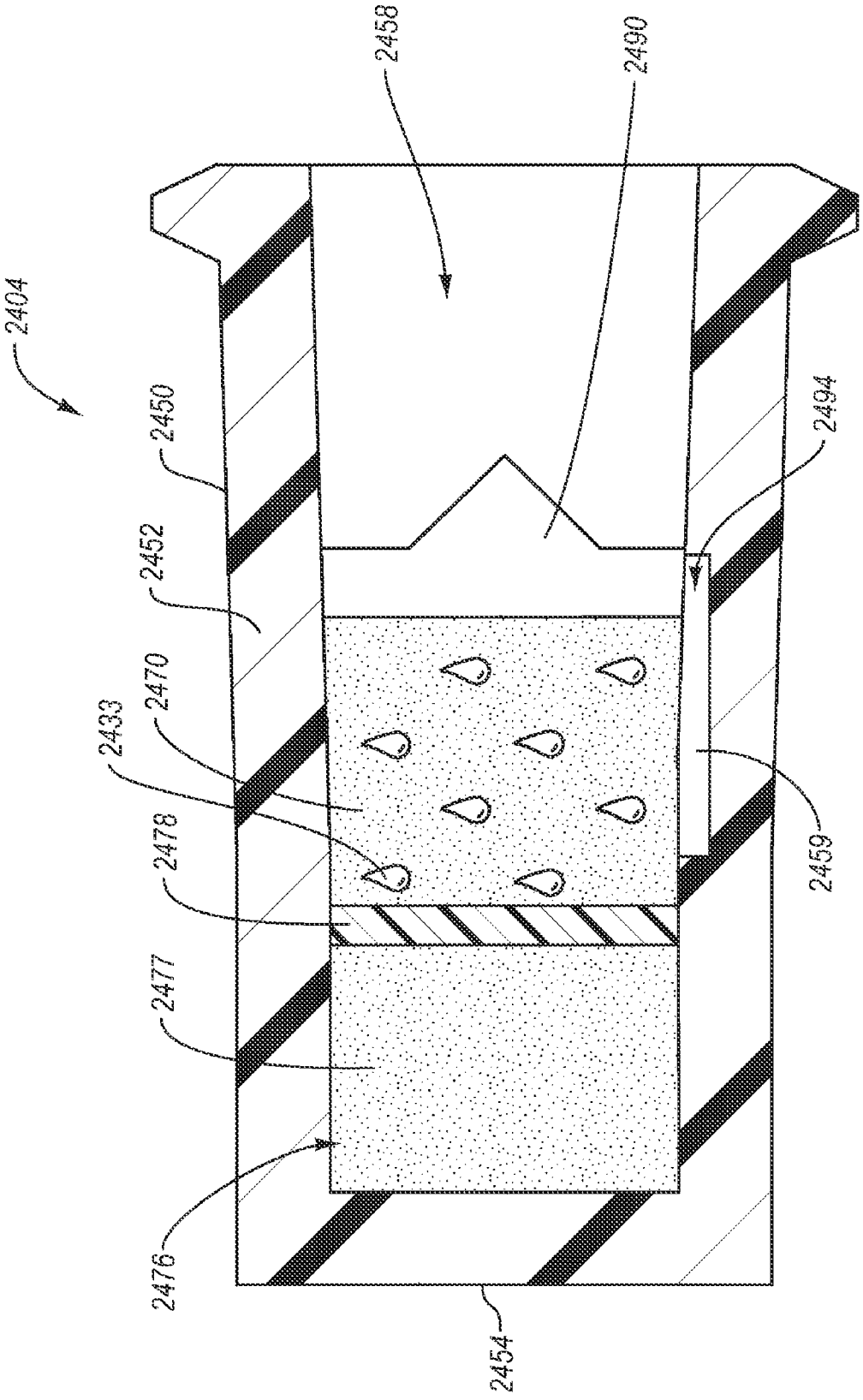


Fig. 46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2476
2454

Fig. 47

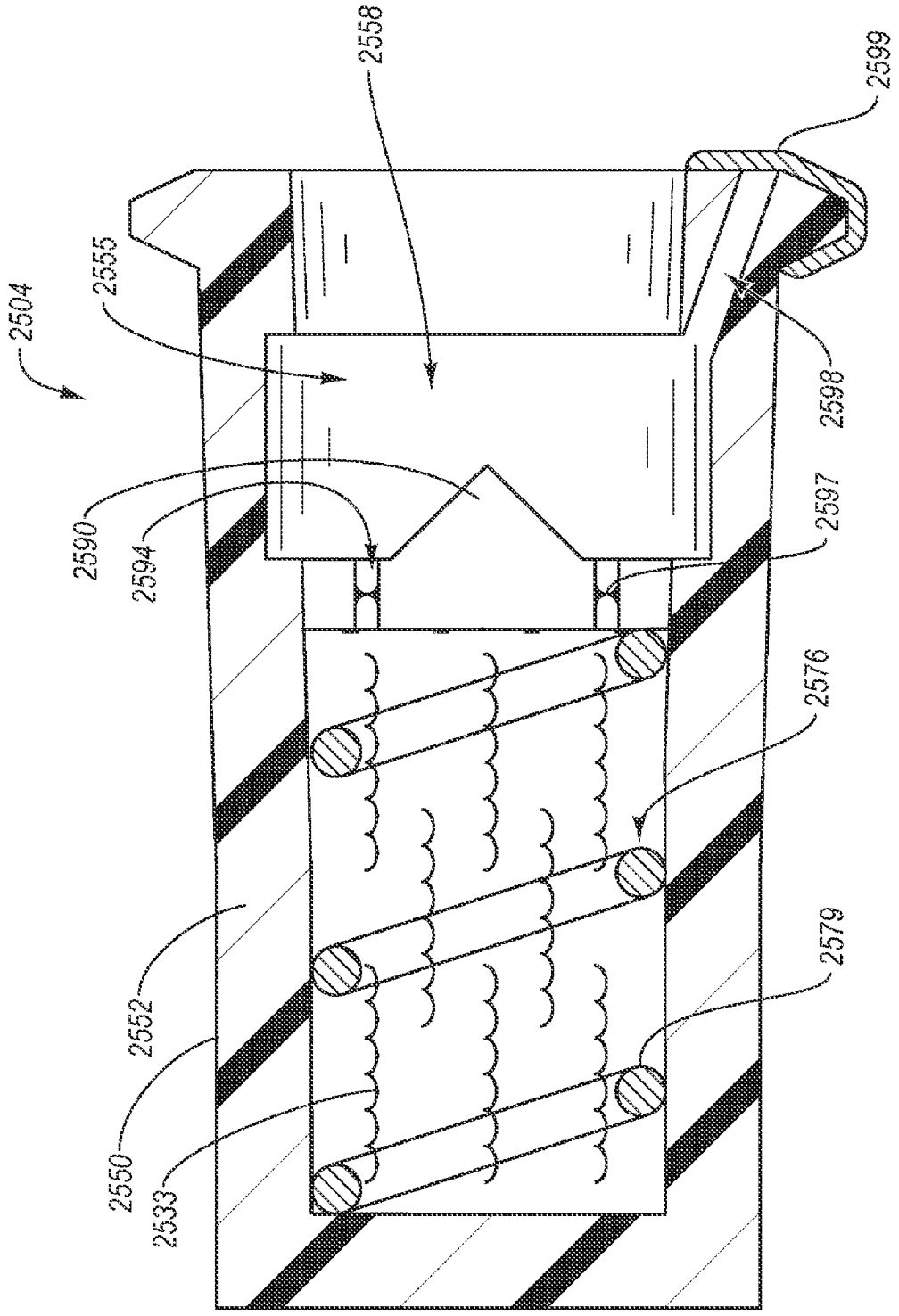
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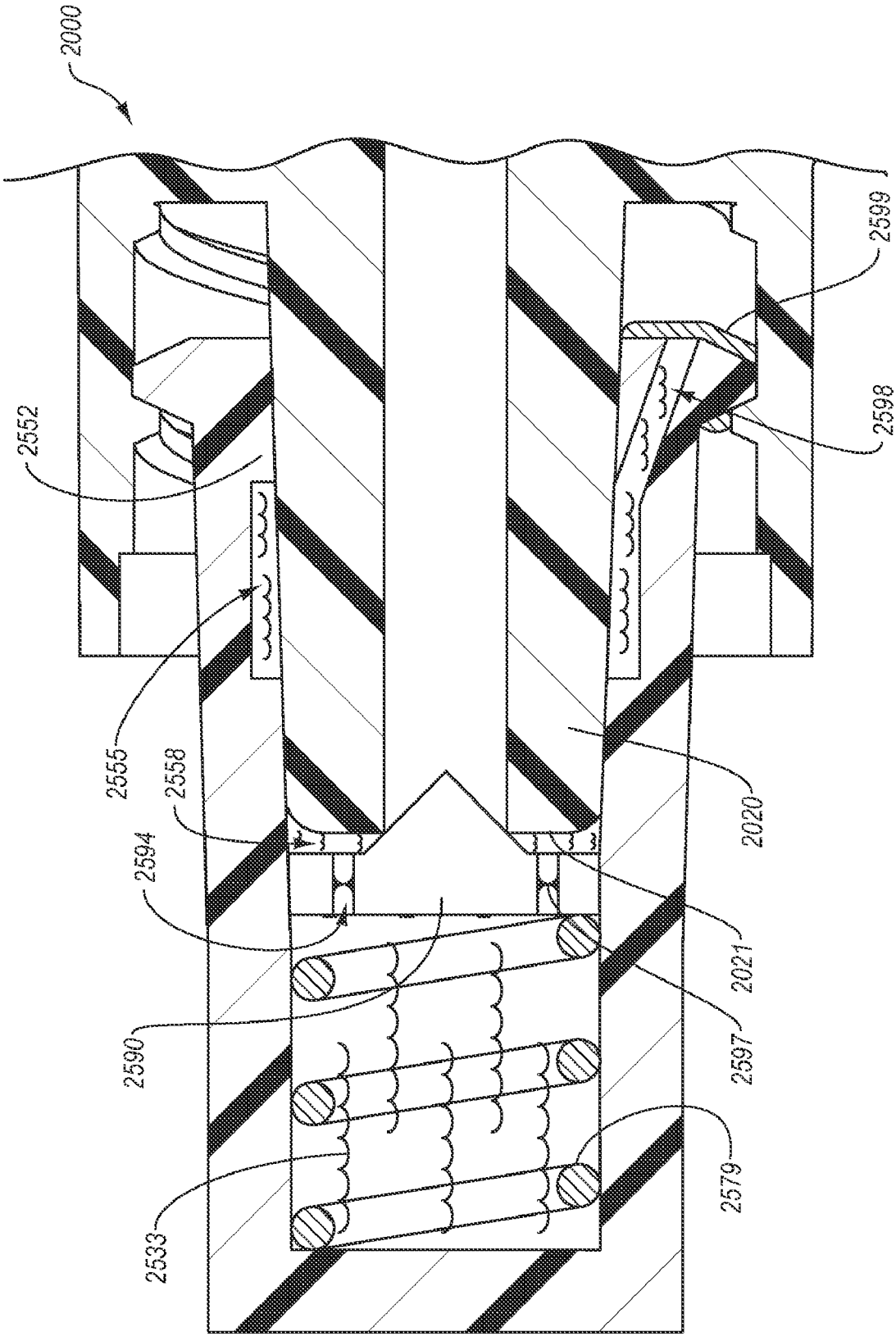
Fig. 48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2533

