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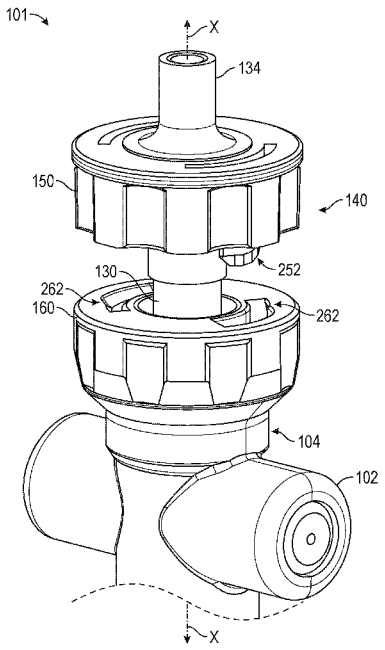


FIG. 2A

(57) Abstract: Disclosed herein are vascular access systems with dilator locking mechanisms, and associated devices and methods. In some embodiments, the dilator locking mechanisms include a first cap coupled to a dilator component and a second cap coupled to the vascular access system. The first cap can include one or more locking members. The second cap can include one or more locking features, each configured to be releasably coupled to one of the locking members. In operation, the dilator component can be inserted into the vascular access system, and at least a portion of one or more of the locking members can be aligned with and inserted into the corresponding locking feature to, e.g., couple the first cap and the second cap. The interaction between first and second caps when coupled can at least partially prevent the dilator from moving relative to the vascular access system.

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CLOT TREATMENT SYSTEMS WITH DILATOR LOCKING MECHANISMS, AND ASSOCIATED DEVICES AND METHODS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 63/307,766 filed February 8, 2022, and titled "CLOT TREATMENT SYSTEMS WITH DILATOR LOCKING MECHANISMS, AND ASSOCIATED DEVICES AND METHODS," which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present technology generally relates to vascular access systems, such as clot treatment systems, including locking mechanisms for releasably locking a dilator to a catheter to facilitate their joint navigation through a patient's skin, tissue, and vasculature.

BACKGROUND

[0003] Thrombosis is the local coagulation or clotting of the blood in a part of the circulatory system, and a thrombus is a blood clot formed in situ within the vascular system. A venous thrombus is a blood clot that forms within a vein. A common type of venous thrombosis is a deep vein thrombosis (DVT), which is the formation of a blood clot within a deep vein (e.g., predominantly in the legs). Nonspecific signs of a thrombosis may include pain, swelling, redness, warmness, and engorged superficial veins.

[0004] If the thrombus breaks off (embolizes) and flows towards the lungs, it can become a life-threatening pulmonary embolism (PE) (e.g., a blood clot in the lungs). In addition to the loss of life that can arise from PE, DVT can cause significant health issues such as post thrombotic syndrome, which can cause chronic swelling, pressure, pain, and ulcers due to valve and vessel damage. Further, DVT can result in significant health-care costs either directly or indirectly through the treatment of related complications and inability of patients to work.

[0005] Existing methods for treating DVT and PE often involve treating the DVT or PE with a catheter system that is advanced through the patient's vasculature, such as along a venous access path. Such catheter systems—especially those having a large size (e.g., greater than 16 French)—often include a dilator component that is inserted through a catheter and used to

dilate the vasculature while the catheter is navigated to a target treatment site. Similarly, such systems are often used in conjunction with an introducer sheath that acts as a resealable access point through which the DVT and PE catheter systems can traverse to easily access the vasculature. The introducer sheath provides a stable tract and prevents excessive manipulation of devices with the access site, and can be inserted through the skin and tissue tract with a dilator component interested therein.

[0006] However, during advancement of a catheter through the vasculature, the dilator component and/or the catheter can experience considerable force or resistance from the patient's vasculature. Similarly, during insertion of an introducer sheath, the dilator component and/or the introducer sheath can experience considerable force or resistance from the patient's skin and tissue. In some instances, the force against the dilator component can cause the dilator component to retract or backslide within the catheter/introducer sheath. If the dilator retracts far enough, the edge of the catheter/introducer sheath can be exposed and may cause damage to a percutaneous access site or the vasculature of the patient.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Many aspects of the present technology can be better understood with reference to the following drawings. The components in the drawings are not necessarily to scale. Instead, emphasis is placed on illustrating clearly the principles of the present disclosure.

[0008] Figure 1 is a partially schematic side view of a vascular access system including a cap assembly and configured in accordance with the present technology.

[0009] Figure 2A–2C are a partially-exploded isometric view, a side cross-sectional view, and an enlarged view, respectively, of the cap assembly of Figure 1 in accordance with embodiments of the present technology.

[0010] Figures 3A–3C are a perspective view, a cross-sectional view, and a bottom view, respectively, of a first cap of the cap