Fig. 49

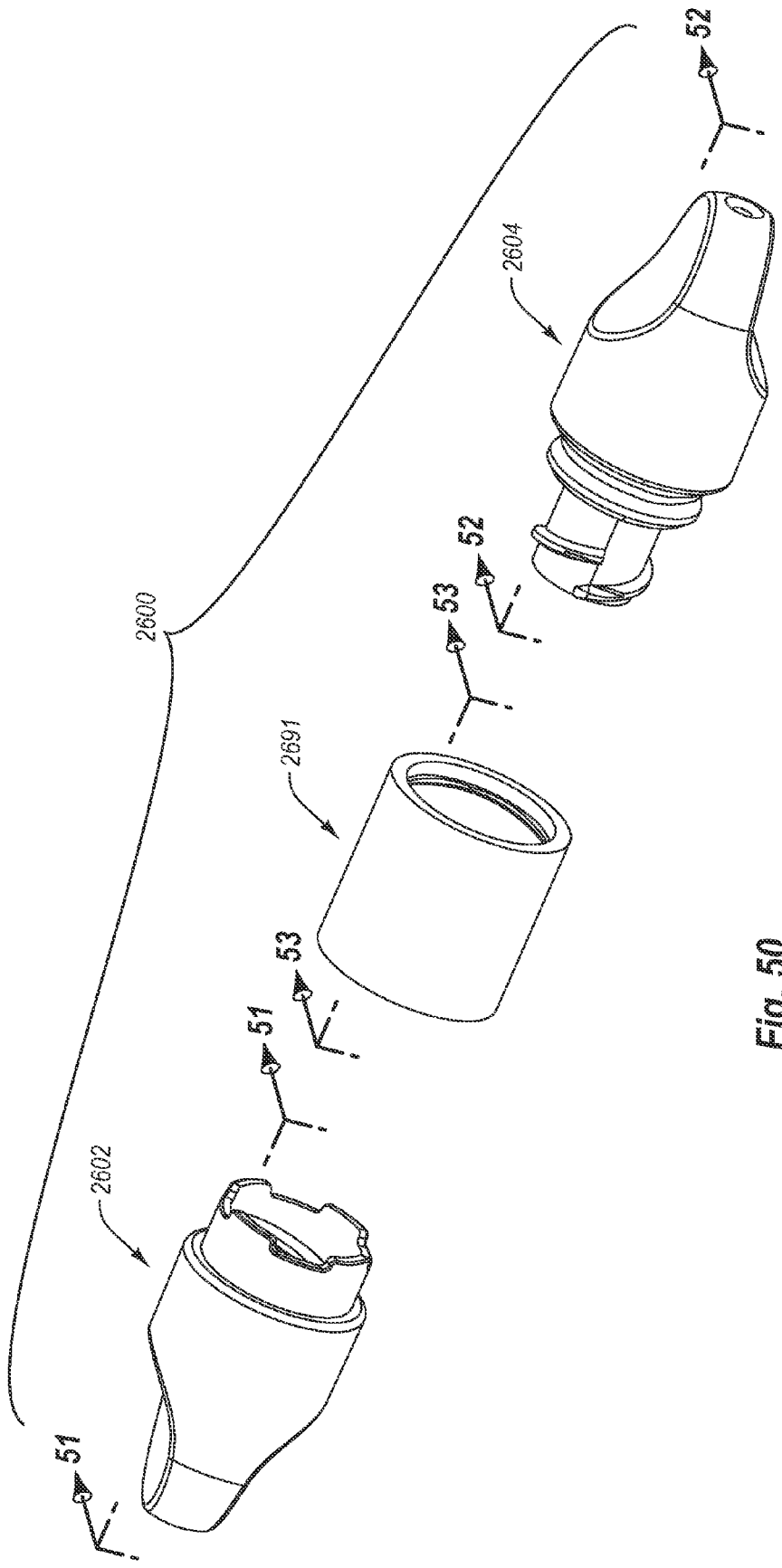

Fig. 50

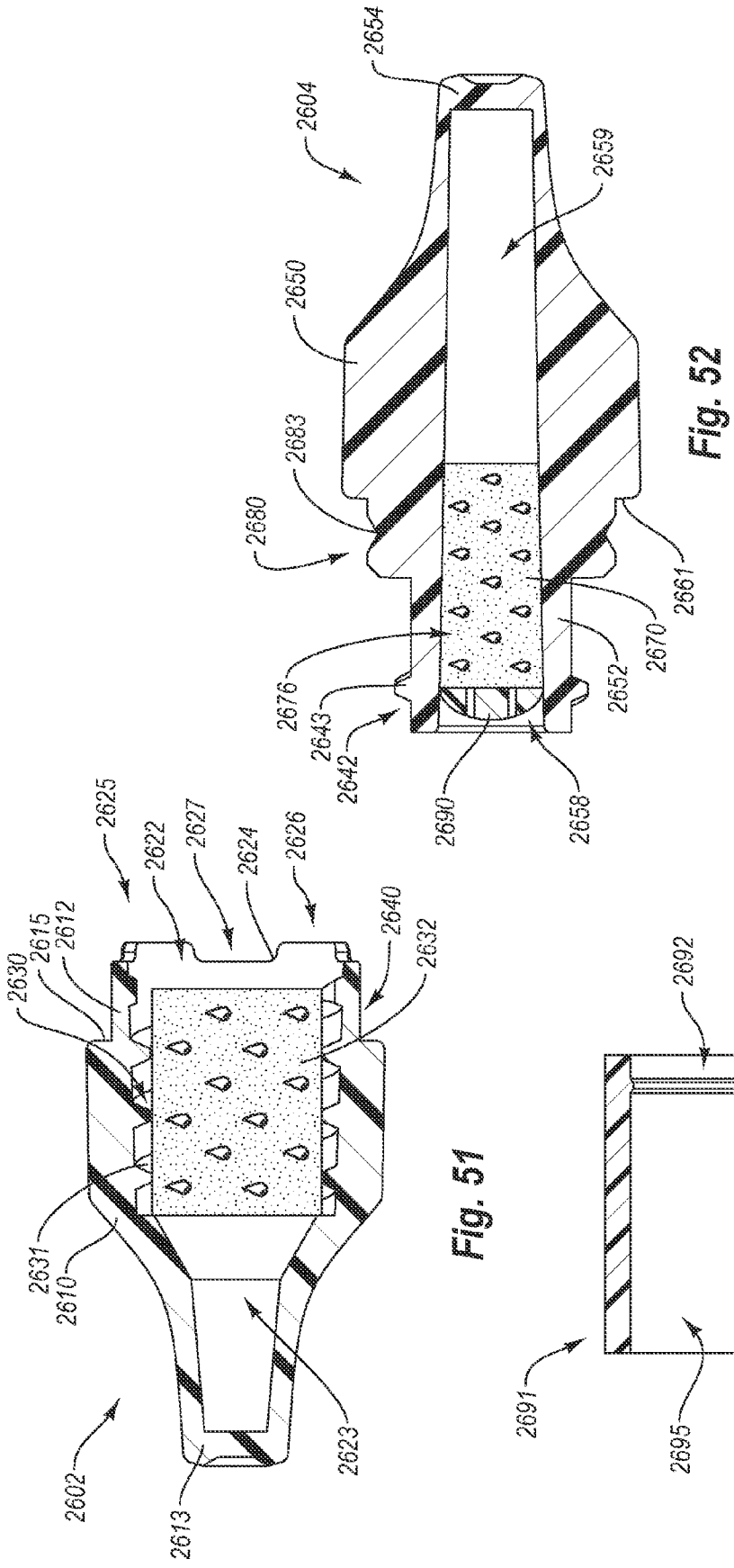

Fig. 52

Fig. 51

Fig. 53

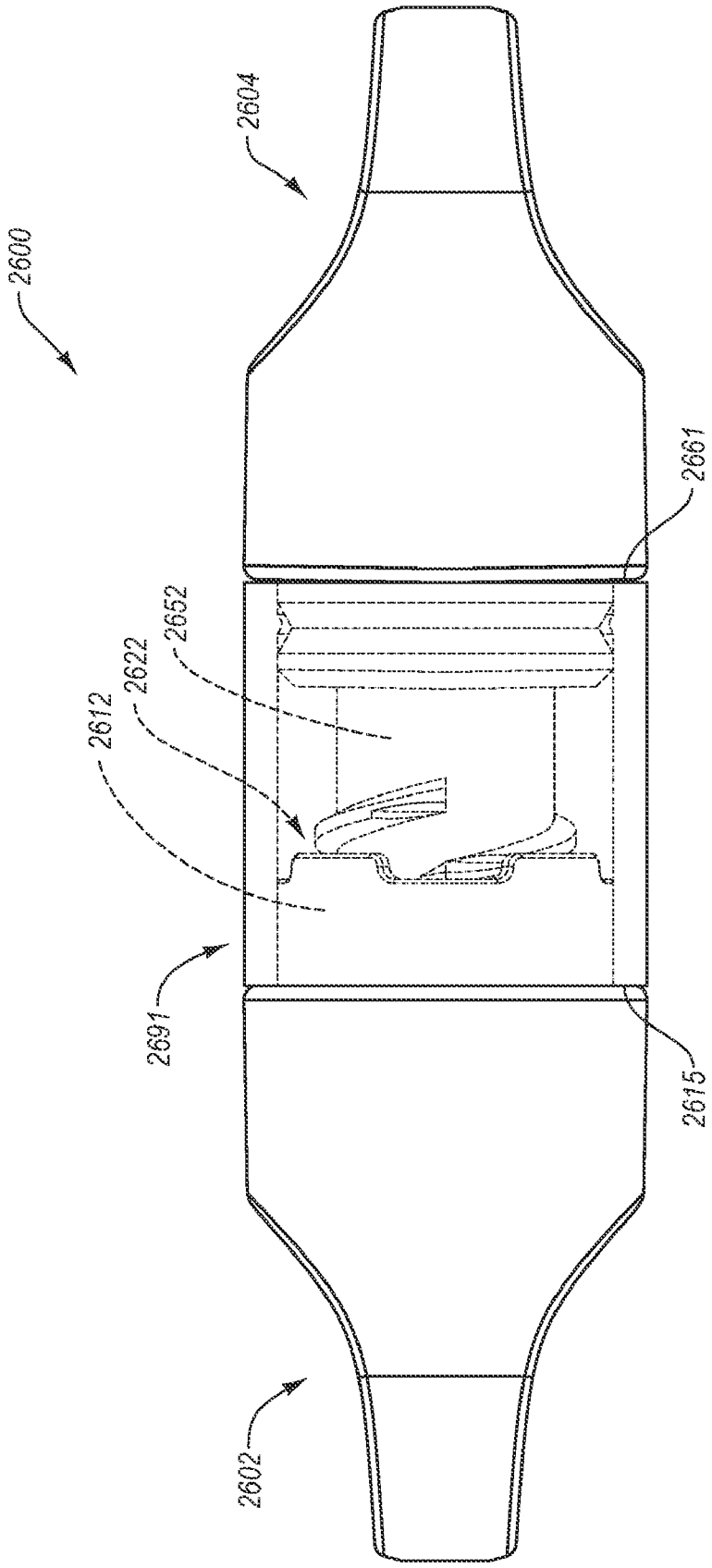

Fig. 54

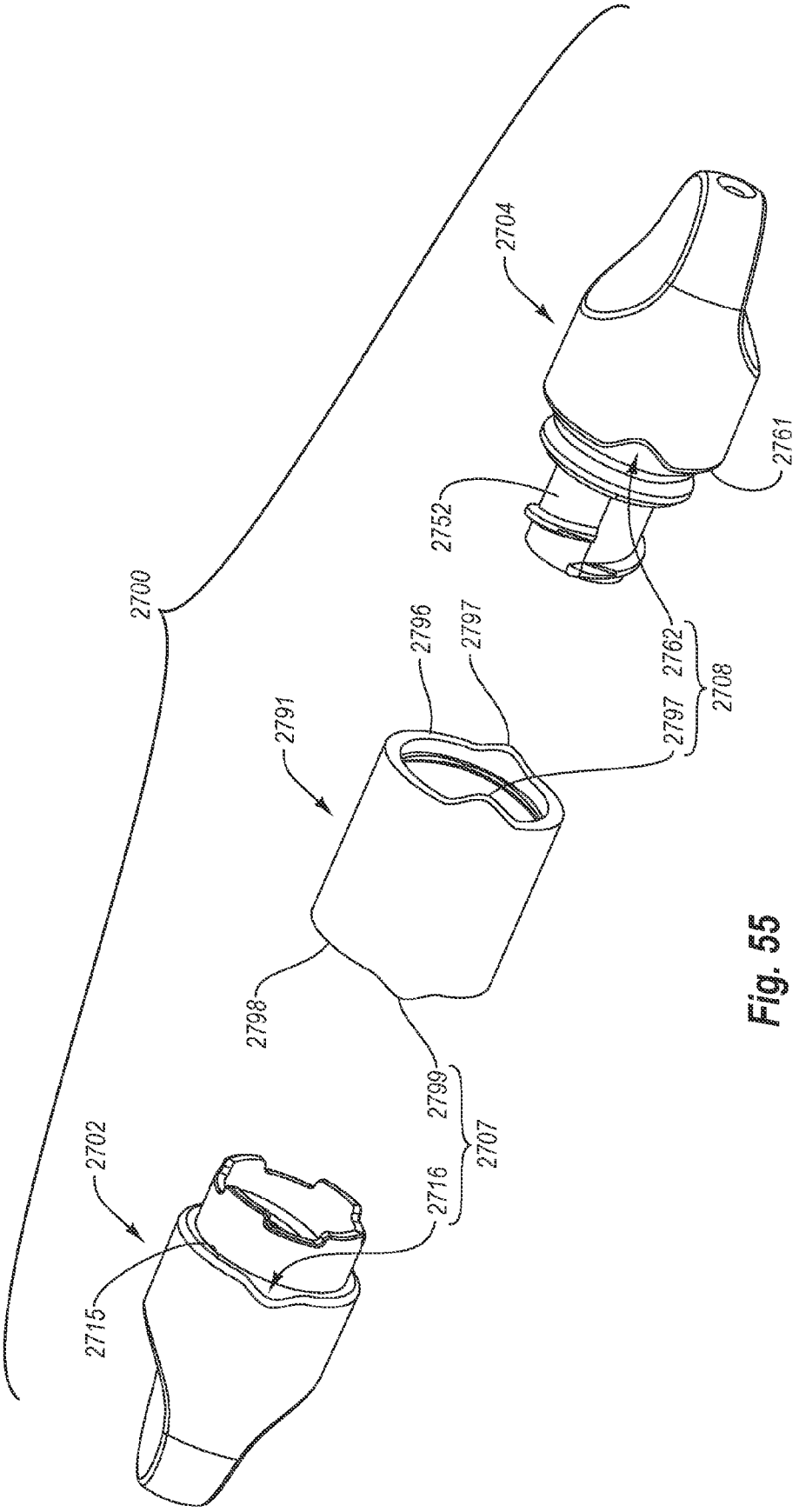
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Fig. 55

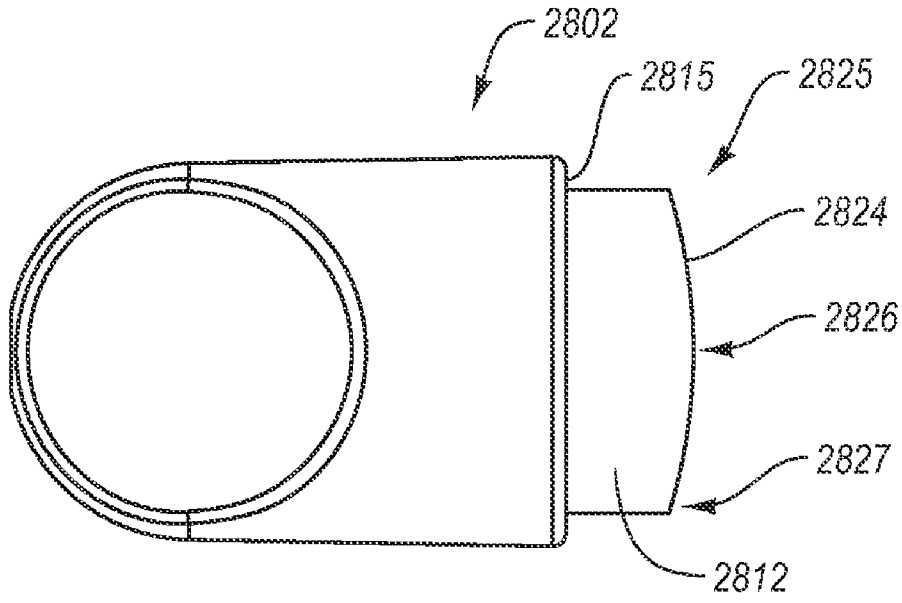
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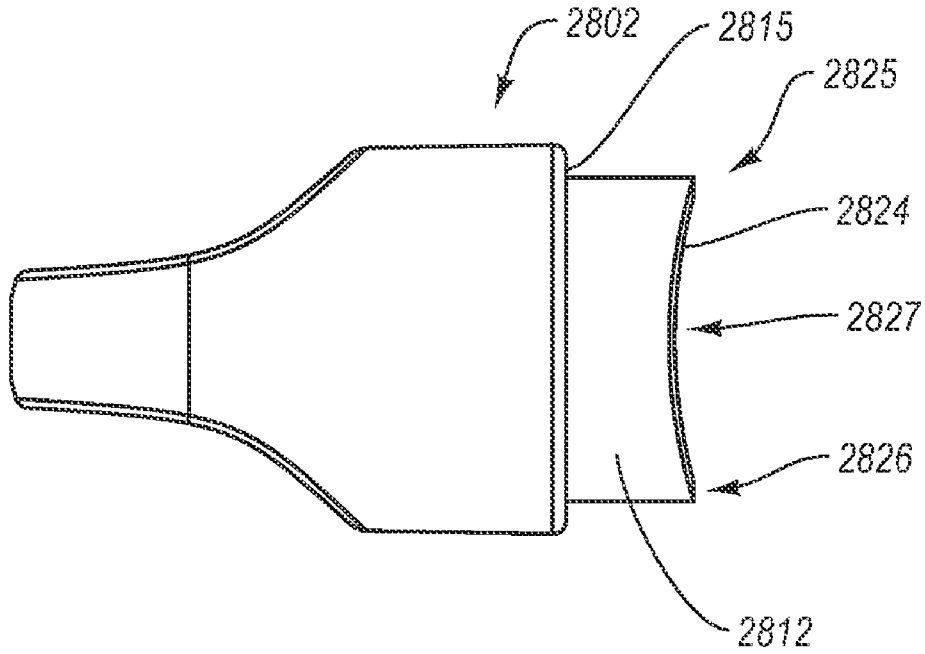
Fig. 56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2812

Fig. 57

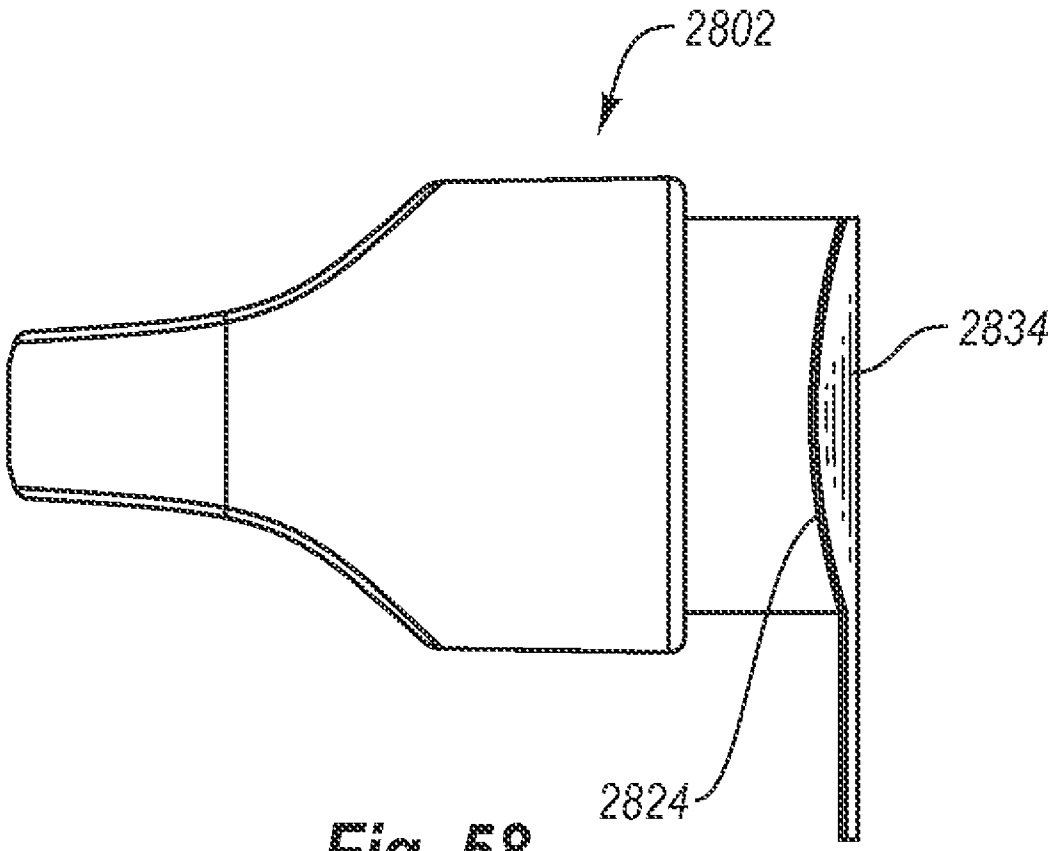

Fig. 58

METHODS FOR DISINFECTING MEDICAL CONNECTORS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 12/171,997, titled STERILITY-PROTECTING CAPS WITH FLUID RESERVOIR FOR SEPARATED CONNECTORS, filed Jul. 11, 2008, which is a continuation-in-part of U.S. patent application Ser. No. 12/164,310, titled NESTABLE STERILITY-PROTECTING CAPS WITH FLUID RESERVOIR FOR SEPARATED CONNECTORS, filed Jun. 30, 2008, which is a continuation-in-part of U.S. patent application Ser. No. 12/014,388, titled NESTABLE STERILITY-PROTECTING CAPS FOR SEPARATED CONNECTORS, filed Jan. 15, 2008, which claims the benefit of U.S. Provisional Application No. 60/880,541, titled ANTISEPTIC PROTECTIVE CAP FOR MALE AND FEMALE SCREW-TOGETHER CONNECTORS, filed Jan. 16, 2007, the entire contents of each of which are hereby incorporated by reference herein.

BACKGROUND

1. Technical Field

The present disclosure generally relates to caps for medical connectors and more specifically relates to caps that can be used to protect the sterility of unconnected medical connectors, such as connectors that may be used for fluid flow or for fluid delivery systems.

2. Related Art

Bloodstream infections, such as may be caused by microorganisms that enter patients via intravascular catheters, are a significant cause of illness and excess medical costs. A substantial number of such infections occur in U.S. intensive care units annually. Additionally, a significant fraction of these infections result in death.

Guidelines from the Centers for Disease Control and Prevention describe various ways to limit bloodstream infections in hospital, outpatient, and home care settings. The guidelines address issues such as hand hygiene, catheter site care and admixture preparation. However, despite these guidelines, such infections continue to plague healthcare systems at relatively unchanged rates.

Impregnating catheters with various antimicrobial agents is one approach for reducing these infections. Impregnated catheters, however, provide less than satisfactory results. Additionally, some microbes have developed resistance to the various antimicrobial agents used in the catheters. Other systems and approaches have also been developed, but these likewise suffer from a variety of limitations and drawbacks.

SUMMARY

Disclosed herein are sterility caps, and related systems and methods, that can reduce the threat of microorganisms entering the bloodstream of a patient via fluid flow or fluid delivery systems, such as, for example, needleless injection sites and/or fluid transfer devices having a male luer. In some embodiments, a cap is configured to couple with and sterilize a medical connector having a male luer. In further embodiments, the cap can include an antiseptic, and can be configured to create a seal with the male luer so as prevent antiseptic from entering a lumen of the male luer. Other or further features of various embodiments are also disclosed and are set forth in the appended claims, which are hereby incorporated by reference in this summary section.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view of an embodiment of an assembly that includes an attached pair of medical caps;

FIG. **1**A is an end perspective view of the caps of FIG. **1**;

FIG. **1**B is an end perspective view of the caps of FIG. **1** shown from a vantage point opposite of that shown in FIG. **1**A;

FIG. **2** is an exploded perspective view of the medical caps of FIG. **1**;

FIG. **3** is a perspective view of a first of the medical caps of FIG. **1**, which shows internal threads;

FIG. **4** is a perspective view of the cap of FIG. **3** and an associated medical connector about to be connected therewith;

FIG. **5** is a perspective view of a second of the caps of FIG. **1** and a luer lock connector to which the male cap may be affixed;

FIG. **6** is a side elevation view of an attached pair of medical caps, similar to the caps of FIG. **1**, but having an embodiment of a sealing mechanism disposed about connecting edges of the caps;

FIG. **7** is an exploded side elevation view of the cap assembly of FIG. **6**;

FIG. **7**A is a perspective view of one of the caps of FIG. **7** with a sealing mechanism disposed thereon;

FIG. **7**B is a perspective view of the other cap of FIG. **7** with a sealing mechanism disposed thereon;

FIG. **8**A is a side elevation view of the interconnected cap assembly of FIG. **6** with an embodiment of a seal partially displaced about connecting edges of the cap assembly;

FIG. **8**B is a side elevation view of the interconnected cap assembly of FIG. **8**A with the seal fully in place;

FIG. **9**A is a side elevation view of the cap portion of FIG. **3** and an absorbent pad positioned above the cap portion;

FIG. **9**B is a side elevation view of the cap portion and pad of FIG. **9**A schematically showing the absorbent pad disposed within the cap portion;

FIG. **9**C is a side elevation view of the cap portion and pad of FIG. **9**B with a quantity of antiseptic material being dispensed into the cap and pad;

FIG. **9**D is a perspective view of the cap portion containing the pad of FIGS. **9**B and **9**C affixed to an associated complementary cap;

FIG. **9**E is a side elevation view of the cap portion of FIG. **5** and an absorbent pad disposed therein;

FIG. **10** is a cross-sectional perspective view of another embodiment of an assembly that includes a pair of caps, which are attached to each other via a threaded interface;

FIG. **11** is an exploded perspective view of the assembly of FIG. **10** showing the caps detached from each other;

FIG. **12** is a cross-sectional perspective view of another embodiment of an assembly that includes a pair of caps, which are attached to each other via a snapping interface;

FIG. **13** is a cross-sectional perspective view of another embodiment of an assembly that includes a pair of caps, which are attached to each other via a friction-fit interface;

FIG. **14** is a cross-sectional perspective view of another embodiment of an assembly that includes a pair of caps, which are attached to each other via a press-fit interface;

FIG. **15** is a cross-sectional perspective view of the assembly of FIG. **14** showing the caps detached from each other;

FIG. **16** is a cross-sectional perspective view of another embodiment of an assembly that includes a pair of caps, which are attached to each other via a welded interface;

FIG. **17** is a cross-sectional perspective view of the assembly of FIG. **16** showing the caps detached from each other;

FIG. **18** is a perspective view of another embodiment of an assembly that includes a pair of caps, which are attached to each other at least partially via a snapping interface;

FIG. **19** is a perspective view of the assembly of FIG. **18** showing the caps detached from each other;

FIG. **20** is a perspective view from a different angle of one of the caps of FIG. **18**;

FIG. **21** is a perspective view from a different angle of another of the caps of FIG. **18**;

FIG. **22** is a perspective view of another embodiment of an assembly that includes a pair of caps, which are attached to each other via a snapping interface;

FIG. **23** is a side elevation view of an embodiment of a cap that is compatible with at least the assemblies of FIGS. **18** and **22**;

FIG. **24** is a cross-sectional view of another embodiment of an assembly that includes a pair of caps, which are attached to each other via a sleeve;

FIG. **25** is a perspective view of another embodiment of an assembly that includes two cap portions integrally connected to each other;

FIG. **26** is an exploded perspective view of the assembly of FIG. **25**;

FIG. **27** is a perspective view focusing on one cap portion of the assembly of FIG. **25**, with covers removed from the assembly;

FIG. **28** is a perspective view focusing on the other cap portion of the assembly of FIG. **25**, with covers removed from the assembly;

FIG. **29** is a cross-sectional view of the assembly of FIG. **28** taken along the view line **29-29**;

FIG. **30** is a cross-sectional view of the assembly of FIG. **25** showing an early stage of coupling a cap portion of the assembly with a medical connector that has a male luer;

FIG. **31** is a cross-sectional view of the assembly of FIG. **25** showing a late stage of coupling the cap portion of the assembly with the medical connector that has a male luer;

FIG. **32** is a cross-sectional view of the assembly of FIG. **25** showing a late stage of coupling the other cap portion of the assembly with a first embodiment of a needleless injection site;

FIG. **33** is a cross-sectional view of the assembly of FIG. **25** showing a late stage of coupling the other cap portion of the assembly with a second embodiment of a needleless injection site;

FIG. **34** is a cross-sectional view of the assembly of FIG. **25** showing a late stage of coupling the other cap portion of the assembly with a third embodiment of a needleless injection site;

FIG. **35** is a cross-sectional view of another embodiment of an assembly that includes two cap portions integrally connected to each other, with covers removed from the assembly;

FIG. **36** is an exploded perspective view of another embodiment of an assembly that includes two cap portions integrally connected to each other;

FIG. **37** is a cross-sectional view of the assembly of FIG. **36** similar to the view shown in FIG. **29**;

FIG. **38** is a cross-sectional view of the assembly of FIG. **36** showing an early stage of coupling a cap portion of the assembly with a medical connector that has a male luer;

FIG. **39** is a cross-sectional view of the assembly of FIG. **36** showing a late stage of coupling a cap portion of the assembly with a medical connector that has a male luer;

FIG. **40** is an exploded perspective view of another embodiment of a cap configured for coupling with a medical connector having a male luer;

FIG. **41** is a cross-sectional view of the assembled cap of FIG. **40** showing an early stage of coupling the cap with a medical connector that has a male luer in which the male luer has not yet contacted a sealing member of the cap;

FIG. **42** is a cross-sectional view such as that of FIG. **41** showing a later stage of coupling the cap with the medical connector in which the male luer forms a fluid-tight seal with the sealing member of the cap;

FIG. **43** is a cross-sectional view such as that of FIG. **41** showing a yet later stage of coupling the cap with the medical connector in which a pad is compressed so as to expel antiseptic therefrom through the sealing member and in which the male luer has not yet formed a fluid-tight seal with a sidewall of the medical connector;

FIG. **44** is a cross-sectional view such as that of FIG. **41** showing a yet later stage of coupling the cap with the medical connector in which the pad is compressed further so as to expel additional antiseptic therefrom through the sealing member and in which the male luer has not yet formed a fluid-tight seal with a sidewall of the medical connector;

FIG. **45** is a cross-sectional view such as that of FIG. **41** showing a yet later stage of coupling the cap with the medical connector in which that pad is compressed even further so as to expel additional antiseptic therefrom through the sealing member and in which the male luer forms a fluid-tight seal with a sidewall of the medical connector;

FIG. **46** is a cross-sectional view such as that of FIG. **41** showing another embodiment of cap coupled with a medical connector having a male luer;

FIG. **47** is a cross-sectional view of another embodiment of a cap configured for coupling with a medical connector having a male luer;

FIG. **48** is a cross-sectional view of yet another embodiment of a cap configured for coupling with a medical connector having a male luer;

FIG. **49** is a cross-sectional view of the cap of FIG. **48** coupled with a medical connector having a male luer;

FIG. **50** is an exploded perspective view of another embodiment of an assembly that includes a female cap and a male cap, which can be connected in a pre-use configuration via a sleeve;

FIG. **51** is a cross-sectional view of the female cap of FIG. **50** taken along the view line **51-51**;

FIG. **52** is a cross-sectional view of the male cap of FIG. **49** taken along the view line **52-52**;

FIG. **53** is a cross-sectional view of the sleeve of FIG. **49** taken along the view line **53-53**;

FIG. **54** is an elevation view of the assembly of FIG. **50** shown in a pre-use configuration;

FIG. **55** is an exploded perspective view of another embodiment of an assembly that includes a female cap and a male cap, which can be connected in a pre-use configuration via a sleeve and that includes separation assists;

FIG. **56** is an elevation view of an embodiment of a cap that includes a seal inhibitor;

FIG. **57** is another elevation view of the cap of FIG. **56** showing a different face thereof; and

FIG. **58** is an elevation view of the cap of FIG. **56** coupled with a removable cover.

DETAILED DESCRIPTION

Disclosed herein are caps that can be used to protect and/or sterilize medical connectors. Systems and methods related to

such caps are also disclosed. An example of medical connectors for which caps disclosed herein may be used are intravascular connectors associated with a fluid pathway, such as an IV line. Commonly, a fluid pathway is used to intermittently administer medications to a patient. For example, a fluid pathway, which communicates fluids with a patient's blood stream, may have one or more connectors associated therewith. Each of the fluid pathway connectors can be connected to other connectors, such as a connector associated with a central line. In such a situation, the medical connectors, such as luer lock connectors, are connected and disconnected at various times, and may remain disconnected for several minutes or hours. Medical connector caps are used to cover and protect the various medical connectors while the connectors are separated from one another. When the medical connectors are separated from each other, there are two connectors that each can benefit from being covered by a cap. Therefore, in some cases, it can be advantageous to have a single connector set that can be used to provide protection for both ends of a separated connection. In other or further embodiments, a cap can include an antiseptic for sterilizing a medical connector. In some cases, it can be advantageous for the cap to form a seal with the medical connector to thereby prevent the antiseptic from exiting the cap into the fluid pathway.

Shown in FIGS. **1**-**1**B, is a system, unit, or assembly **100** of a pair of separable caps **102** and **104**, which are securely, but releasably, affixed one to the other across a common interface **106**. Internal parts and surfaces of the assembly **100** are sterile and are able to reduce, prevent, or eliminate contamination of connectors with which caps **102**, **104** can be coupled.

As further discussed below, in various embodiments, caps **102** and **104** can be distributed in a coupled state, such as that shown in FIGS. **1**-**1**B, and may be decoupled by a user (e.g., a medical professional) and subsequently coupled with connectors. Caps **102** and **104** can include features to aid in such a decoupling action and/or in the coupling of caps **102**, **104** with the respective connectors. For example, in the illustrated embodiment, each cap **102**, **104** includes gripping features **103**.

The gripping features **103** can comprise longitudinally extending lands or ridges **105** that taper from a relatively wide width near the interface **106** of the caps **102**, **104** to a narrower width at or near an outer end of the cap **102**, **104**. The gripping features **103** can further include longitudinally extending depressions or grooves **107** between adjacent ridges **105**. For example, as can be seen in FIGS. **1**-**8**B, the grooves **107** can extend radially inwardly from an outer surface of the cap **102** that comprises the ridges **105**, and the grooves **107** can also commence at a position near the interface **106** and can grow wider and deeper toward an outer end of the cap **102**. The gripping features **103** can further include longitudinally extending bumps or protrusions **108** between adjacent ridges **105**. As can be seen in FIGS. **1**-**8**B, the protrusions **108** can extend radially outwardly from an outer surface of the cap **104** that comprises the ridges **105**, and the protrusions **108** can also commence at a position near the interface **106** and can grow wider and taller toward an outer end of the cap **104**. The uneven surfaces provided by the ridges **105** and the grooves **107** or protrusions **108** can facilitate rotational movement of the caps **102**, **104** (e.g., rotational movement relative to each other), which can aid in decoupling the caps **102**, **104** from each other and/or securing the caps **102**, **104** to separated connectors. For example, the uneven surfaces may be easily gripped by the fingertips of a medical practitioner.

As can be seen, for example, in FIGS. **1**A and **1**B, the patterns of the ridges **105**, grooves **107**, and/or protrusions **108** can be different for the caps **102**, **104**. In the illustrated embodiment, cap **102** includes only ridges **105** and grooves **107**, whereas cap **104** includes only ridges **105** and protrusions **108**. Such differences can aid in distinguishing the caps **102**, **104** from each other. Other features and methods for distinguishing the caps **102**, **104** from each other are discussed further below.

Caps **102** and **104** are shown as separated from each other, or in a decoupled state, in FIG. **2**, wherein cap **104** is shown as having an insertable or male section **108**. Section **108** has an elongated portion **110** that ends at an exteriorly disposed threaded segment **112**. Threaded segment **112** comprises threads **114** that are sized and shaped to be inserted and joined by threading into cap **102**.

Cap **102**, as shown in FIG. **3**, has a closed, hollow interior **116**, which may also be referred to as a sterilization cavity or chamber, which opens outwardly at a proximal end **118** to expose an interiorly disposed threaded segment **120** that includes threads **122**. Threads **122** are of a size and pitch to complementarily engage threads **114** of cap **104** for a screw or push-on tight fit with cap **104**.

As illustrated in FIG. **4**, cap **102** has an interior surface **124**, an opening edge **126** and an exterior surface **128**, opening edge **126** being a common link between interior surface **124** and exterior surface **128**. Further, threads **122** also have a size and pitch to engage a threadable segment **130** of a female connector, such as for example, female luer connector **132**. Such connectors are generally and commonly used as catheter and other fluid-tight protective connectors in medical applications. As seen in FIG. **4**, cap **102** provides a protective cover for connector **132** when encased about connector **132** (displaced in direction of arrow **134**) whereupon threadable segment **130** engages and is drawn into a secure, but releasable connection with threads **122** of cap **102**.

In some embodiments, the connector **132** comprises a needleless injection site, which may sometimes referred to as a needleless injection port, hub, valve, or device, or as a needleless access site, port, hub, valve, or device, and which can include such brands as, for example, Clave® (available from ICU Medical, Inc.), SmartSite® (available from Cardinal Health, Inc.), and Q-Syte™ (available from Becton, Dickinson and Company). Stated otherwise, in some embodiments, cap **102** can be suitably connected with any of a variety of different needless injection sites, such as those previously listed. In certain embodiments, once cap **102** has been applied to or coupled with connector **132**, it is unnecessary to disinfect (e.g. treat with an alcohol swab) the connector **132** prior to each reconnection of the connector **132** with another connector, as the connector **132** will be kept in an uncontaminated state while coupled with the cap **102**. Use of the cap **102** thus can replace the standard swabbing protocol.

As seen in FIG. **5**, threads **114** of cap **104** are of a size and pitch to engage threads **138** of a male luer-lock connector **136**. For example, connector **136** can comprise the end of an IV tubing set that is disconnected from an IV catheter needleless injection site. Note that cap **104** has a medially disposed, elongated hole **140**, which may also be referred to as a sterilization chamber, into which a frustoconical luer **142** of connector **136** may be facilely and securely inserted when cap **104** is displaced in the direction of arrow **144** to engage connector **136**.

Cap **104** also has a surface **146** which continues through to a circular edge **148**. Further, distally displaced from circular edge **148**, surface **146** abruptly ends at a circular ring shaped edge **150**, which is therefrom joined to an outside surface **152**. It may be noted that opening edge **126** (see FIG. **4**) and ring shaped edge **150** combine to form common interface **106** (see

FIG. 1) when cap **102** is affixed to cap **104** to construct assembly **100**. It should also be noted that, in certain embodiments, surfaces of assembly **100**, which contact internal surfaces of a connector, such as connector **132** or connector **136**, are sufficiently sterile to not contaminate the inner surfaces thereof.

Internal portions and associated edges of caps **102** and **104** can be pre-sterilized and so maintained until use. Caps **102** and **104** may be injection molded using polypropylene or other material that can be sterilized and which is impervious to contaminating agents while cap **102** is nested with cap **104**, before being opened for use. Caps **102** and **104** can also be impregnated or coated with an antimicrobial substance. As an example, each cap **102** and cap **104** may be individually sterilized by ethylene oxide (ETO) before final assembly and aseptically paired, or assembly **100** may be finally consolidated as a single unit and then sterilized, such as by radiation (e.g. gamma). Even so, assembly **100** should be kept intact until time for use, with internal surfaces of nested parts **102** and **104** remaining clean and sterile until assembly **100** is opened for use.

Reference is now made to FIGS. **6** through **7**B, wherein a seal, such as an "O" ring, is disposed between surfaces **126** and **150** to provide yet another barrier against internal surface contamination of caps **102** and **104**. As seen in FIG. **6**, an "O" ring **154** is disposed between surfaces **126** and **150** to provide a seal thereby. While "O" ring **154** can be displaced from caps **102** and **104** as illustrated in FIG. **7**, it is anticipated that "O" ring **154** can be adapted to remain affixed to one of caps **102** and **104**. For example, as illustrated in FIG. **7**A, "O" ring **154** can remain positioned adjacent surface **150** on cap **104** when caps **102** and **104** are disconnected from one another, rather than being separated when cap **104** is displaced from cap **102**, as seen in FIG. **7**.

Alternatively, "O" ring **154** can be associated with cap **102**, as seen in FIG. **7**B. In particular, opening edge **126** of cap **102** can have an annular groove **156** for receiving "O" ring **154** therein. Annular groove **156** can be sized and shaped such that "O" ring **154** sealingly engages cap **104** or a medical connector when cap **102** is coupled thereto. It will be appreciated that annular groove **156** can be disposed in opening edge **126** toward the exterior of cap **102** as illustrated in FIG. **7**B, or annular groove **126** can be disposed in opening edge **126** towards the interior of cap **102**. In some exemplary embodiments, opening edge **126** of cap **102** does not have annular groove **126** therein. In such embodiments, "O" ring **154** can be mounted directly to opening edge **126**. "O" ring **154** can be mounted on or to caps **102** or **104** in any suitable manner, including with the use of an adhesive, such as glue, a mechanical fastener, or a friction fitting.

While the seal between caps **102** and **104** has been described as being an "O" ring mounted on one of caps **102** or **104**, it will be appreciated that other seals are contemplated. For example, each of caps **102** and **104** can have an "O" ring mounted thereon. In such a configuration, the two "O" rings abut each other when caps **102** and **104** are coupled together, thereby forming a seal to antiseptically partition the internal and external surfaces of caps **102** and **104**. In an alternate embodiment, an "O" ring or other sealing mechanism can be mounted on surfaces **109***a* and **109***b*. Alternatively, one or both of caps **102** and **104** can be formed with a lip, bump, or groove that provides a sealing function when caps **102** and **104** are coupled to each other or to separated medical connectors. In one exemplary embodiment, one of caps **102** and **104** has a ridge extending around its interfacing surface, and the other cap has a corresponding groove in its interfacing surface into which the ridge is received to create the seal. In yet another exemplary embodiment, one or both of caps **102** and **104** can be overmolded or comolded using any known and suitable overmolding or comolding process. For example, one or both of caps **102** and **104**, and associated surfaces **126** and **150**, can be overmolded or comolded. Thus, caps **102** and **104** can be formed of a polymer, and surfaces **126** and **150** can be formed of a softer polymer that is comolded or overmolded to the rest of caps **102** or **104**. Surfaces **126** and **150**, formed of the softer polymer, are thus able to be compressed or deformed sufficiently to create an impermeable seal when caps **102** and **104** are coupled together or coupled to separated medical connectors.

As noted elsewhere herein, a sealing mechanism, as described herein, can be used to limit or prevent evaporation or loss of an antiseptic agent disposed within caps **102** and **104** when caps **102** and **104** are coupled together. Additionally, a sealing mechanism, as described herein, can also limit or prevent evaporation or loss of an antiseptic agent disposed within caps **102** and **104** when caps **102** and **104** are coupled to separated medical connectors. Further, a sealing mechanism, as described herein, can also limit or prevent microbial ingress within caps **102** and **104** when they are coupled to each other, or within caps **102** and **104** when caps **102** and **104** are individually coupled to separated medical connectors. Moreover, a sealing mechanism, as described herein, can be adapted to maintain an antiseptic agent within caps **102** and **104** when caps **102** and **104** are either coupled to one another or to separated medical connectors for a predetermined amount of time. Thus, the seal may be adapted to limit or prevent microbial ingress, while also partially or completely preventing evaporation of an antiseptic agent disposed within caps **102** and **104** when caps **102** and **104** are coupled together or when caps **102** and **104** are coupled to separated medical connectors. Similarly, the seal may be adapted to limit or prevent microbial ingress while not preventing evaporation of an antiseptic agent disposed within caps **102** and **104**. In yet other embodiments, no seal is provided between caps **102** and **104** when coupled together or between caps **102** and **104** when coupled to separated medical connectors.

Further safety in sealing against internal surface contamination may be provided by a sealing tape, or a planar or foil seal, such as tape **158** seen in FIG. **8**A. Tape **158** is disposed to fully cover exposed edges of surfaces **126** and **150**. Tape **158** may, for example, be of an impervious pliable material, such as a metallized-surface mylar. As seen in FIG. **8**B, tape **158** is wrapped about surfaces **126** and **150** to provide a secure seal. It is preferred that tape **158** frangibly divides when cap **102** is separated from cap **104** to facilitate separation of caps **102** and **104** and provide a visible indication that the seal is broken. Thus tape **158** provides both a seal to prevent microbial ingress and a mechanism for maintaining the secure connection between caps **102** and **104** prior to use. It will be appreciated, however, that any suitable sealing mechanism can be used to maintain the secure connection between caps **102** and **104** prior to use. For example, any sealing mechanism can be used that securely and selectively couples caps **102** and **104** together, requires deliberate action to break the seal, and provides a visual indication of whether the seal has been broken. By way of example and not limitation, a suitable sealing mechanism may include a heat stake, a frictional seal, a barbed seal, a ratchet seal, and the like.

When capping disconnected medical connectors, it can be desirable to do more than merely cover the connectors. For example, an absorbent pad, such as pad **160**, seen in FIG. **9**A, may be included within cap **102** (e.g., within the sterilization chamber **116**), such as by displacing pad **160** into cap **102** as indicated by arrow **162**. Pad **160** is seen disposed in cap **102**

in FIG. **9**B. An antiseptic **164** can also be disposed within cap **102** as illustrated in FIG. **9**C. Antiseptic **164** can be in liquid or solid form. For example, alcohol or another stable liquid antiseptic may be added from a container **166** to be received within, wet, soak, or saturate pad **160** to a predetermined concentration level. Note that once assembly **100** is fully assembled, pad **160** will substantially remain at the predetermined concentration level due to the exterior seals provided for assembly **100** as described herein. Alternatively, or additionally, pad **160** may receive or be impregnated with a dry antiseptic, such as, for example, chlorhexidine gluconate.

Further note that once cap **104** is securely affixed to cap **102**, as seen in FIG. **9**D, pad **160** is disposed to contact at least circular edge **148** (see also FIG. **5**). (In FIG. **9**D, parts of cap **104** which are internal to assembly **100** are seen with hidden or dashed lines.) Such contact provides a wiping action preferred to make contact with a surface before contact is made with an associated connector. Note also that residual antiseptic on associated internal surfaces of cap **104** may be transferred to related parts of the associated connector for cleaning and/or disinfecting purposes.

Pad **160** can be formed of a deformable, resilient material such that when cap **104** is coupled to cap **102**, elongated portion **110** can compress pad **160** within cap **102**, as illustrated in FIG. **9**D. Further, pad **160** can expand to its original shape when cap **104** is removed from cap **102**. Similarly, pad **160** can be compressed within cap **102** when cap **102** is coupled to a medical connector, such as medical connector **132**. More specifically, during the connection of cap **102** to a medical connector, cap **102** and pad **160** rotate relative to an opening edge of the medical connector, thereby drawing the medical connector into cap **102**. The rotation of cap **102** causes pad **160** to wipe or scrub the opening edge of the medical connector. Pad **160** and any antiseptic disposed within cap **102** can thus cleanse and disinfect the opening edges of the medical connector. Pad **160** can also be formed such that when a medical connector is coupled to cap **102**, pad **160** is deformed such that pad **160** extends around the opening edges and/or threads of the medical connector. For example, pad **160** can be formed such that as cap **102** is twisted onto medical connector **132**, pad **160** deforms around threads **130** and/or the opening edges of medical connector **132**, thereby scrubbing threads **130** and/or the opening edge of medical connector **132**.

Pad **160** can also provide additional functionality when a liquid antiseptic is disposed within cap **102**. In particular, pad **160** acts as a sponge to absorb or release the liquid antiseptic within cap **104**. More specifically, when pad **160** is compressed by elongate portion **110** of cap **104** (FIG. **9**D; see also elongate portion **268** compressing pad **160** in FIG. **14**) or the opening edges of a medical connector coupled to cap **102**, pad **160** releases at least a portion of the antiseptic so that the antiseptic can be transferred to elongate portion **110** or the opening edges of the medical connector. Conversely, when cap **102** or a medical connector is disconnected from cap **102**, pad **160** expands and absorbs excess antiseptic so that the antiseptic does not drip or spill out of cap **102**.

Similar to pad **160** and antiseptic **164** disposed within cap **102**, cap **104** may also have a pad and/or an antiseptic disposed therein. For example, as illustrated in FIG. **9**E, a pad **170** may be disposed within elongate hole **140** of cap **104**. An antiseptic can also be disposed within cap **104** in a manner similar to antiseptic **164** in cap **102**. Antiseptic can be in liquid or solid form. For example, alcohol or another stable liquid antiseptic may be added from a container to saturate pad **170** to a predetermined level. Alternatively, or additionally, pad **170** may be impregnated with a dry antiseptic, such as chlorhexidine gluconate. Once assembly **100** is fully assembled, an antiseptically saturated pad **170** disposed within cap **104** will substantially remain at the predetermined saturation level due to the exterior seals for assembly **100** as described above. Once caps **102** and **104** are disconnected from each other and connected to individual medical connectors, pad **170** disposed within cap **104** may scrub related parts of the associated connector for cleaning and/or disinfecting purposes. It will be appreciated, however, that in some embodiments, pad **170** may not contact a medical connector coupled to cap **104**. Additionally, the antiseptic disposed within cap **104** may be transferred to the related parts of the associated medical connector for cleaning and/or disinfecting purposes.

Additional embodiments of caps such as the caps **102**, **104** are provided in FIGS. **10-29** and the associated written description of U.S. patent application Ser. No. 12/171,997, titled STERILITY-PROTECTING CAPS WITH FLUID RESERVOIR FOR SEPARATED CONNECTORS, which was filed on Jul. 11, 2008 and was published as U.S. Patent Application Publication No. 2009/0062766 on Mar. 5, 2009 ("the Publication"), which is hereby incorporated by reference herein. As indicated in the Publication, any suitable feature of the illustrative embodiments of FIGS. 16-29 of the Publication, which are described with respect to a female-type cap similar to the cap **102**, may be applied to or incorporated within a male-type cap, similar to the cap **104**. Likewise, the female-type caps described with reference to FIGS. 16-29 of the Publication can be coupled to a male-type cap in a manner similar to that described with reference to caps **102** and **104**, in which the caps **102**, **104** are nested with each other. In other embodiments, any suitable feature of the caps described with respect to FIGS. 1-29 of the Publication, whether of a male or female variety, can be formed and/or employed without being nested or otherwise associated with a complementary cap.

Discussed hereafter are additional embodiments of caps, which can have coupling arrangements and/or other features that differ in certain respects from those of the caps **102**, **104** described above and other caps described in the Publication. Any suitable feature of such caps can be incorporated into the caps described hereafter, and vice versa.

FIGS. **10** and **11** depict a system or assembly **1000** that includes a first protective medical connector, shield, or cap **1002** and a second protective medical connector, shield, or cap **1004**. As shown in FIG. **10**, the caps **1002**, **1004** are connected to each other when the assembly **1000** is in a shipping or pre-use state. As shown in FIG. **11**, the caps **1002**, **1004** can be separated from each other such that each may be coupled with a corresponding or complementary medical connector. For example, as with the cap **102**, the cap **1002** can be configured to couple with a female connector, such as a female luer lock or a needleless injection site (see, e.g., FIG. **4**). Accordingly, the cap **1002** may be referred to as a female cap. As with the cap **104**, the cap **1004** can be configured to couple with a male connector, such as a male luer lock (see, e.g., FIG. **5**). Accordingly, the cap **1004** and may be referred to as a male cap.

With continued reference to FIGS. **10** and **11**, the cap **1002** can comprise a housing **1010**. The housing **1010** can be elongated, and may define a cylinder or any other suitable shape. For example, in the illustrated embodiment, the housing **1010** includes a sidewall **1012** that defines a substantially cylindrical outer surface **1014**. The outer surface can be smooth, as shown, which can enhance comfort to a patient if the cap **1002** contacts the patient when coupled with a medical connector. In other embodiments, the outer surface can include gripping features, which can aid in rotating the cap **1002** relative to the

cap **1004** to permit separation of the caps **1002**, **1004** and/or aid in rotating the cap **1002** relative to a medical connector. Such gripping features can include, for example, ridges, grooves, an/or protrusions similar to the ridges **105**, grooves **107**, and protrusions **108** described above and/or an elastomeric or other coating or layer having a relatively high coefficient of friction. The sidewall **1012** can define a sealing surface **1016** at one end thereof and can define a terminal edge **1018** at an opposite end thereof.

The housing **1010** can further include a transverse wall or partition **1020**. In the illustrated embodiment, the partition **1020** defines a plane that is substantially perpendicular to a longitudinal axis of the sidewall **1012**. A first portion of the sidewall **1012** can cooperate with one side of the partition **1020** to define a sterilization chamber **1022**, which is closed at one end by the partition **1020** and open at an opposite end thereof (e.g., the sealing surface **1016** can define an open end of the sterilization chamber **1022**). Similarly, a second portion of the sidewall **1012** can cooperate with an opposite side of the partition **1020** to define a coupling chamber **1024**, which likewise is closed at one end by the partition **1020** and open at an opposite end thereof (e.g., the terminal edge **1018** can define an open end of the coupling chamber **1024**).

An interior surface the sidewall **1012** can include a connection interface **1030** in the region of the sterilization chamber **1022**. The connection interface **1030** can comprise inwardly projecting threads **1031** similar to the threads **122** described above, and can be configured to complementarily engage a connection interface of a medical connector, such as, for example, outwardly projecting threads of a needleless injection site. The threaded connection interface **1030** thus can allow for selective coupling of the cap **1002** to a medical connector in a secure, yet selectively removable fashion. Other configurations of the connection interface **1030** may permit the cap **1002** to be coupled with a medical connector in a secure, yet selectively removable fashion, such as friction-fit, snap-fit, or other suitable interfacing arrangements.

The sterilization chamber **1022** can include a pad **1032** therein. The pad **1032** can resemble the pads **160**, **170** described above. In various embodiments, the pad **1032** can be deformable, and can also be configured to retain an antiseptic **1033**, such as, for example, the antiseptic **164** described above. In further embodiments, the pad **1032** can be resiliently deformable. For example, the pad **1032** can comprise any suitable sponge-like material, such as an elastomeric foam, any open-cell foam, felt, or non-woven fiber matrix, and can be configured to conform to the contours of a portion of a medical connector that is introduced into the sterilization chamber **1022** (e.g., uneven surfaces of an end of a needleless injection site; see also FIGS. **32-34** and the associated written description herein). The pad **1032** can also comprise any closed-cell foam, as well as a solid elastomeric foam such as Silicon or the like.

The pad **1032** can have a series or network of openings or spaces therein that can retain the antiseptic **1033** when the pad **1032** is in an expanded state. For example, the antiseptic **1033** can be received within, occupy, fill (or partially fill), wet, soak, or saturate at least a fraction of the pad **1032**, or stated otherwise, can fill the pad **1032** to a given concentration level. Compression of the pad **1032** can cause antiseptic **1033** to egress from the pad **1032** so as to contact the medical connector. Resilient expansion of the foam upon removal of a compressive force can allow the pad **1032** to soak up or absorb at least some of the antiseptic **1033** that had previously been forced from the pad **1032**. In some embodiments, the antiseptic **1033** can comprise any liquid antiseptic, such as alcohol, Isopropyl alcohol at various concentrations ranging from 50-90%, ethanol at various concentrations ranging from 50-95%, and combinations of any alcohols with any antiseptics, or a dry material, such as chlorhexidine, ethylenediaminetetraacetic acid (EDTA), lodaphors, or any combination thereof. Accordingly, although the antiseptic **1033** is schematically depicted in FIG. **10** as a series of droplets, the antiseptic **1033** is not necessarily liquid and may fill the pad **1032** to a greater or lesser extent. In the illustrated embodiment, when the sterilization chamber **1022** is in a sealed state (e.g., in its pre-use condition), the pad **1032** is in a relaxed, expanded, or uncompressed state in a longitudinal direction. It is noted that the pad **1032** may be uncompressed in one or more dimensions, yet compressed in one or more other dimensions, when the assembly **1000** is in the pre-use state. For example, the pad **1032** can be expanded or in a relaxed state in a longitudinal direction, yet compressed radially inwardly via the sidewall **1012**, when the assembly **1000** is in the pre-use state. Such a lack of compression of the pad **1032** in the longitudinal direction can result from the fact that the cap **1004** does not interact with the connection interface **1030** of the cap **1002** to seal the cap **1002**, and thus no portion of the cap **1004** contacts the pad **1032** when the caps **1002**, **1004** are in the pre-use configuration.

In the illustrated embodiment, the pad **1032** is substantially cylindrical and defines an outer diameter that is approximately the same size as an inner diameter of the threads **1031**. In other embodiments, the outer diameter of the pad **1032** can be larger than the inner diameter of the threads **1031** so as to be radially compressed and held tighter within the sterilization chamber **1022**. In further embodiments, the pad **1032** can include threading that projects radially inwardly and that is complementary to the threads **1031** to thereby secure the pad **1032** within the chamber **1022**.

The sterilization chamber **1022** can be sealed at the sealing surface **1016** via a cover **1034** that can span an open end of the sterilization chamber **1022**. The cover **1034** can be secured to the housing **1010** in any suitable manner, such as, for example, via an adhesive. Preferably, the cover **1034** can be readily removed by a practitioner. For example, in some embodiments, the cover **1034** can include a tab **1035** and a practitioner can readily remove the cover **1034** by holding the housing **1010** in one hand and pulling the tab **1035** away from the housing **1010** with the other hand. The removable cover **1034** can be formed of any suitable material, such as, for example, an impervious pliable material (e.g., foil, plastic, metallized-surface mylar, and the like). The cover **1034** can provide a hermetic seal that can assist in maintaining the sterility of the sterilization chamber **1022** prior to use of the cap **1002** and/or can prevent evaporative loss of antiseptic **1033** from the sterilization chamber **1022**.

When the cap **1002** is coupled with a medical connector, the coupling action can bring a portion of the medical connector into contact with the pad **1032** and can allow the pad **1032** to wipe or scrub the medical connector, as described above. Likewise, the antiseptic **1033** can be forced into contact with the medical connector during the coupling phase and can remain in contact with the medical connector, while the cap **1002** is coupled with the medical connector. The connection interface **1030** can cooperate with a connection interface of the medical connector to maintain the cap **1002** in an attached configuration relative to the connector. Moreover, the connection interface **1030** can couple with the medical connector, such as via complementary threading, so as to prevent antiseptic from leaking from the sterilization chamber **1022**.

In some embodiments, such as where the pad **1032** is formed of a material that is not fully elastically resilient or

that requires a relatively long relaxation time in which to transition from a compressed state to a relaxed or uncompressed state (e.g., in a longitudinal direction), pre-use storage in the relaxed or uncompressed state in at least one dimension can preserve or enhance the cleaning, scrubbing, or sterilization properties of the pad **1032**. For example, as the cap **1002** is coupled with the medical connector (e.g., the medical connector **132** of FIG. **4**), an end of the medical connector can come into contact with a proximal surface (e.g., the surface furthest from the partition **1020**) of the pad **1032**. Further advancement of the cap **1002** onto the medical connector can cause the pad **1032** to deform to complement a contour of the end of the medical connector as the pad **1032** is compressed, which can permit a relatively tight or continuous contact between the pad **1032** and the medical connector. In the illustrated embodiment, the cap **1002** is rotated relative to the medical connector, as it is advanced onto the medical connector. This rotational motion causes the contoured surface of the pad **1032** to rub the medical connector. In certain embodiments, increasingly greater compression of the pad **1032** yields increasingly stronger rubbing of the medical connector, coupled with greater amounts of the antiseptic **1033** being expelled from the pad **1032**. Accordingly, when the pad **1032** is uncompressed in at least one dimension (e.g., in a longitudinal direction) in a pre-use state, and thus is not plastically deformed or is not subject to time-consuming elastic recovery from pre-compression, the pad **1032** can be in sanitizing contact with the medical connector for a relatively greater portion of the coupling procedure. In some embodiments, a practitioner can more quickly couple the cap **1002** to the medical connector, as there is no need to first wait for the pad **1032** to relax to an uncompressed or expanded state to achieve better sterilization of the medical connector.

Various parameters can be adjusted to determine the amount of antiseptic **1033** that is expelled from the pad **1032** when the cap **1002** is coupled with a medical connector. For example, the depth to which the medical connector is received within the sterilization chamber **1022**, the concentration of antiseptic **1033** within the pad **1032**, and/or other parameters can be altered. In various embodiments, no less than about ¼, no less than about ⅓, no less than about ½, no less than about ⅔, or no less than about ¾ of the antiseptic **1033** is expelled from the pad **1032** when the cap **1002** is coupled with a medical connector. In some embodiments, all, or substantially all, of the antiseptic **1033** is expelled from the pad **1032**.

With reference to FIG. **10**, an interior surface the sidewall **1012** can include another connection interface **1040** in the region of the coupling chamber **1024**. The connection interface **1040** can be configured to complementarily engage a connection interface **1042** of the cap **1004**. For example, in the illustrated embodiment, the connection interface **1040** of the cap **1002** comprises inwardly projecting threads **1041**, and the connection interface **1042** of the connector **1004** comprises outwardly projecting threads **1043** complementary thereto at an exterior surface of the cap **1004**. The connection interfaces **1040**, **1042** thus can allow the caps **1002**, **1004** to be coupled to each other in a secure, yet selectively removable fashion. Other configurations of the connection interfaces **1040**, **1042** may similarly permit the caps **1002**, **1004** to be coupled with each other in a secure, yet selectively removable fashion, such as friction-fit, snap-fit, or other suitable interfacing arrangements. The coupling chamber **1024** can further include a sealing member **1044**, such as an elastomeric gasket described further below.

With reference to FIGS. **10** and **11**, the cap **1004** can comprise a housing **1050**. The housing **1050** can be elongated, and may define a stepped, substantially cylindrical shape, or may define any other suitable shape. For example, in the illustrated embodiment, the housing **1050** includes a sidewall **1052**, which is substantially cylindrical, and a base wall **1054** at one end of the sidewall **1052**. A sealing end **1056** of the sidewall **1052** can be located opposite the base wall **1054**, and can define an opening into a sterilization chamber **1058**. The sidewall **1052** and the base wall **1054** thus can cooperate to define the sterilization chamber **1058**.

In some embodiments, the housing **1050** includes a skirt **1060**, which can extend radially outwardly from the sidewall **1052**. In some embodiments, the skirt **1060** provides a convenient surface for manipulation of the cap **1004**. For example, in some embodiments, an outer diameter of the sidewall **1052** is smaller than an outer diameter of the sidewall **1012** of the cap **1002** such that the disparity between the outer diameters could complicate the gripping and rotation of the caps **1002**, **1004** relative to each other. Moreover, in some embodiments, the sidewall **1052** defines a relatively small outer surface area, which could make it difficult to grip the cap **1004**. The larger outer diameter and corresponding larger surface area of the skirt can facilitate gripping of the cap **1004**. The outer surface of the skirt **1060** can be smooth, as shown, or may include gripping features, which can aid in rotating the cap **1004** relative to the cap **1002** to permit separation of the caps **1002**, **1004** and/or aid in rotating the cap **1004** relative to a medical connector. Such gripping features can include, for example, ridges, grooves, and/or protrusions similar to the ridges **105**, grooves **107**, and protrusions **108** described above and/or an elastomeric or other coating having a relatively high coefficient of friction.

In some embodiments, a terminal edge **1062** of the skirt **1060** can be substantially coplanar with an outer surface of the base wall **1054**. In certain of such embodiments, the skirt **1060** can increase the stability of the assembly **1000**. For example, the assembly **1000** can stand uprightly on the base wall **1054**, and the skirt **1060** can inhibit tipping of the assembly **1000**.

With reference to FIG. **10**, the sterilization chamber **1058** can include a pad **1070** such as the pad **1032**. The pad **1070** can be deformable, so as to conform to the contours of a portion of a medical connector that is introduced into the sterilization chamber **1058** (e.g., an outer surface of a male luer). Compression and/or decompression of the pad **1070** can cause an antiseptic **1033** to exit from and/or be absorbed by the pad **1070**, respectively, in a manner such as described above with respect to the pad **1032** (it is noted that the antiseptic **1033** used with the pad **1070** need not necessarily be the same antiseptic as that used with the pad **1032**, although such is possible). Likewise, scrubbing or sanitization of a medical connector via the pad **1070** can proceed in a manner such as that described above with respect to the pad **1032**. In the illustrated embodiment, the pad **1070** is in a relaxed or uncompressed state in at least a longitudinal direction when the sterilization chamber **1058** is in a sealed or pre-use configuration.

As previously discussed, the cap **1004** can include the connection interface **1042**, which can interact with the connection interface **1040** of the cap **1002**. The connection interfaces **1040**, **1042** can cooperate to hold the cap **1004** tightly against the sealing member **1044**. For example, where the connection interfaces **1040**, **1042** comprise threading, appropriate rotation of the cap **1004** relative to the cap **1002** can draw the sealing end **1056** of the sidewall **1052** into abutment with the sealing member **1044**, and additional rotation in the same direction may deform the sealing member **1044**. The sealing end **1056** and the sealing member **1044** can form a hermetic seal that can assist in maintaining the sterility of the

sterilization chamber **1058** prior to use of the cap **1004**, and can prevent evaporative loss of an antiseptic from the sterilization chamber **1058**. In further embodiments, a sealing tape (not shown), such as the sealing tape **158** (see FIGS. **8**A and **8**B), can be positioned about the caps **1002**, **1004** so as to contact a lower edge of the housing **1010** (e.g., an outer surface of the portion of the sidewall **1012** that defines the coupling chamber **1058**) and an outer surface of the skirt **1060** of the housing **1050**. The tape can aid in preventing evaporative loss of the antiseptic and/or can indicate whether the caps **1002**, **1004** have been separated or otherwise moved from their initial or pre-use configuration. For example, in some embodiments, the tape can be frangible.

In the illustrated embodiment, the connection interface **1042** comprises outwardly projecting threads similar to the threads **114** described above, and can be configured to complementarily engage a connection interface of a medical connector, such as, for example, inwardly projecting threads of a skirt that surrounds a male luer. The threaded connection interface **1042** thus can allow for selective coupling of the cap **1004** to a medical connector in a secure, yet selectively removable fashion. Other configurations of the connection interface **1042** may permit the cap **1004** to be coupled with a medical connector in a secure, yet selectively removable fashion, such as friction-fit, snap-fit, or other suitable interfacing arrangements.

With continued reference to FIG. **10**, additional description of the illustrated embodiment of the assembly **1000** in the pre-use state will now be provided. As previously discussed, each sterilization chamber **1022**, **1058** can be defined by a separate housing **1012**, **1050**. The chambers **1022**, **1058** can be isolated from each other in the pre-use condition, or stated otherwise, no fluid communication may exist between the chambers **1022**, **1058**.

The caps **1002**, **1004** can cooperate to seal one of the chambers (e.g., the chamber **1058** in the illustrated embodiment) such that manipulation of the caps **1002**, **1004** away from their pre-use configuration can unseal the chamber **1058**, whereas the other chamber (e.g., the chamber **1022** in the illustrated embodiment) can remain in a sealed orientation independent of the relative orientations of the caps **1002**, **1004**. At least a portion of the housing **1050** of the cap **1004** can be received within, or can nest within, a portion of the housing **1010** of the cap **1002**. In the illustrated embodiment, the pad **1032** is free of any compression from the cap **1004** and the pad **1070** is free of any compression from the cap **1002** when the sterilization chambers **1022**, **1058**, in which the pads **1032**, **1070** are housed, are in a pre-use, sealed condition.

In the illustrated embodiment, the caps **1002**, **1004** are substantially coaxial with each other. As previously discussed, the sterilization chambers **1022**, **1058** defined by the caps **1002**, **1004** each can have an open end and a closed end, and in the pre-use configuration, the chambers **1022**, **1058** can be oriented such that their sealed open ends face in the same direction along the common axis of the caps **1002**, **1004**.

With reference to FIG. **11**, in order to prepare the cap **1004** for use with a medical connector (e.g., the connector **136** of FIG. **5**), the caps **1002**, **1004** are decoupled from each other. For example, in the illustrated embodiment, the caps **1002**, **1004** are rotated in opposite directions about a common longitudinal axis such that the connection interfaces **1040**, **1042** urge the caps **1002**, **1004** away from each other and are eventually released from each other. The cap **1004** can then be coupled with the medical connector via the connection interface **1042**, such as in a secure, yet selectively removable manner.

The cap **1002** can be prepared for use with a medical connector (e.g., the connector **132** of FIG. **4**) and connected to the medical connector independent of the coupling status of the caps **1002**, **1004** relative to each other. The cover **1034** can be removed from the cap **1002**, thereby permitting the cap **1002** to be coupled with the medical connector via the connection interface **1040**, such as in a secure, yet selectively removable manner.

The pre-use configuration of the system **1000**, in which the caps **1002**, **1004** are coupled with each other, can ease clinician handling of the system **1000**. As the caps **1002**, **1004** may be used to cover female and male connectors, respectively, immediately upon decoupling of the female and male connectors from each other, having the caps **1002**, **1004** available in a coupled yet easily separable configuration can be convenient and time saving. Moreover, the system **1000** can include relatively few parts, which can reduce manufacturing costs. In some embodiments, the pre-use coupled configuration of the caps **1002**, **1004** likewise can reduce packaging costs of the system **1000**.

FIG. **12** illustrates another embodiment of an assembly **1100**, which can resemble the assembly **1000** described above in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "11." Relevant disclosure set forth above regarding similarly identified features thus may not be repeated hereafter. Moreover, specific features of the assembly **1100** may not be identified by a reference numeral in the drawings or specifically discussed in the written description that follows. However, such features may clearly be the same, or substantially the same, as features depicted in other embodiments and described with respect to such embodiments. Accordingly, the relevant descriptions of such features apply equally to the features of the assembly **1100**. Any suitable combination of the features and variations of the same described with respect to the assembly **1000** and components thereof can be employed with the assembly **1100** and components thereof, and vice versa. This pattern of disclosure applies equally to further embodiments depicted in subsequent figures and described hereafter.

As with the assembly **1000**, the assembly **1100** can include a cap **1102** and a cap **1104** that are coupled with each other when in a pre-use state and that can be removed from each other. The cap **1102** can be configured to couple with a female connector, and the cap **1104** can be configured to couple with a male connector. The cap **1102** can include a housing **1110**, which can include a sidewall **1112** and a partition **1120**. A portion of the sidewall **1112** can cooperate with the partition **1120** to define a sterilization chamber **1122** such as the sterilization chamber **1022**. In the illustrated embodiment, the sterilization chamber **1122** is somewhat shorter than the sterilization chamber **1022** (see FIG. **10**). The sterilization chamber **1122** can include a connection interface **1130**, which, in the illustrated embodiment, includes threading **1131**. The sterilization chamber **1122** can include a pad **1132**, such as the pad **1032**, and can be sealed via a removable cover **1134**.

Another portion of the sidewall **1112** can cooperate with the partition **1120** to define a coupling chamber **1124** that extends in a direction opposite the sterilization chamber **1122**. A terminal edge **1118** of the sidewall **1112** can define an opening of the sterilization chamber **1122**. The sidewall **1112** can define a connection interface **1140** that is configured to aid in coupling the caps **1102**, **1104** with each other, as described further below.

With continued reference to FIG. **12**, the cap **1104** can include a housing **1150** that includes a sidewall **1152** and a base wall **1154**. The sidewall **1152** and the base wall **1154** can

cooperate to define a sterilization chamber **1158**, which can include a pad **1170** therein. The sterilization chamber **1158** can be sealed at a sealing end **1156** of the sidewall **1152** via a removable cover **1136**, which can resemble the cover **1134**. A portion of the sidewall **1152** can define a connection interface **1142**, which includes one or more threads **1143** in the illustrated embodiment.

The housing **1150** can define a skirt **1160** that projects radially outwardly from the sidewall **1152**. The skirt **1160** can terminate at a terminal edge **1162**. In the illustrated embodiment, the skirt **1160** is shorter than the skirt **1060** of the housing **1050** (see FIG. **10**) and is spaced above a plane that is defined by an outer surface of the base wall **1154**. In some embodiments, the terminal edge **1162** contacts or is in close proximity to the terminal edge **1118** of the housing **1110** when the caps **1102**, **1104** are coupled with each other in a pre-use configuration, which can provide continuity to an outer surface of the assembly **1100** when it is in a pre-use configuration. The skirt **1160** can be rounded or beveled at the terminal edge **1162**, and an end of the sidewall **1112** can be rounded or beveled at the terminal edge **1118**, which can provide the system **1100** with an annular recess **1163** that can provide a visual and/or tactile indication of the transition from the skirt **1160** to the sidewall **1112**. The rounded ends can also enhance practitioner and/or patient comfort during use of the caps **1102**, **1104**.

In the illustrated embodiment, the sidewall **1152** of the housing **1150** defines a connection interface **1180** that is configured to couple with the connection interface **1140** of the housing **1110**. In particular, the connection interface **1180** includes an outward projection **1181** and the connection interface **1140** includes a recess **1144** that extends radially outwardly relative to the connection chamber **1124** and that is sized to receive the annular projection **1181** therein in a snap-fit engagement. In the illustrated embodiment, each of the projection **1181** and the recess **1144** is annular and extends about the cap **1104** and the cap **1102**, respectively, in its entirety. In other embodiments, the projection **1181** and/or the recess **1144** extend about only a portion of the caps **1102**, **1104**. In still other or further embodiments, the connection interface **1180** can include a recess in the sidewall **1152** and the connection interface **1140** can include an inward projection sized to fit within the recess in a snap-fit engagement. In still other or further embodiments, the connection interfaces **1140**, **1180** can include complementary threading, such as the connection interfaces **1040**, **1042** described above. Other coupling arrangements are also possible.

Features, usage, and operation of the assembly **1100** can resemble that of the assembly **1000** described above. For example, when the assembly **1100** is in the pre-use condition, each sterilization chamber **1122**, **1158** can be defined by a separate housing **1112**, **1150**, and the sterilization chambers **1122**, **1158** can be fluidly isolated from one another (e.g., no fluid communication may exist between the sterilization chambers **1122**, **1158**). Likewise, at least a portion of the housing **1150** of the cap **1104** can be received within, or can nest within, a portion of the housing **1110** of the cap **1102**. In the illustrated embodiment, each of the pads **1132**, **1170** is in an uncompressed or expanded state when each of the sterilization chambers **1122**, **1158** in which it is housed is in a pre-use, sealed condition.

However, certain differences can exist between the assembly **1100** and the assembly **1000**. For example, each of the sterilization chambers **1122**, **1158** can remain sealed independent of the coupling status of the caps **1102**, **1104**. Stated otherwise, the caps **1102**, **1104** do not cooperate to seal either of the chambers **1122**, **1158**. Accordingly, one or both of the caps **1102**, **1104** can be unsealed (e.g., the covers **1134**, **1136** can be removed) and coupled with a separate medical connector (e.g., via the connection interfaces **1130**, **1142**) without detaching the caps **1102**, **1104** from each other. Stated in yet another manner, either of the caps **1102**, **1104** can be installed on a medical connector without being detached from and/or without unsealing the other cap **1102**, **1104**. Alternatively, the caps **1102**, **1104** can be detached from each other, one or both of the caps **1102**, **1104** each can be connected with a separate medical connector (i.e., via the connection interfaces **1130**, **1142**), and the caps **1102**, **1104** can be reattached to each other (i.e., via the connection interfaces **1140**, **1180**), while remaining connected to the one or more medical connectors.

Moreover, in the illustrated embodiment, the caps **1102**, **1104** are substantially coaxial with each other, thus resembling the caps **1002**, **1004**. However, the sterilization chambers **1122**, **1158** are oriented such that their sealed open ends face away from each other (e.g., outwardly in opposite directions) along the common axis of the caps **1102**, **1104**, when the assembly **1100** is in the pre-use configuration.

FIG. **13** illustrates another embodiment of an assembly **1200**, which can resemble one or more of the assemblies described above in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "12." As with the assembly **1100**, the assembly **1200** can include a cap **1202** and cap **1204** that are coupled with each other, when in a pre-use state, and that can be removed from each other.

The caps **1202**, **1204** can differ from the caps **1102**, **1104** in the manner by which they are coupled with each other. In particular, the cap **1202** includes a housing **1210** that defines a connection chamber **1224** configured to receive a portion of a housing **1250** of the cap **1204**. The housing **1210** defines a connection interface **1240**, and the housing **1250** defines a connection interface **1280**. Rather than cooperating in a snap-fit engagement, however, the connection interfaces **1240**, **1280** cooperate with each other in a friction-fit engagement to provide a secure attachment between the caps **1202**, **1204** and yet to permit the caps **1202**, **1204** to be selectively removable from each other and to permit selective reattachment of the caps **1202**, **1204** to each other. Features, usage, and operation of the assembly **1200** can otherwise resemble that of the assembly **1100** described above.

FIGS. **14** and **15** illustrate another embodiment of an assembly **1300**, which can resemble one or more of the assemblies described above in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "13." The assembly **1300** can include a cap **1302** and cap **1304** that are coupled with each other when in a pre-use state and that can be removed from each other. However, as discussed further below, the caps **1302**, **1304** can include connection interfaces **1340**, **1380**, respectively, that attach the caps **1302**, **1304** to each other in a pre-use configuration, and that permit ready detachment of the caps **1302**, **1304** one from another, but that do not themselves permit reattachment of the caps **1302**, **1304**.

The cap **1302** can include a housing **1310**, which can include a sidewall **1312** and a base wall **1313**. The sidewall **1312** and the base wall **1313** can cooperate to define a sterilization chamber **1322** that can include a pad **1332** therein and that can be sealed via a removable cover **1334**. The base wall **1313** can include a terminal surface **1318** and can define the connection interface **1340**. In the illustrated embodiment, the connection interface **1340** includes a depression or recess **1345** that bows the terminal surface **1318** inwardly, or toward

the sterilization chamber **1322**. The connection interface **1340** further includes a pin **1346** that extends outwardly, or away from the sterilization chamber **1322**.

With continued reference to FIGS. **14** and **15**, the cap **1304** can include a housing **1350** that includes a sidewall **1352** and a base wall **1354**. The sidewall **1352** and the base wall **1354** can cooperate to define a sterilization chamber **1358**, which can include a pad **1370** therein. The sterilization chamber **1358** can be sealed via a removable cover **1336**. A portion of the sidewall **1352** can define a connection interface **1342**, which includes one or more threads **1343** in the illustrated embodiment.

The housing **1350** can define a skirt **1360** that projects radially outwardly from the sidewall **1352**. The skirt **1360** can terminate at a terminal edge **1362**. In the illustrated embodiment, the skirt **1360** extends past a plane that is defined by an outer surface of the base wall **1354** and is sufficiently long to permit the terminal edge **1362** thereof to contact the terminal surface **1318** of the housing **1310** when the caps **1302**, **1304** are in a pre-use configuration. As with the skirt **1160** and the sidewall **1112**, the skirt **1360** can be rounded or beveled at its terminal edge **1362**, and the sidewall **1112** can be rounded or beveled at the terminal surface **1118**, which can provide the system **1300** with an annular recess **1363**.

The housing **1350** defines the connection interface **1380**, which is configured to couple with the connection interface **1340** of the housing **1310**. The connection interface **1380** includes a protrusion **1382** that extends from the base wall **1354** in a direction opposite the sterilization chamber **1358**. The protrusion **1382** is sized and shaped to receive therein at least a portion of the pin **1346**, and may be substantially annular. In various embodiments, the protrusion **1382** is joined to the pin in any suitable manner, such as, for example, press-fit or friction-fit engagement and/or any suitable adhesive.

In the illustrated embodiment, an additional protrusion **1384** is coaxial with and encircles the protrusion **1382**, and may also be substantially annular. The protrusion **1384** can contact the terminal surface **1318** of the housing **1310** when the caps **1302**, **1304** are in a pre-use configuration, and can provide stability to the connection interfaces **1340**, **1380** and assist in preventing premature separation of the caps **1302**, **1304**. The protrusion **1384** can be said to define a connection chamber **1324** in which the connection interface **1380** is located.

As shown in FIG. **15**, the caps **1302**, **1304** can be separated from each other, which can facilitate coupling of the caps **1302**, **1304** to separate medical connectors by removing a constraint on the range of motion of the caps **1302**, **1304** relative to each other. In the illustrated embodiment, the pin **1346** can be sufficiently thin, sufficiently weak, or otherwise configured to break away from the housing **1310**, and can remain attached to the protrusion **1382** of the housing **1350**. In various embodiments, in order to break the pin **1346**, a practitioner can rotate the caps **1302**, **1304** relative to each other about their common longitudinal axis and/or can rotate one or more of the caps **1302**, **1304** about an axis perpendicular to its longitudinal axis so as to move the longitudinal axes of the caps **1302**, **1304** out of alignment with each other.

Breaking the pin **1346** can leave a nub **1347** on the housing **1310**. In certain embodiments, the nub **1347** can be fully below the terminal surface **1318** of the housing **1310** due to the recess **1345**, which can prevent or reduce contact with the nub **1347**, such as by a patient or practitioner.

In certain embodiments, the connection interfaces **1340**, **1380** are configured so as to not rejoin with each other once the caps **1302**, **1304** have been separated from the pre-use configuration. For example, once the pin **1346** has been broken, the caps **1302**, **1304** cannot readily be rejoined to each other via the pin **1346**. Accordingly, the caps **1302**, **1304** can be configured to be attached with each other in a pre-use configuration and readily separated from each other as desired, but not readily rejoined with each other once separated.

Features, usage, and operation of the assembly **1300** can resemble those of one or more of the assemblies described above in other respects. For example, when the assembly **1300** is in the pre-use condition, each sterilization chamber **1322**, **1358** can be defined by a separate housing **1312**, **1350**, and the sterilization chambers **1322**, **1358** can be fluidly isolated from one another. Likewise, at least a portion of one of the housings **1310**, **1350** can be received within, or can nest within, a portion of the other housing **1310**, **1350**. To this end, it is noted that in other embodiments of the assembly **1300**, the housing **1350** of the cap **1304** may define the pin **1346** (or, more generally, the connection interface **1340**), and the housing **1310** of the cap **1302** may define the annular extension **1382** (or, more generally, the connection interface **1380**). In the illustrated embodiment, each of the pads **1332**, **1370** is in an uncompressed or expanded state when the sterilization chamber **1322**, **1358** in which it is housed is in a pre-use, sealed condition. Like the assemblies **1100**, **1200**, each of the sterilization chambers **1322**, **1358** can remain sealed independent of the coupling status of the caps **1302**, **1304**. One or both of the sterilization chambers **1322**, **1358** can be opened and used, while the caps **1302**, **1304** are connected with each other, or the caps **1302**, **1304** can be separated from each other and one or both of the sterilization chambers **1322**, **1358** can then be opened and each used with a separate medical connector.

FIGS. **16** and **17** illustrate another embodiment of an assembly **1400**, which can resemble the assembly **1300** described above in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "14." The assembly **1400** can include a cap **1402** and cap **1404** that are coupled with each other when in a pre-use state, and that can be removed from each other in a manner similar to the caps **1302**, **1304**. However, connection interfaces **1440**, **1480** of the caps differ from the connection interfaces **1340**, **1380** of the caps **1302**, **1304**.

The connection interface **1440** can be defined by a terminal surface **1418** of a housing **1410** of the cap **1402**. The connection interface **1440** can include a depression or recess **1448** that bows the terminal surface **1418** inwardly, or toward a sterilization chamber **1422**. The recess **1448** can be annular, although other shapes and configurations are possible.

A sidewall **1452** of the cap **1404** can be somewhat longer than the sidewall **1352** of the cap **1304**, and a base wall **1454** of the cap **1404** can be in close proximity with or adjacent to the terminal surface **1418** of the cap **1402**. A protrusion **1485** can extend outwardly from the base wall **1454**, or in a direction away from a sterilization chamber **1458**. The protrusion **1485** can be annular so as to be received within the annular recess **1448**, although other shapes and configurations are possible. The protrusion **1485** can be joined to the recess **1448** in any suitable manner, such as via an adhesive or via welding (e.g., spin, ultra-sonic, laser, radio frequency, thermal, etc.).

In the illustrated embodiment, the protrusion **1485** is welded to the recess **1448**, and the weld is configured to be broken to permit separation of the caps **1402**, **1404**. As shown in FIG. **17**, a weld edge **1486** can remain within the recess **1448** when the caps **1402**, **1404** are separated. In certain embodiments, the weld edge **1486** can be fully below the terminal surface **1418** of the housing **1410**, which can prevent

or reduce contact with the weld edge **1486**, such as by a patient or practitioner. In order to break the weld, a practitioner can rotate the caps **1402**, **1404** relative to each other about their common longitudinal axis and/or can rotate one or more of the caps **1402**, **1404** about an axis perpendicular to its longitudinal axis, so as to move the longitudinal axes of the caps **1402**, **1404** out of alignment with each other. In other embodiments, the connection interfaces **1440**, **1480** can be reversed such that the cap **1402** includes the protrusion **1485** and the cap **1404** can includes the recess **1448**.

FIGS. **18-21** illustrate another embodiment of an assembly **1500**, which can resemble one or more of the assemblies described above in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "15." As can be seen in FIGS. **18** and **19**, and as discussed hereafter, the assembly **1500** can include a cap **1502** and cap **1504** that are coupled with each other when in a pre-use state and that can be removed from each other. The cap **1502** can be configured to couple with a female connector, and the cap **1504** can be configured to couple with a male connector. The caps **1502**, **1504** can be in a side-by-side arrangement when connected to each other in a pre-use configuration. In the illustrated embodiment, both caps **1502**, **1504** can be sealed shut in the pre-use configuration via a common cover **1537**.

The cap **1502** can include a housing **1510**, which can include a sidewall **1512** and a base wall **1513**. The sidewall **1512** can cooperate with the base wall **1513** to define a sterilization chamber **1522**. The sterilization chamber **1522** can include a connection interface **1530**, which, in the illustrated embodiment, includes threading **1531** disposed on an interior surface of the housing **1512**. The connection interface **1530** can be configured to attach the cap **1502** to a medical connector in a secure yet selectively removable manner. The sterilization chamber **1522** can include a pad **1532**.

The housing **1510** can further include a skirt **1561** that projects radially outwardly from the sidewall **1512** and that can also extend substantially parallel to the sidewall **1512**. The skirt **1561** can include one or more spacers or supports **1564** that can provide structural rigidity to the skirt **1561**. As shown in FIGS. **19** and **21**, the housing **1510** can define a connection interface **1540** that is configured to aid in coupling the caps **1502**, **1504** with each other in a pre-use configuration, as discussed further below. The connection interface **1540** can include a slot **1548** defined by the skirt **1561**, which can extend in a direction substantially parallel to a longitudinal axis of the sterilization chamber **1522**. The sidewall **1512** and the skirt **1561** can cooperate to define an open connection chamber **1524**, which is also discussed below. The slot **1548** can define a side opening of the connection chamber **1524**.

With reference to FIGS. **19** and **20**, the cap **1504** can include a housing **1550** that includes a sidewall **1552** and a base wall **1554**. The sidewall **1552** and the base wall **1554** can cooperate to define a sterilization chamber **1558**, which can include a pad **1570** therein. A portion of the sidewall **1552** can define a connection interface **1542**, which includes one or more threads **1543** in the illustrated embodiment. The connection interface **1542** can be configured to attach the cap **1504** to a medical connector in a secure yet selectively removable manner. The housing **1550** can define a skirt **1560** that projects radially outwardly from the sidewall **1552** and that can also extend substantially parallel to the sidewall **1552**. In the illustrated embodiment, the skirt **1560** extends about only a portion of the cap **1504**. The skirt **1560** can include one or more spacers or supports **1565** that can provide structural rigidity to the skirt **1560**.

The housing **1550** can further define a connection interface **1580** that is configured to interact with the connection interface **1540** of the housing **1510** to couple the caps **1502**, **1504**. The connection interfaces **1540** can maintain the caps **1502**, **1504** in a pre-use configuration, and can permit the caps **1502**, **1504** to be selectively removed from this configuration. In the illustrated embodiment, the connection interfaces **1540**, **1580** can further interact with each other to permit selective reattachment of the caps **1502**, **1504** to each other.

In the illustrated embodiment, the connection interface **1580** includes a locking member, snapping member, or radial extension **1585**. The extension **1585** projects radially from the sidewall **1552** and includes an enlarged region at its outermost end. The extension **1585** is configured to be received within the slot **1548** and the connection chamber **1524** of the cap **1502**. The enlarged portion of the extension **1585** can prevent the extension **1585** from moving out of the slot **1548** in a lateral direction. Although not shown, in some embodiments, the slot **1548** and the extension **1585** can include keying, such as a protrusion and recess that cooperate in a snapping fashion, which can selectively prevent the extension **1585** from moving out of the slot **1548** in a longitudinal direction in the absence of application of sufficient force by a practitioner. In other embodiments, the connection interfaces **1540**, **1580** can be reversed such that the cap **1402** includes the extension **1585** and the cap **1504** includes the slot **1548**.

In the illustrated embodiment, a terminal surface **1518** of the cap **1502** and a terminal surface **1562** of the cap **1504** are substantially coplanar when the system **1500** is in the pre-use configuration. This can contribute to the stability of the pre-use system **1500**, as the connected system **1500** can be set on a planar surface without a predisposition to tipping. Likewise, in the illustrated embodiment, a sealing end **1516** of the cap **1502** and a sealing end **1556** of the cap **1504** are substantially coplanar when the system **1500** is in the pre-use configuration. Each sealing end **1516**, **1556** can be sealed closed via a single or common removable cover **1537**. In the illustrated embodiment, the cover **1537** includes two tabs **1538** that can permit selective opening of just one of the caps **1502**, **1504**, or the opening both of the caps **1502**, **1504** by beginning with opening one of the caps **1502**, **1504** by removing a portion of the cover **1537** from that cap **1502**, **1504** and then continuing to remove the cover **1537** from the remaining cap **1502**, **1504**. Other arrangements are also possible.

The cover **1537** can assist in maintaining the caps **1502**, **1504** coupled with each other in the pre-use configuration, as it can be sufficiently tight to resist longitudinal movement of the caps **1502**, **1504** relative to each other. In various embodiments, the cover **1537** is removed from one or both of the caps **1502**, **1504** prior to removing the caps **1502**, **1504** from each other, as shown in FIG. **19**. In other embodiments, the connection interfaces **1540**, **1580** of the caps **1502**, **1504** can be decoupled from each other prior to removing the cover **1537**.

Features, usage, and operation of the assembly **1500** can resemble that of one or more of the assemblies described above. For example, when the assembly **1500** is in the pre-use condition, each sterilization chamber **1522**, **1558** can be defined by a separate housing **1512**, **1550**, and the sterilization chambers **1522**, **1558** can be fluidly isolated from one another. Likewise, at least a portion of the housing **1550** of the cap **1504** can be received within, or can nest within, a portion of the housing **1510** of the cap **1502**. In the illustrated embodiment, each of the pads **1532**, **1570** is in an uncompressed or expanded state when the sterilization chamber **1522**, **1558** in which it is housed is in a pre-use, sealed condition.

However, certain differences can exist. For example, in the illustrated embodiment, the caps **1502**, **1504** are side-by-side,

rather than coaxial, when in the pre-use configuration. Stated otherwise, each cap **1502**, **1504** can define a longitudinal axis, and the longitudinal axes can be substantially parallel with each other or non-collinear relative to each other when the caps **1502**, **1504** are in the pre-use configuration. In the illustrated embodiment, the sterilization chambers **1522**, **1558** are oriented such that their sealed open ends face in substantially the same direction when the assembly **1500** is in the pre-use configuration.

FIG. **22** illustrates another embodiment of an assembly **1600**, which can resemble one or more of the assemblies described above, particularly the assembly **1500**, in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "16." The assembly **1600** can include caps **1602**, **1604** such as the caps **1502**, **1504**. Rather than including a single cover **1537**, however, an individual cover **1634**, **1636** is provided to each of the caps **1602**, **1604**. Such an arrangement can, in some instances, facilitate removal of the caps **1602**, **1604** from each other while the caps **1602**, **1604** are maintained in a sealed configuration.

FIG. **23** illustrates an embodiment of a cap **1702** that can be used in the place of the caps **1502**, **1602** in the systems **1500**, **1600**. The cap **1702** can include a housing **1710** that includes a sidewall **1712** and a skirt **1761**. The sidewall **1712** can taper radially outwardly with increasing distance from the skirt **1761**. Moreover, the housing **1710** can include an extension region **1717** that projects in an opposite direction from the skirt **1761**. The extension region **1717** can include a rounded terminal surface **1718**. The cap **1702** thus can more closely resemble the cap **102** described above. For example, the extension region **1717** can include gripping features **1703**, such as ridges **1705** and grooves **1707**. Similar alterations can be made to the caps **1504**, **1604**.

FIG. **24** illustrates another embodiment of an assembly **1800**, which can resemble one or more of the assemblies described above in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "18." The assembly **1800** can include a cap **1802** and cap **1804** that are coupled with each other when in a pre-use state and that can be removed from each other. In particular, the caps **1802**, **1804** can be coupled with each other via a sealing mechanism. In the illustrated embodiment, the caps **1802**, **1804** are coupled with each other via a sealing sleeve **1890**. The caps **1802**, **1804** can have open ends facing one another, and sterilization chambers **1822**, **1858** of the caps **1802**, **1804** can be in fluid communication with each other, when in the pre-use configuration.

The cap **1802** can include a housing **1810**, which can include a sidewall **1812** and a base wall **1813**. The sidewall **1812** can cooperate with the base wall **1813** to define the sterilization chamber **1822**. The sterilization chamber **1822** can include a connection interface **1830**, which, in the illustrated embodiment, includes threading **1831** disposed on an interior surface of the housing **1812**. The connection interface **1830** can be configured to attach the cap **1802** to a medical connector in a secure yet selectively removable manner. The sterilization chamber **1822** can include a pad **1832**.

An exterior surface of the sidewall **1812** can define a connection interface **1840** that is configured to couple the cap **1802** with a connection interface **1891** of the sleeve **1890**. In the illustrated embodiment, the connection interfaces **1840**, **1891** couple with each other via a friction-fit engagement. The friction fit can be sufficiently strong to provide a fluid-tight seal between the cap **1802** and the sleeve **1890**, yet can allow the cap **1802** to be removed from the sleeve **1890** via mere manipulation by a medical practitioner (e.g., without the use of ancillary tools). The fluid-tight seal can prevent evaporative loss of antiseptic from the pad **1832** and/or can maintain the sterility of the sterilization chamber **1822**. In other or further embodiments, the connection interfaces **1840**, **1891** can include threading or other suitable attachment features.

In the illustrated embodiment, the base wall **1813** protrudes slightly beyond an end of the sleeve **1890**, which can aid in manipulating the cap **1802** away from the sleeve **1890**. In other embodiments, the base wall **1813** can protrude even further, or can include one or more protrusions or gripping features, that can aid in removing the cap **1802** from the sleeve **1890**.

The cap **1802** can include a flange **1815** having an outer diameter larger than an inner diameter of the end of the sleeve **1890** that connects with the cap **1802**. The flange **1815** can prevent the cap **1802** from being inserted into the sleeve **1890** too deeply. In other or further embodiments, the flange **1815** can cooperate with an end surface of the sleeve **1890** to create a liquid-tight seal. For example, in some embodiments, a sealing member, such as an "O" ring, is included between the flange **1815** and the end of the sleeve **1890** to provide the liquid-tight seal.

The cap **1804** can include a housing **1850** that includes a sidewall **1852** and a base wall **1854**. The sidewall **1852** and the base wall **1854** can cooperate to define a sterilization chamber **1858**, which can include a pad **1870** therein. A portion of the sidewall **1852** can define a connection interface **1842**, which includes one or more threads **1843** in the illustrated embodiment. The connection interface **1842** can be configured to attach the cap **1804** to a medical connector in a secure yet selectively removable manner. Additionally, the connection interface **1842** can cooperate with a connection interface **1892** defined by the sleeve **1890** to couple the cap **1804** with the cap **1802**. The connection interface **1892** can include threading **1893** that is complementary to the threading **1843**. The interfaces **1842**, **1892**, when coupled with each other, can provide a fluid-tight seal between the cap **1804** and the sleeve **1890**. In other embodiments, the connection interfaces **1842**, **1890** can instead define a friction-fit seal, such as that provided by the illustrated embodiment of the connection interfaces **1840**, **1891** described above. In still other or further embodiments, a flange **1859** defined by the housing **1850** can cooperate with an end surface of the sleeve **1890** to create a liquid-tight seal, which can prevent evaporative loss of antiseptic from the pad **1870** and/or maintain the sterility of the sterilization chamber **1858**. For example, in some embodiments, a sealing member, such as an "O" ring, is included between the flange **1859** and the end of the sleeve **1890** to provide the liquid-tight seal.

Features, usage, and operation of the assembly **1800** can resemble that of one or more of the assemblies described above. For example, when the assembly **1800** is in the pre-use condition, each sterilization chamber **1822**, **1858** can be defined by a separate housing **1812**, **1850**. Likewise, the caps **1802**, **1804** can be coaxial with each other, and the open ends of the caps **1802**, **1804** can face in opposite directions (e.g., towards each other). In the illustrated embodiment, each of the pads **1832**, **1870** is in an uncompressed or expanded state when the sterilization chamber **1822**, **1858** in which it is housed is in a pre-use, sealed condition.

However, certain differences can exist. For example, in the illustrated embodiment, the sterilization chambers **1822**, **1858** are in fluid communication with each other when the caps **1802**, **1804** are in the pre-use state. Moreover, in the illustrated embodiment, no portion of the housing **1850** of the cap **1804** is received within, or nested within, any portion of the housing **1810** of the cap **1802**.

FIGS. **25-29** illustrate another embodiment of an assembly **1900**, which can resemble one or more of the assemblies described above in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "19." As shown, for example, FIGS. **25** and **26**, the assembly **1900** can include a male cap portion or cap **1902** and a female cap portion or cap **1904** that are integrally formed or otherwise permanently attached with each other. For example, the caps **1902**, **1904** can include a single, integrally molded housing **1910**. The cap **1902** can be configured to couple with a female connector, and the cap **1904** can be configured to couple with a male connector. In the illustrated embodiment, the caps **1902**, **1904** are in a coaxial arrangement. As shown, for example, in FIGS. **26** and **28**, the assembly **1900** can include a pad **1970** that is received within one or more of the caps **1902**, **1904**. As shown, for example, in FIGS. **25** and **26**, each cap **1902**, **1904** can be sealed shut in the pre-use configuration via a separate cover **1934**, **1938**, respectively. Each cover **1934**, **1938** can include a tab **1935**, **1939**, respectively, that can aid in removal of the cover.

With continued reference to FIGS. **25-29**, the housing **1910** can define at least a portion of each of the caps **1902**, **1904**. The housing **1910** includes a first sidewall **1912** that defines a first sterilization chamber **1922** and includes a second sidewall **1952** that defines a second sterilization chamber **1958**. As shown in FIG. **29**, the first sidewall **1912** can define larger inner and outer diameters than those defined by the second sidewall **1952**. The housing **1910** can transition from the first sidewall **1912** and the first sterilization chamber **1922** to the second sidewall **1952** and the second sterilization chamber **1958** at a constriction or abutment **1920**. The housing **1910** can be substantially hollow such that the first and second sterilization chambers **1922**, **1958** are in fluid communication with each other. The housing **1910** can define another abutment **1921**, which is discussed further below.

As shown in FIGS. **26**, **28**, and **29**, the male cap **1902** can include a connection interface **1930** that is configured to couple with a connection interface of a medical connector, such as a needleless injection site. The connection interface **1930** can include threading **1931**, which can be disposed at an interior of the sidewall **1912**. In some embodiments, the male cap **1902** includes one or more gripping features **1903** at an exterior surface of the sidewall **1912**. In the illustrated embodiment, the gripping features **1903** are raised areas. In other embodiments, the gripping features **1903** can include depressed areas. The gripping features **1903** can be formed in the shape of a company logo or any other suitable shape.

As shown in FIGS. **26**, **27**, and **29**, the female cap **1904** can include a connection interface **1942** that is configured to couple with a connection interface of a medical connector, such as a medical attachment having a male luer. The connection interface **1942** can include threading **1943**, which can be disposed at an exterior surface of the sidewall **1952**. The cap **1904** can include one or more vents **1959**, which can be located at an end of the sidewall **1952**. The one or more vents can also extend along the length of sidewall **1952**. In the illustrated embodiment, a constriction, rim, or lip **1953** projects radially inwardly at the end of the sidewall **1952**, which can aid in maintaining the pad **1970** within the cap **1904**. In particular, the lip **1953** can define a smaller inner diameter than an outer diameter of the pad **1970** (see FIG. **29**). The vents **1959** can comprise notches in the lip **1953**. The illustrated embodiment includes four vents **1959**, although more or fewer vents are possible.

With reference to FIG. **26**, the pad **1970** can define a shape generally resembling a series of tiered cylinders. A rim **1971** can extend transversely, or radially outwardly, from a cylinder that has the smallest diameter. Another rim **1972** can extend transversely from a cylinder having an intermediate diameter. The largest cylinder can have a recess **1973** disposed therein. In certain embodiments, such as the illustrated embodiment, one or more extensions **1974** protrude from an end of the pad **1970** in a longitudinal direction. Each extension **1974** can include a groove **1975** therein, as discussed further below. In other embodiments, the one or more extensions **1974** are omitted.

With reference to FIG. **29**, the pad **1970** can be secured within the housing **1910** in any suitable manner, and thus can resist translational movement in either direction that would cause the pad **1970** to exit the housing **1910** from either open end of the housing. For example, in the illustrated embodiment, interaction of the threads **1931** with a left end of the pad **1970** can prevent the pad **1970** from moving out of the housing **1910** in a leftward direction as a portion of a medical connector (e.g., a male luer connector) is inserted into the housing **1910** from the right. As shown in FIG. **29**, some portions of the pad **1970** can be compressed by the threads **1931**, whereas the grooves **1975** of the extensions **1974** can accommodate the threads **1931**. The enlarged tiered sections of the pad **1970**, and the resultant interaction of the rims **1971**, **1972** with the abutments **1920**, **1921**, respectively, can prevent the pad **1970** from moving out of the housing **1910** in the rightward direction as a portion of a medical connector (e.g., a needleless injection site) is advanced into the housing **1920** from the left. In other or further embodiments, the pad **1970** can be adhered to the housing **1910**.

With reference to FIGS. **26** and **27**, the cover **1938** can be secured to the housing **1910** in any suitable manner. For example, in some embodiments, an end of the cover **1938** is adhered or otherwise sealed to a sealing surface **1956** at an end of the sidewall **1952** so as to provide a hermetic seal. A side portion of the cover **1938** thus can cover the connection interface **1942** of the cap **1904**. In other or further embodiments, a lower circumferential edge of the cover **1938** can be adhered or otherwise sealed to a sealing surface **1957** at a base end of the sidewall **1952** so as to provide a hermetic seal. With reference to FIGS. **26** and **28**, the cover **1934** can be adhered or otherwise sealed to a sealing surface **1916** at an end of the sidewall **1912** of the housing **1910**.

FIG. **30** illustrates an early stage of the coupling of a medical connector **2000** with the cap **1904**. The medical connector **2000** can include a housing **2005** that complies with ISO standards (e.g., ISO 594-1:1986 and ISO 594-2: 1998). The housing **2005** can include a skirt **2010** that defines a connection interface **2012**, which itself can include threading **2014**. The housing **2005** can also include a male luer **2020**, which can define a fluid passageway **2022**.

In the illustrated embodiment, a tip of the male luer **2020** can contact an end surface of the pad **1970** prior to engagement of the connection interfaces **1942**, **2012** (e.g., the threadings **1943**, **2014**) with each other. Accordingly, some compression of the pad **1970** may occur without assistance from the connection interfaces **1942**, **2012**. In other embodiments, the connection interfaces **1942**, **2012** may engage one another prior to contact being made between the tip of the male luer **2020** and the end surface of the pad **1970**, such as may occur when the pad **1970** is more recessed within the housing **1910** and/or the skirt **2010** and its connection interface **2012** are longer. In either case, in some embodiments, the connection interfaces **1942**, **2012** can assist in the compression of the pad **1970**. The desired antiseptic concentration level of the pad **1970** is determined by the volume required to fully coat and

sterilize the medical connector **2000**, while taking into consideration the evaporative loss that may occur during the shelf life of cap **1904**.

FIG. **31** illustrates a later stage of the coupling of the medical connector **2000** with the cap **1904**. As the male luer **2020** is advanced into the sterilization chamber **1958** of the cap **1904**, it compresses the pad **1970** and causes antiseptic **1933** to egress therefrom. The pad **1970** can remain relatively fixed, rotationally, while the male luer **2020** is rotated and advanced further into the chamber **1958**, which can effect a rubbing or scrubbing of the tip of the luer **2020**, particularly as increased compression of the pad **1970** provides an increased force of the pad **1970** against the tip. The released antiseptic can fill an opening or volume of space between the sidewall **1952** of the housing **1910** and an outer surface of the male luer **2020**, and can thereby sterilize the outer surface of the male luer **2020**. Additionally, in the illustrated embodiment, the fluid passageway **2022** of the male luer **2020** is open such that antiseptic fluid **1933** may enter into it.

In certain embodiments, a seal can form between the lip **1953** and the male luer **2020** when the luer **2020** is advanced sufficiently far into the chamber **1958**. The seal thus formed can be an interrupted seal, such that the seal is formed only at those regions where the luer **2020** and the lip **1953** are in contact with each other. Antiseptic **1933** can be permitted to exit from the chamber **1958** via the vents **1959**. In some embodiments, the vents **1959** are sufficiently large to permit antiseptic **1933** to exit from the chamber **1958** freely once the antiseptic **1933** has been expelled from the pad **1970**. Antiseptic **1933** that exits from the chamber **1958** through the vents **1959** can sterilize portions of the male luer **2020** that are proximal of the lip **1953**.

In other embodiments, the vents **1959** are sufficiently small to prevent antiseptic **1953** from exiting from the chamber **1958** when a pressure within the chamber **1958** is the same or approximately the same as a pressure outside of the chamber **1958** (e.g., atmospheric pressure), and yet are sufficiently large to permit antiseptic **1933** to exit the chamber **1958** when the pressure within the chamber **1958** is significantly greater than the pressure outside of the chamber **1958**, such as may result when the luer **2020** is being advanced deeper within the chamber **1958**. The vents **1959** thus can permit selective egress of the antiseptic **1933** to aid in achieving the desired positioning of the male luer **2020**, yet can maintain the antiseptic **1933** within the chamber **1958** in order to bathe a portion of the male luer **2020** once the male luer **2020** is positioned as desired. In still other embodiments, a fluid-tight seal is formed between the lip **1953** and the male luer **2020**.

In certain embodiments, the pad **1970** may be recessed within the chamber **1958** to a greater degree when in the uncompressed state (e.g., when in the state shown in FIG. **30**). Moreover, the threads **2014** of the connection interface **2012** and the threads **1943** of the connection interface **1942** can permit the antiseptic **1933** to pass through them, so as to provide additional venting of the chamber **1958**. For example, threaded connection interfaces **2012**, **1942** can permit antiseptic **1933** that has exited from the chamber **1958** to spiral about an outer surface of the second sidewall **1952** in a distal direction.

Each of FIGS. **32-34** illustrates the cap **1902** coupled with a separate needleless injection site **2040**, **2060**, **2080**. As with other caps disclosed herein, the cap **1902** can be versatile so as to couple with a variety of different types of medical connectors in a secure fashion that sterilizes each type of medical connector. As can be seen in each of FIGS. **32-34**, coupling of the needleless injection sites **2040**, **2060**, **2080** with the cap **1902** can effect compression of one end of the pad **1970** in a manner similar to that described above with respect to compression of the other end of the pad **1970**. Compression of the pad **1970** and rotation of the needleless injection site **2040**, **2060**, **2080** can effect rubbing, swabbing, or scrubbing of the needleless injection site and sterilization thereof via the antiseptic **1933**.

With reference to FIG. **32**, the needleless injection site **2040** can comprise a Clave® port available from ICU Medical, Inc. The needleless injection site **2040** can include a housing **2042** that defines a connection interface **2044**. The needleless injection site **2040** can further include an elastomeric seal **2046**, which is shown in a closed configuration in which fluid access is not permitted into a fluid passageway **2048**. Small crevices can exist between the housing **2042** and the elastomeric seal **2046** at an end of the needleless injection site **2040** that is inserted into sterilization chamber **1922**. As the connection interface **2044** cooperates with the connection interface **1930** defined by the sidewall **1912** to draw the tip of the needleless injection site **2040** into the sterilization chamber **1922**, the pad **1970** can be compressed so as to generally conform to the crevices. Compression of the pad **1970** likewise can expel antiseptic **1933**, which, in some instances, can fill in portions of the crevices that the pad **1970** may not be able to contact directly. As the pad **1970** is compressed, the seal **2046** can remain closed so as to prevent antiseptic **1933** from entering the fluid passageway **2048**. With reference again to FIG. **29**, if present, the one or more extensions **1974**, due to their positioning over the threads **1031**, additionally can rub or scrub the side surfaces of the needleless injection site **2040**. Thus, a thorough rubbing and sterilization of the needleless injection site **2040** can be accomplished via the cap **1902**, and the performance of the cap **1902** in this regard can exceed that achieved via standard swabbing protocols and can be less susceptible to human error.

With reference to FIG. **33**, the needleless injection site **2060** can comprise a Q-Syte® port available from Becton, Dickinson and Company. The needleless injection site **2060** can include a housing **2062** and an elastomeric seal **2066**, which is shown in a closed configuration in which fluid access is not permitted into a fluid passageway **2068**. As with the needleless injection site **2040**, small crevices can exist between the housing **2062** and the elastomeric seal **2066**. However, the crevices can exist at a side portion of the needleless injection site **2060**, rather than at its tip. Nevertheless, as the needleless injection site **2060** is advanced into the cap **1902**, the pad **1970** can be compressed so as to generally conform to these differently shaped crevices. Compression of the pad **1970** likewise can expel antiseptic **1933**, which, in some instances, can fill in portions of the crevices that the pad **1970** may not be able to contact directly. The seal **2066** can be maintained in the closed position during the coupling procedure, so as to prevent any of the antiseptic **1933** from entering the fluid passageway **2068**.

With reference to FIG. **34**, the needleless injection site **2080** can comprise a SmartSite® port available from Cardinal Health, Inc. The needleless injection site **2080** can include a housing **2082** and an elastomeric seal **2086**, which is shown in a closed configuration in which fluid access is not permitted into a fluid passageway **2088**. As with the needleless injection sites **2040**, **2060**, small crevices can exist between the housing **2082** and the elastomeric seal **2086**. However, these crevices can be in yet different positions than those of the needleless injection sites **2040**, **2060**. Nevertheless, as the needleless injection site **2080** is advanced into the cap **1902**, the pad **1970** can be compressed so as to generally conform to these differently shaped crevices. Compression of the pad **1970** likewise can expel antiseptic **1933**, which, in some

instances, can fill in portions of the crevices that the pad **1970** may not be able to contact directly. The seal **2086** can be maintained in the closed position during the coupling procedure so as to prevent any of the antiseptic **1933** from entering the fluid passageway **2088**. Additionally, each of the needleless injection sites **2040**, **2060**, **2080** may advance into the cap **1902** by different amounts. The cap **1902** thus can be adaptable and versatile. Additional, non-limiting examples of needleless injection sites with which the cap **1902** can selectively couple include the Clearlink® Site available from Baxter and the InVision-Plus® available from Rymed.

Features, usage, and operation of the assembly **1900** can resemble that of one or more of the assemblies described above. For example, in the illustrated embodiment, the pad **1970** is in an uncompressed or expanded state when the sterilization chambers **1922**, **1958** in which it is housed are in a pre-use, sealed condition. Additionally, the caps **1902**, **1904** are coaxial with each other with open ends that face in opposite directions. Likewise, the caps **1902**, **1904** are connected to each other when the assembly **1900** is in a pre-use state.

However, certain differences can exist. For example, in the illustrated embodiment, the caps **1902**, **1904** cannot be removed from each other. Moreover, the assembly **1900** includes a single pad **1970** that is used in both caps **1902**, **1904**. Although not shown in the drawings, it is understood that each cap **1902**, **1904** can be coupled with a separate medical connector such that the pad **1970** is compressed from both ends when the caps **1902**, **1904** are in a coupled state.

FIG. **35** illustrates another embodiment of an assembly **2100**, which can resemble one or more of the assemblies described above, particularly the assembly **1900**, in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "21." The assembly **2100** can include caps **2102**, **2104**, such as the caps **1902**, **1904**, that are fixedly, permanently, or integrally connected with each other. Covers such as the covers **1934**, **1938**, which are not shown in FIG. **35**, can be used with the caps **2102**, **2104**. The assembly **2100** can include a single housing **2110** that defines two sterilization chambers **2122**, **2158**. The housing **2110** can include a partition **2120** that separates the sterilization chambers **2122**, **2158** from each other such that the chambers **2122**, **2158** are fluidly separated from one another. Each chamber **2122**, **2158** can include a separate pad **2132**, **2170** therein.

FIGS. **36** and **37** illustrate another embodiment of an assembly **2200**, which can resemble one or more of the assemblies described above, particularly the assemblies **1900** and **2100**, in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "22." The assembly **2200** can include a female cap **2202** and a male cap **2204** that are fixedly, permanently, or integrally connected with each other. The assembly can include a housing **2210**, which can include a sidewall **2252** that defines a sterilization chamber **2258** and a connection interface **2242**. Covers **2234**, **2238**, such as the covers **1934**, **1938**, can be used with the caps **2202**, **2204**.

The female cap **2202** can be substantially the same as the female cap **1902**. However, the male cap **2204** can differ from the male cap **1904** in certain respects. For example, the cap **2204** can include a sealing member **2290**. In the illustrated embodiment, the sealing member **2290** is shaped substantially as a conical disk. The sealing member **2290** can include a seal region **2292** which, in the illustrated embodiment, is rounded and projects toward an open end of the sterilization chamber **2258** when situated therein. Alternatively, the sealing member **2290** may be in the form of other shapes such as, for example, a square shape or other non-circular shapes. Further, the sealing member **2290** and the seal region **2292** may be a separate components that are integrally connected. The sealing member **2290** can include one or more ports **2294**, which can define openings or channels **2293** that extend between opposing faces of the sealing member **2290**. Other configurations of the ports **2294** are also contemplated, such as, for example, self-sealing slits. In other configurations wherein the sealing member **2290** is a non-circular shape, the ports can be eliminated since the antiseptic can flow around the sides of the sealing member **2290**. In some embodiments, the sealing member **2290** can be relatively rigid so as to maintain a pre-formed shape, but may be configured to readily form a liquid-tight seal with a male luer of a medical connector. The sealing member **2290** can be formed of any suitable material, such as an elastomer or any thermoplastic such as polypropylene, polycarbinate, acrylonitrile butadiene styrene (ABS), polyvinyl chloride (PVC), or rigid or semi-rigid thermoset plastic. The sealing member **2290** can be formed in any suitable fashion, such as via molding or die cutting.

The sealing member **2290** can be coupled with a biasing element **2276**, which can be configured to resist or oppose movement of the sealing member **2290**. Stated otherwise, the biasing element **2276** can provide a bias to the sealing member **2290** in a direction of an initial position of the sealing member **2290**, such as that shown in FIG. **37**, once the sealing member **2290** has been displaced from that initial position. Accordingly, in the embodiment depicted in FIG. **37**, the biasing element **2276** biases the sealing member **2290** in a proximal direction when the sealing member **2290** is displaced distally. The terms "proximal" and "distal," when used herein relative to a cap, are such that a medical device is inserted into a proximal end of the cap and advanced toward a distal end of the cap. Accordingly, in the illustrated embodiment, the proximal ends of the caps **2202**, **2204** are at opposite ends of the assembly **2200** and the distal ends of the caps **2202**, **2204** are fixedly joined with each other.

The male cap **2204** can include a rim **2253**, similar to the lip **1953**, which can include one or more vents **2259**. However, in the illustrated embodiment, the rim **2253** is more recessed from a proximal end of the cap **2204** (e.g., deeper within the cavity **2258**). A portion of a pad **2270** that is positioned within the sterilization chamber **2258** can be shorter than a corresponding portion of the pad **1970**, so as to more readily fit below the more recessed rim **2253**. As shown in FIG. **37**, the pad **2270** can be seated beneath the sealing member **2290**, and the sealing member **2290** can be seated beneath the rim **2253** when the male cap is in the pre-use configuration. In some embodiments, the pad **2270** is in an uncompressed state (e.g., a longitudinally uncompressed state) when situated as shown in FIG. **37**. The pad **2270** can include an antiseptic **2233** therein.

In the illustrated embodiment, the pad **2270** is resiliently compressible such that the biasing element **2276** comprises the pad **2270**. Stated otherwise, compression of the pad **2270** gives rise to a biasing force that tends to restore the pad **2270** to its uncompressed state. The biasing force may increase with greater compression of the pad **2270**. In some embodiments, the pad **2270** is fixedly secured to the sealing member **2290**, such as by an adhesive or any suitable lamination technique. In other embodiments, the sealing member **2290** is not secured to the pad **2270**, but movement of the sealing member **2290** within the sterilization chamber **2258** can nevertheless be constrained by a proximal end of the pad **2270** and a distal edge of the rim **2253**.

The sealing member **2290** can aid in maintaining the antiseptic **2233** within the pad **2270** when the cap **2204** is in a

pre-use condition. For example, in some embodiments, only a small surface area of the proximal end of the pad **2270** that is directly beneath the ports **2294** of the sealing member **2290** is directly exposed to air when the proximal end of the cap **2204** is uncovered. Accordingly, evaporative loss of the antiseptic **2233** can be slowed. Moreover, in other or further embodiments, the ports **2294** may be defined by channels that are sufficiently small to prevent liquid antiseptic **2233** from passing through them when the pressure on both sides of the sealing member **2290** is balanced. However, the ports **2294** may permit liquid antiseptic **2233** to pass through them when the pressure on one side of the sealing member **2290** is greater than the pressure on the other side of the sealing member **2290**, as discussed further below. The pad **2270** itself can also be configured to retain the antiseptic **2233** until it is compressed.

In some embodiments, an outer edge of the sealing member **2290** can form a liquid-tight seal with an inner surface of the sidewall **2252** when the cap **2204** is in the pre-use state. In further embodiments, the seal can be maintained as the sealing member **2290** is moved distally within the sterilization chamber **2258** such that liquid antiseptic **2233** is only permitted to bypass the sealing member **2290** through the ports **2294**. In other embodiments, an outer edge of the sealing member **2290** may not form a liquid-tight seal with the sidewall **2252**, whether initially or after having been moved from the pre-use condition, such that antiseptic **2233** can bypass the sealing member **2290** around its outer edge.

FIG. **38** illustrates an early stage of coupling a medical connector **2000** with the cap **2204**. A tip **2021** of a male luer **2020** contacts the seal region **2292** of the sealing member **2290**. In the illustrated embodiment, a portion of the sealing member **2290** extends into a lumen **2022** of the connector **2000** such that the contact is primarily between an inner edge of the tip **2021** and a thin band of the sealing member **2290**. Such an arrangement can assist in forming a liquid-tight seal due to a relatively higher pressure that results between the tip **2021** and the sealing member **2290** when forces (e.g., an insertion force on the tip and an oppositely directed biasing force on the sealing member) are distributed over relatively smaller areas. Such an arrangement likewise can allow antiseptic to contact much or all of an external surface of the luer **2020**, including a distal surface of the tip **2021**.

In the illustrated embodiment, contact between the tip **2021** and the sealing member **2290** occurs just prior to engagement of a connection **2012** of the connector **2000** with the connection interface **2242**. In other embodiments, the connection interfaces **2012**, **2242** can engage each other prior to contact between the tip **2021** and the sealing member **2290**. In either case, as the connection interfaces **2012**, **2242** cooperate with each other to connect the cap **2204** to the medical connector **2000** (e.g., as the cap **2204** is threaded onto the connector **2000**), a liquid-tight seal is formed or maintained between the seal region **2292** of the sealing member **2290** and the tip **2021** of the male luer **2020**.

FIG. **39** illustrates a late or final stage of coupling the medical connector **2000** with the cap **2204**. To arrive at this stage, cap **2204** is advanced over the male luer **2020** to a greater extent. As a result, the luer **2020** is advanced further into the sterilization chamber **2258**, thereby moving the sealing member **2290** distally and compressing the pad **2270**. Compression of the pad **2270** forces antiseptic **2233** out of the pad **2270**. Moreover, as the pad **2270** is compressed, the volume of the portion of the sterilization chamber **2258** that is on the distal side of the sealing member **2290** is reduced, thereby increasing the pressure in that portion of the sterilization chamber **2258**. As a result, the antiseptic **2233** is forced through the ports **2294** into the portion of the sterilization chamber **2258** on the proximal side of the sealing member **2290**. Due to the seal between the sealing member **2290** and the luer **2020**, the antiseptic **2233** is prevented from entering the lumen **2022** of the luer **2020**, and thus is prevented from contacting or mixing with medical fluid that may be within the lumen **2022** when the cap **2204** is coupled with the medical connector **2000** and/or that may flow through the lumen **2022** after the cap **2204** has been removed from the connector **2000**. The antiseptic **2233** can fill the open region of the sterilization chamber **2258** on the proximal side of the sealing member **2290**.

As the luer **2020** is advanced distally in the sterilization chamber **2258**, another seal, or partial seal, can be formed between an outer surface of the luer **2020** and an inner surface of the rim **2253**. Where present, the seal can be substantially liquid-tight. However, the vents **2259** can interrupt the seal so as to permit antiseptic **2233** to exit from the chamber **2258**. In further embodiments, a proximal or distal surface of the rim **2253** can be covered with a covering, such as, for example, Tyvek® or other nonwoven material, which can filter microbes from the air entering the sterilization chamber **2258** via the vents **2259**, yet can permit antiseptic **2233** to pass through it so as to exit from the sterilization chamber **2258**. In other embodiments, the rim **2253** is uninterrupted (e.g., is free of vents **2259**) such that an uninterrupted seal can be formed between the rim **2253** and the male luer **2020**.

With continued reference to FIG. **39**, when the cap **2204** is connected to the medical device **2000**, antiseptic **2233** can fill the sterilization chamber **2258** between the seals formed by contact between the luer **2020** and the sealing member **2290** and between the luer **2020** and the rim **2253**. An outer surface of the luer **2020** between these two sealed regions of the luer **2020** thus can be bathed in the antiseptic **2233** and sterilized thereby. As mentioned with respect to the assembly **1900**, the rim **2253** can be positioned at a deeper or a more shallow position relative to the housing **2252**, which can result in sterilization of a smaller or greater surface area of the luer **2020**, respectively. In certain embodiments in which the proximal seal between the rim **2253** and the male luer **2020** is interrupted (e.g., where the rim **2253** includes vents **2259**), antiseptic **2233** can be permitted to exit from the chamber **2258**. In some embodiments, the vents **2259** are sufficiently large to permit antiseptic **2233** to exit from the chamber **2258** freely once the antiseptic **2233** has been expelled from the pad **2270**. Antiseptic **2233** that exits from the chamber **2258** through the vents **2259** can sterilize portions of the male luer **2020** that are proximal of the rim **2253**.

When the cap **2204** is removed from the medical device **2000**, it can naturally or automatically return to the orientation shown in FIG. **37**. In particular, the resiliently compressible pad **2270** can move the sealing member **2290** distally to its pre-use position. In so doing, the expanding portion of the sterilization chamber **2258** that is distal of the sealing member **2290** can have a decreased pressure such that antiseptic **2233** is forced back through the ports **2294** of the sealing member **2290** in a distal direction. The expanding pad **2270** can soak up or absorb the returned antiseptic **2233**.

In other embodiments, the caps **2202**, **2204** can more closely resemble the caps **2102**, **2104** described above. For example, the cap **2202** can have a separate pad, which is separated from the pad **2270** by a partition. In still other embodiments, the caps **2202**, **2204** can be readily disconnected from each other, and in further embodiments, may be configured for selective reconnection with each other in manners such as those described with respect to other caps herein.

FIGS. **40-45** illustrate another embodiment of a cap **2304**, which can resemble one or more of the caps described above in certain respects. For example, the cap **2304** can replace or readily be altered to replace any of the caps **1004**, **1104**, **1204**, **1304**, **1404**, **1504**, **1604**, **1804**, **1904**, **2104**, **2204** in the systems **1000**, **1100**, **1200**, **1300**, **1400**, **1500**, **1600**, **1800**, **1900**, **2100**, **2200** described above. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "23."

The cap **2304** can include a housing **2350** having a sidewall **2352** and a base wall **2354** that define a sterilization chamber **2358**. The housing **2350** can further include a coupling interface **2342**. The cap **2304** can include a biasing member **2376**, which can comprise a resiliently compressible pad **2370**, which can in turn include an antiseptic **2333** therein. The cap **2304** can further include a sealing member **2390**, which includes a sealing region **2392** and one or more ports **2394**, which include channels **2393** that extend through the sealing member **2390**.

The sidewall **2352** of the housing **2350** can be different from that of the illustrated embodiment of the cap **2204**. In particular, at least a portion of an inner surface of the sidewall **2352** (e.g., a proximal region thereof) can be tapered so as to form a liquid-tight seal with a male luer. For example, at least a portion of the inner surface of the sidewall **2352** can comply with ISO standards (e.g., ISO 594-1:1986 and ISO 594-2: 1998) for forming a seal with a male luer. In the illustrated embodiment, the sidewall **2352** is devoid of any inwardly projecting rims that could interrupt complementarities between the sidewall **2352** and a male luer.

FIGS. **41-45** illustrate consecutive stages of the cap **2304** being coupled with a medical device **2000**. As shown in FIG. **41**, a tip **2021** of a male luer **2020** can be received within the sterilization chamber **2358** prior to contacting the sealing member **2390**. Stated otherwise, the sealing member **2390** can be recessed relative to a proximal end of the sidewall **2352** by a distance that is sufficiently great to permit at least a portion of the male luer **2020** to be received within the sidewall **2352** before the male luer contacts the sealing member **2390**.

In FIG. **42**, the luer **2020** has been advanced further within the sterilization chamber **2358** so as to contact the seal region **2392** of the sealing member **2390**. In the illustrated embodiment, the connection interface **2342** of the cap **2304** engages a connection interface **2012** of the medical connector **2000** just prior to contact being made between the tip **2021** of the luer **2020** and the seal region **2392**. The connection interfaces **2342**, **2012** thus can assist in the creation of a fluid-tight seal between the luer **2020** and the sealing member **2390**.

The sealing member **2390** can remain in the initial or pre-use position that is shown in both FIGS. **41** and **42** until the seal has been formed between the luer **2020** and the sealing member **2390**. Further advancement of the luer **2020** into the sterilization chamber **2358** can strengthen the seal due to the spring force that arises as the pad **2370** is compressed. When the sealing member **2390** is in the initial orientation, the ports **2394** can prevent antiseptic **2333** from passing through them. Also, the composition of the pad **2370** or the affinity of the pad **2370** to absorb antiseptic **2333** will determine the retention of the antiseptic **2333** in the pad **2370**.

In FIG. **43**, the luer **2020** has been advanced slightly further into the sterilization chamber **2358**, thereby compressing the pad **2370** somewhat and forcing antiseptic **2333** through the ports **2394**. As schematically shown by wavy lines, the antiseptic **2333** begins to fill the space between the sealing member **2390** and the tip **2021** of the luer **2020**. The antiseptic **2333** does not, however, enter into a lumen of the luer **2020** due to the seal between the luer **2020** and the sealing member **2390**.

In FIG. **44**, the luer **2020** has been advanced even further into the sterilization chamber **2358**, thereby compressing the pad **2370** to a greater extent and forcing additional antiseptic **2333** through the ports **2394**. Although the outer surface of the luer **2020** appears to be nearly parallel to and in contact with an inner surface of the tapered portion of the sidewall **2352**, a seal has not yet been formed in this area. Accordingly, the antiseptic **2333** can fill not only the space between the sealing member **2390** and the tip **2021** of the luer **2020**, but also the small amount of space between the luer **2020** and the sidewall **2352**. The luer **2020** thus can be covered in antiseptic **2333** and sterilized thereby. In some embodiments, the antiseptic **2333** remains within portions of the space between the luer **2020** and the sidewall **2352** only temporarily, as additional advancement of the luer **2020** can close this space to form a seal.

FIG. **45** illustrates a final or fully coupled stage, or an end-of-stroke orientation, in which the luer **2020** has been advanced even further into the sterilization chamber **2358** such that the luer **2020** forms a seal with the sidewall **2352**. Antiseptic **2333** can be retained in all open portions of the sterilization chamber **2358** that are between the seal formed by the luer **2020** and the sealing member **2390** and the seal formed by the luer **2020** and the sidewall **2352**. In the illustrated embodiment, only a small portion of the luer **2020**, which includes the tip **2021**, is in continual contact with the portion of the antiseptic **2333** thus retained. This portion of the luer **2020** can be bathed by the antiseptic **2333** and sterilized thereby. In other embodiments, larger portions of the luer **2020** can be bathed.

The seal formed by the luer **2020** and the sealing member **2390** and the seal formed by the luer **2020** and the sidewall **2352** is accomplished by appropriate sizing of the individual components. The sizing is subject to and based upon the ISO luer taper specification, which implies a range of axial engagement of 2 millimeters. All manufactured components can vary with tolerance limits between a maximum and minimum material condition. The maximum material condition and minimum material condition indicate large and small components, respectively. When all combinations of maximum and minimum material condition parts are considered, the variation in mating depth in the axial direction is 2 millimeters. The minimum material condition in this case is also the case of maximum mating depth (or stroke). In other words, the minimum material condition is the loosest fit, and the maximum material condition is the tightest fit of the taper. A minimum dispense stroke of 1 millimeter indicates that the components have been dimensioned such that for the tightest fitting luer **2020** (i.e., maximum material condition), a minimum of 1 millimeter dispense stroke will exist. Hence, a minimum of 1 millimeter of seal movement will exist prior to luer engagement.

FIG. **46** illustrates another embodiment of a cap **2304'** in an end-of-stroke orientation. The cap **2304'** is substantially the same as the cap **2304** just discussed. For example, a substantial portion of an interior surface of the sidewall **2352** is tapered so as to be complementary to the male luer **2020**. However, the sidewall **2352** includes one or more venting channels or vents **2353** therein that prevent the sidewall **2352** from sealing with the male luer **2020**. The illustrated vent **2352** extends from a proximal end of the sidewall **2352** in a longitudinal direction to a position just beyond (or distal of) an end-of-stroke position of the tip **2021** of the male luer **2020**. Accordingly, after liquid-impervious contact is estab-

lished between the male luer **2020** and those portions of the sidewall **2352** having a taper complementary to the male luer **2020**, antiseptic **2333** can still exit the chamber **2358** via the vent **2353**. In certain embodiments, the coupled connection interfaces **2012**, **2342** can permit the antiseptic **2333** to pass through them so as to provide additional venting of the chamber **2358**. For example, threaded connection interfaces **2012**, **2342** can permit antiseptic **2333** that has exited from the chamber **2358** to spiral about an outer surface of the sidewall **2352** and/or otherwise seep in a distal direction.

In various embodiments, the cap **2304'** comprises one or more, two or more, three or more, or four or more vents **2353**. One or more of the vents **2353** can be substantially linear in a longitudinal direction (as shown) and/or can define alternate orientations. For example in some embodiments, one or more vents **2353** can be angled relative to a longitudinal axis of the cap **2304'** (e.g., can be helical), or can include a portion that is so angled. One or more of the vents **2353** can extend any suitable distance between the proximal end of the sidewall **2352** and the base wall **2354**. For example, in various embodiments, the vents **2353** extend no less than about ¼, no less than about ⅓, no less than about ½, no less than about ⅔, or no less than about ¾ the distance between the proximal end of the sidewall **2352** and the base wall **2354**. Where suitable, one or more vents **2353** can be incorporated into embodiments of the caps described above, as well as those described hereafter.

FIG. **47** illustrates another embodiment of a cap **2404**, which can resemble one or more of the caps described above, particularly the caps **2304**, **2304'**, in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "24." The cap can include a housing **2450**, a biasing member **2476**, and a sealing member **2490**. The housing **2450** can have a sidewall **2452** and a base wall **2454** that define a sterilization chamber **2458**. The housing **2450** can further define one or more ports **2494**. In the illustrated embodiment, the port **2494** comprises a longitudinal groove **2459** extending a distance along the sidewall **2452**. The longitudinal distance which the groove **2459** extends can be varied as desired. In some embodiments, the longitudinal distance is greater than or equal to a stroke length through which the sealing member **2490** is displaced when the cap **2404** is connected to a medical connector for reasons discussed hereafter, although such is not required.

The sealing member **2490** can be devoid of channels, and may act in a plunger-like fashion. The sealing member **2490** can form a liquid-impermeable seal with the sidewall **2452** when in the pre-use configuration shown in FIG. **47**. However, distal displacement of the sealing member **2490** can move a proximal end of the sealing member **2490** past a proximal end of the channel **2494**, thereby opening the channel **2494**. This can permit an antiseptic **2433** to be forced from a pad **2470** by the displaced sealing member **2494** and moved through the channel **2494**, thereby entering the portion of the sterilization chamber **2458** which is proximal to the sealing member **2490**. In embodiments where the longitudinal length of a channel **2459** is greater than or equal to a stroke length through which the sealing member **2490** is displaced, antiseptic **2433** can be permitted to pass through the channel **2494** during all stages of the displacement.

In the illustrated embodiment, the biasing member **2476** includes a resiliently compressible pad **2477**, although additional or other components are possible (e.g., a compressible spring). The pad **2477** is separated from the pad **2470** by a barrier **2478**, which can comprise any suitable material capable of preventing passage of the antiseptic **2433**. For example, in some embodiments, the barrier **2478** comprises a plastic film or disk. The barrier **2478** thus can restrain the antiseptic **2433** to a predetermined portion of the sterilization chamber **2458** that is closest to the sealing member **2490**. Such an arrangement can permit the usage of less antiseptic **2433**, as a greater portion of the antiseptic **2433** can be expelled from the pad **2470**.

In some embodiments, both of the pads **2470**, **2477** comprise the same material, while in other embodiments different materials may be selected for desired properties. For example, the pad **2470** may comprise a more absorbent foam while the pad **2477** may comprise a springier foam. In some embodiments, both pads **2470**, **2477** can provide a bias to the sealing member **2490** when they are compressed such that the biasing member **2476** can be said to include both pads **2470**, **2477**. In still other or further embodiments, the biasing member **2476** can comprise a spring or other at least somewhat resiliently deformable element in place of the pad **2477**.

Although in the illustrated embodiment, the sealing member **2490** is devoid of ports, other embodiments can include ports in addition to or instead of the channels **2494** in the sidewall **2452**. Likewise, it is understood that channels **2494** could be included in other embodiments of caps described herein in addition to or in place of ports through sealing members. Similar substitutions and rearrangements are possible with respect to other features of the cap **2404**, such as the two-part biasing member **2476** and the barrier **2478**.

FIGS. **48** and **49** illustrate another embodiment of a cap **2504**, which can resemble one or more of the caps described above, particularly the caps **2304**, **2304'**, **2404**, in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "25." The cap can include a housing **2550**, a biasing member **2576**, and a sealing member **2590**. The housing **2550** can have a sidewall **2552** that defines a sterilization chamber **2558**. The housing **2550** can further define a bathing recess **2555** within the sterilization chamber **2558**, which can be included in a tapered region at a proximal end of the sidewall **2552**. As shown in FIG. **49**, antiseptic **2533** can be retained within the bathing recess **2555** and maintained in contact with an outer surface of a male luer **2020**. Accordingly, a greater portion of the luer **2020** than just a tip **2021** thereof can be maintained in contact with the antiseptic **2533** when the luer **2020** is in an end-of-stroke position.

The housing **2550** can further define a vent **2598** having a cover **2599**. The vent **2598** can be defined by a channel that extends from an interior of the sidewall **2552** to an exterior thereof. A distal end of the vent **2598** can open into the bathing recess **2555**, and a proximal end of the vent **2598** can be at a proximal end of the sidewall **2552**. The vent **2598** can function in manners such as those described above with respect to other vents.

In some embodiments, the cover **2599** can comprise a material, such as, for example, Tyvek® or other nonwoven material, which can filter microbes from the air entering the sterilization chamber **2558** via the vent **2598** and can permit antiseptic **2533** to exit from the sterilization chamber **2558**.

With continued reference to FIGS. **48** and **49**, the antiseptic **2533** can be held within the sterilization chamber **2533** without pads. A biasing member **2576** can include a compression spring **2579**. A sealing member **2590** can form a fluid-tight seal with the sidewall **2552** to retain the antiseptic **2533** within a reservoir portion of the chamber **2533**. While the sealing member **2590** can resemble any of the sealing members discussed above, the illustrated embodiment includes ports **2594** that have two-way valves **2597** therein. In various embodiments, the two-way valves **2597** are formed of self-sealing slits and/or the two-way valves **2597** can be disposed within channels through the sealing member **2590**.

FIG. **50** illustrates another embodiment of an assembly **2600**, which can resemble one or more of the assemblies described above, particularly the assembly **1800**, in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "26." The assembly **2600** can include a cap **2602** and cap **2604** that are coupled with each other when in a pre-use state and that can be removed from each other. In particular, the caps **2602**, **2604** can be coupled with each other via a sealing mechanism. In the illustrated embodiment, the caps **2602**, **2604** are coupled with each other via a sealing sleeve **2691**.

With reference to FIG. **51**, the cap **2602** can include a housing **2610**, which can include a sidewall **2612** and a base wall **2613**. The housing **2610** can include a substantially cylindrical region toward a proximal end thereof, which can be flattened and taper toward the narrower base wall **2613**. Such a shape can provide a convenient handle at a distal end of the cap **2602**. A cavity **2623** can be formed at an interior of the sidewall **2612** and the base wall **2613**, which can reduce material costs for the cap **2602**.

The sidewall **2612** can define a sterilization chamber **2622**, which can include a connection interface **2630** that includes threads **2631**. The connection interface **2630** can be configured to attach the cap **2602** to a medical connector in a secure yet selectively removable manner. The sterilization chamber **2622** can further include a pad **2632**.

A proximal surface **2624** of the sidewall **2612** can define a seal inhibitor **2625** that is configured to prevent the cap **2602** from forming a fluid-tight seal with a medical connector, such as a needleless injection site, when it is coupled therewith. For example, in the illustrated embodiment, the proximal surface **2624** of the sidewall **2612** is substantially castellated such that it defines a series of offset contact regions **2626** and venting regions **2627**. In the illustrated embodiment, each of the contact regions **2626** and venting regions **2627** includes a planar surface that is substantially perpendicular to a longitudinal axis of the cap **2602**. The contact regions **2626** are at a more proximal position than are the venting regions **2627**. Accordingly, when the cap **2602** is coupled with certain embodiments of needleless injection sites, the contact regions **2626** can come into contact with surfaces of the needleless injection sites that project outwardly, whereas the venting regions **2627** can avoid making any such contact.

For example, in arrangements such as those depicted in FIGS. **32** and **33**, the cap **2602** can be advanced onto a needleless injection site **2040**, **2060** sufficiently to bring the planar surfaces of the contact regions **2626** into contact with a radially outwardly projecting planar surfaces of the needleless injection site **2040**, **2060**. However, in such a configuration, the venting regions **2627** would be spaced from the outwardly projecting planar surface of the needleless injection site **2040**, **2060** so as not to form a seal therewith. The cap **2602** thus would be permitted to vent via the venting regions **2627**. As further discussed below, other configurations of the seal inhibitor **2625** are also possible. Moreover, in some embodiments, the cap **2625** is devoid of a seal inhibitor **2625**.

With reference to FIGS. **51** and **53**, an exterior surface of the sidewall **2612** can define another connection interface **2640** that is configured to couple the cap **2602** with a connection interface **2695** of the sleeve **2691**. In the illustrated embodiment, the connection interfaces **2640**, **2695** couple with each other via a friction-fit engagement. The friction fit can be sufficiently strong to provide a fluid-tight seal between the cap **2602** and the sleeve **2691**, yet can allow the cap **2602** to be removed from the sleeve **2691** via mere manipulation by a medical practitioner (e.g., without the use of ancillary tools). The fluid-tight seal can prevent evaporative loss of antiseptic from the pad **2632** and/or can maintain the sterility of the sterilization chamber **2622**. In other or further embodiments, the connection interfaces **2640**, **2695** can include threads or other suitable attachment features.

The cap **2602** can include a flange **2615** having an outer diameter larger than an inner diameter of the end of the sleeve **2691** that connects with the cap **2602**. The flange **2615** can prevent the cap **2602** from being inserted into the sleeve **2690** too deeply. In other or further embodiments, the flange **2615** can cooperate with an end surface of the sleeve **2690** to create a liquid-tight seal (see FIG. **54**). For example, in some embodiments, a sealing member, such as an "O" ring, is included between the flange **2615** and the end of the sleeve **2690** to provide the liquid-tight seal.

With reference to FIG. **52**, the cap **2604** can include a housing **2650** that includes a sidewall **2652** and a base wall **2654**, which can cooperate to define a cavity **2659** similar to the cavity **2623** described above. Likewise, the housing **2650** can define a substantially cylindrical shape at a proximal end of the cap **2604**, which flattens and tapers toward the base wall **2654**.

The sidewall **2652** can define a sterilization chamber **2658**, which can include a sealing member **2690** and a biasing member **2676**. The sealing member **2690** and the biasing member **2676** can resemble any suitable combination of these components, and features thereof, described above. In the illustrated embodiment, the biasing member **2676** comprises a pad **2670**.

A portion of the sidewall **2652** can define a connection interface **2642**, which includes one or more threads **2643** in the illustrated embodiment. The connection interface **2642** can be configured to attach the cap **2604** to a medical connector in a secure yet selectively removable manner.

With reference to FIGS. **52** and **53**, the sidewall **2652** can define an additional connection interface **2680**, which can cooperate with a connection interface **2692** defined by the sleeve **2691** to couple the cap **2604** with the cap **2602**. The connection interface **2680** of the cap **2604** can include a groove **2683**, which may be substantially annular and extend about a periphery of the cap **2604**. The connection interface **2692** of the sleeve **2691** can include a complementary inward projection **2693**, which likewise can be substantially annular. The interfaces **2680**, **2692**, when coupled with each other, can provide a fluid-tight seal between the cap **2604** and the sleeve **2690**. In other embodiments, the connection interfaces **2680**, **2690** can instead define a friction-fit seal, such as that provided by the illustrated embodiment of the connection interfaces **2640**, **2695** described above. In still other or further embodiments, a flange **2661** defined by the housing **2650** can cooperate with an end surface of the sleeve **2691** to create a liquid-tight seal (see FIG. **54**), which can prevent evaporative loss of antiseptic from the pad **2670** and/or maintain the sterility of the sterilization chamber **2658**. For example, in some embodiments, a sealing member, such as an "O" ring, is included between the flange **2659** and the end of the sleeve **2691** to provide the liquid-tight seal.

With reference to FIG. **54**, when the assembly **2600** is in a fully coupled or pre-use state, a proximal end of the sidewall **2652** of the cap **2604** is received within the cavity **2622** defined by the sidewall **2612** of the cap **2602**. In some embodiments, the sidewall **2652** of the cap **2604** does not contact any portion of the sidewall **2612** of the cap **2602** in this pre-use configuration, nor does the sidewall **2652** contact the pad **2632** that is within the cap **2602**. Such a configuration can result in a relatively compact assembly **2600** in which each cap **2602**, **2604** can be quickly prepared for use. In other embodiments, the sidewalls **2652**, **2612** may contact or

couple with each other (e.g., via the connection interfaces **2642**, **2630**) and/or the sidewall **2652** may contact the pad **2632** in the pre-use configuration. In still other embodiments, the sidewalls **2652**, **2612** may be spaced from each other such that the sidewall **2652** is not received within the cavity **2622**.

FIG. **55** illustrates another embodiment of an assembly **2700**, which can resemble one or more of the assemblies described above, particularly the assemblies **1800**, **2600**, in certain respects. Accordingly, like features are designated with like reference numerals, with the leading digits incremented to "27." The assembly **2700** can include a cap **2702** and cap **2704** that are coupled with each other when in a pre-use state via a sealing sleeve **2791**.

The assembly **2700** can include one or more separation assists **2707**, **2708**, which can aid in removal of the cap **2702** and/or the cap **2704** from the sleeve **2791**. In the illustrated embodiment, the separation assists **2707**, **2708** each includes a complementary recess/protrusion pair. In particular, a flange **2715** of the cap **2702** defines a recess **2716** that is sized and dimensioned to receive therein a protrusion **2799** that is defined by an edge **2798** of the sleeve **2791**. The recess **2716** and the protrusion **2799** cooperate with each other as a separation assist **2707**. Similarly, a flange **2761** of the cap **2704** defines a recess **2762** that is sized and dimensioned to receive therein a protrusion **2797** that is defined by an edge **2796** of the sleeve **2791**. The recess **2762** and the protrusion **2797** cooperate with each other as a separation assist **2708**.

Focusing now on the separation assist **2707**, the recess **2716** can include two substantially planar surfaces that meet at a rounded base. The planar surfaces can be at an angle relative to a plane that is perpendicular to a longitudinal axis (or central axis) of the cap **2702** (e.g., a plane defined by portion of the flange **2715** that does not include the recess **2716**, in the illustrated embodiment). For example, in the illustrated embodiment, each of the planar surfaces of the recess **2716** defines an angle of about 20 degrees relative to the perpendicular plane. Similarly, the protrusion **2799** can include two substantially planar surfaces that meet at a rounded apex. The planar surfaces can be at the same angle relative to the perpendicular plane as are the planar surfaces of the recess **2716**. For example, in the illustrated embodiment, each of the planar surfaces of the protrusion **2799** defines an angle of about 20 degrees relative to a plane defined by the portion of the edge **2798** of the sleeve **2791** that does not include the protrusion **2799**.

When the cap **2702** is joined with the sleeve **2791** in a pre-use configuration (similar to that shown in FIG. **54**), the planar portions of the recess **2716** and of the protrusion **2799** can be in close proximity to each other or can contact each other. In order to separate the cap **2702** from the sleeve **2791**, the cap **2702** can be rotated relative the sleeve **2791**, which can cause opposing planar surfaces of the recess **2716** and the protrusion **2799** to contact each other and slide past each other. This interaction can convert the rotational movement of the cap **2702** about a common axis of the cap **2702** and the sleeve **2791** into translational movement of the cap **2702** away from the sleeve **2791** along the common axis. Due to the symmetry of the planar surfaces of each of the recess **2716** and the protrusion **2799** of the illustrated embodiment, the cap **2702** can be rotated in either direction to achieve the same lifting action via the separation assist **2707** that tends to move the cap **2702** away from the sleeve **2791**.

In other embodiments, the separation assist **2707** can be configured to aid in separating the cap **2702** from the sleeve **2791** only when the cap **2702** is rotated in one predetermined direction (e.g., either clockwise or counterclockwise). For example, one planar surface may be at about 20 degrees relative to the perpendicular plane, whereas the other planar surface may be at a about 90 degrees relative to the perpendicular plane (i.e., approximately parallel to or extending through a central axis of the cap **2702**). In other embodiments, one or more of the planar surfaces of the recess **2716** and/or the protrusion **2799** may be at larger or smaller angles relative to the perpendicular plane. For example, in various embodiments, a set of complementary planes may be at an angle of no more than about 15 degrees, no more than about 20 degrees, no more than about 30 degrees, no more than about 45 degrees, no more than about 60 degrees, or no more than about 75 degrees. Other configurations of the separation assist **2707** are also possible. For example, in some embodiments, the complementary surfaces of the recess **2716** and the protrusion **2799** can define angles as just described, but the surfaces may be rounded or otherwise non-planar.

The foregoing discussion regarding the separation assist **2707** applies equally to the separation assist **2708**. In the illustrated embodiment, the separation assist **2707** and the separation assist **2708** are substantially identical, such that the recess **2762** and the protrusion **2797** likewise include complementary planar surfaces that are at an angle of about 20 degrees relative to a plane oriented perpendicularly through a central axis of the cap **2704** and the sleeve **2791**. In other embodiments, the arrangements of the separation assists **2707**, **2708** may be different from each other. For example, the planar surfaces of the separation assist **2707** may be at a larger or smaller angle than those of the separation assist **2708** so as to provide a different amount of separation force. Moreover, in some embodiments, the assembly **2700** includes a number of separation assists **2707** equal to the number of separation assists **2708**, whereas in other embodiments, the assembly **2700** may include more or fewer separation assists **2707** as compared with the number of separation assists **2708**. For example, in the illustrated embodiment, the assembly **2700** includes one separation assist **2707** and two separation assists **2708**.

In the illustrated embodiment, the two separation assists **2708** are at diametrically opposite positions. Such an orientation can aid in maintaining the cap **2704** and the sleeve **2791** in a substantially coaxial orientation as the cap **2704** is being removed, which can prevent an elongated sidewall **2752** from contacting an inner surface of the sleeve **2791** and thereby potentially complicating removal of the cap **2704**. In other arrangements, additional separation assists **2708** may be used, and the separation assists **2708** may be equally spaced from each other about a perimeter of the sleeve **2791**.

Other arrangements of the separation assists **2707**, **2708** are contemplated. For example, in some embodiments, the caps **2702**, **2704** include one or more of the protrusions **2799**, **2797**, respectively, whereas the sleeve **2791** includes one or more of the recesses **2716**, **2762**.

FIGS. **56** and **57** illustrate another embodiment of a cap **2802**, which in some embodiments can be used in place of the cap **2602** in the assembly **2600**. In other embodiments, the cap **2802** can be modified so as to be used in place of the cap **2702** in the assembly **2700**, such as by altering a flange **2815** of the cap **2802** to include a recess.

The cap **2802** can include a seal inhibitor **2825** having a different arrangement from that shown with respect to the caps **2602**, **2702**. In the illustrated embodiment, the seal inhibitor **2825** is defined by a proximal surface **2824** of a sidewall **2812** of the cap **2802**, which defines a rounded, sinusoidal contour. In particular, the proximal surface **2824** can define two contact regions **2826** and two venting regions **2827**. In the illustrated embodiment, the contact regions **2826** are at diametrically opposite positions and the venting regions

2827 likewise are at diametrically opposite positions. The contact regions **2626** are at a more proximal position than are the venting regions **2627**. As discussed above with respect to the cap **2602**, the venting regions **2827** can prevent the cap **2802** from forming a seal with a medical connector, and can permit venting of the cap **2802** when it is coupled with the medical connector.

As shown in FIG. **58**, the proximal surface **2824** of the cap **2802** can be well-suited for coupling with a removable cover **2834** such as the removable covers discussed above. Accordingly, various embodiments of the cap **2802** either can be readily fitted with a cover **2834** and distributed for individual use, or can be incorporated into an assembly, such as the assemblies **2600**, **2700** described above, and distributed for use in a dual-cap system. Such versatility can reduce manufacturing costs, such as by eliminating tooling costs.

The caps described herein can be formed of, or coated with various colored materials or coatings. In some embodiments, the caps each include the same color. In other embodiments, the caps include different colors. Coloring the caps can, in some instances, provide advantages, such as ready identification of the type of cap, ready matching of a particularly colored cap with a particular type of medical connector, and the like.

The foregoing disclosure recites various embodiments that include systems configured for use with a pair of separated medical connectors. Examples of first means for coupling a male cap with a first medical connector include the connection interfaces **1042**, **1142**, **1342**, **1542**, **1842**, **1942**, **2242**, **2342**, **2642** of the caps **1004**, **1104**, **1304**, **1504**, **1804**, **1904**, **2204**, **2304**, **2304'**, **2604**. Examples of first means for sterilizing a male luer of a first medical connector include the pads **1070**, **1170**, **1370**, **1570**, **1870**, **2170**, **2270**, **2370**, **2470**, **2670**. Examples of second means for coupling the female cap with a second medical connector include the connection interfaces **1030**, **1130**, **1530**, **1830**, **1930**, **2230**, **2630** of the caps **1002**, **1102**, **1502**, **1802**, **1902**, **2202**, **2602**. Examples of second means for sterilizing at least a portion of a second medical connector include the pads **1032**, **1132**, **1332**, **1532**, **1832**, **2132**, **2632**. Examples of means for coupling the male and female caps in a pre-use configuration include the connection interfaces **1040** and **1042**; **1140** and **1180**; **1240** and **1280**; **1340** and **1380**; **1440** and **1480**; **1540** and **1580**; **1840**, **1891**, **1842**, and **1892**; and **2640**, **2695**, **2680**, and **2692**. Examples of means for sealing a lumen of a male luer include the sealing members **2290**, **2390**, **2490**, **2590**, and **2690**. Examples of means for biasing a means for sealing a lumen of a male luer include the biasing members **2276**, **2376**, **2476**, **2576**, and **2676**.

It will be understood by those having skill in the art that many changes may be made to the details of the above-described embodiments without departing from the underlying principles presented herein. For example, any suitable combination of features of the various embodiments of assemblies described above is contemplated.

Any methods disclosed herein comprise one or more steps or actions for performing the described method. The method steps and/or actions may be interchanged with one another. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order and/or use of specific steps and/or actions may be modified.

It should be appreciated that in the above description of embodiments, various features are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure. This method of disclosure, however, is not to be interpreted as reflecting an intention that any claim require more features than those expressly recited in that claim. Rather, as the following claims reflect, inventive aspects lie in a combination of fewer than all features of any single foregoing disclosed embodiment. Thus, the claims following this Detailed Description are hereby expressly incorporated into this Detailed Description, with each claim standing on its own as a separate embodiment. This disclosure includes all permutations of the independent claims with their dependent claims.

Recitation in the claims of the term "first" with respect to a feature or element does not necessarily imply the existence of a second or additional such feature or element. Elements recited in means-plus-function format are intended to be construed in accordance with 35 U.S.C. §112 ¶6. It will be apparent to those having skill in the art that changes may be made to the details of the above-described embodiments without departing from the underlying principles of the invention.

What is claimed is:

1. A method of disinfecting a male luer connector of the type including a post having a lumen through which fluid flows, the method comprising:

providing a male-disinfecting cap including

a receiving portion having a sidewall defining a chamber into which the post of the male luer connector can be received;

a biasing member disposed in the chamber;

a sealing member disposed in the chamber; and

an antiseptic agent disposed in the chamber; and

moving the cap in relation to the male luer connector so that (i) the post is received into the chamber, (ii) the biasing member urges the sealing member toward the post to cover the lumen and maintain the sealing member against the lumen, and, (iii) while the sealing member covers the lumen so as to inhibit at least the antiseptic agent from entering the lumen, at least a portion of the antiseptic agent is caused to come into contact with the post.

2. A method according to claim **1**, wherein the sealing member is configured to permit the flow of the antiseptic agent past the sealing member to the post.

3. A method according to claim **2**, wherein the sealing member includes at least one channel near its periphery.

4. A method according to claim **1**, further comprising providing a pad disposed in the chamber abutting the sealing member, the pad containing the antiseptic.

5. A method according to claim **1**, further comprising providing a cover disposed over an opening of the chamber.

6. A method according to claim **5**, wherein the cover comprises an impervious pliable material.

7. A method according to claim **6**, wherein the impervious pliable material is a foil.

8. A method according to claim **1**, wherein a portion of the sidewall of the receiving portion has a taper that narrows toward an interior of the chamber.

9. A method according to claim **8**, wherein the taper is near an opening of the chamber.

10. A method according to claim **8**, further comprising engaging the post against the taper of the sidewall.

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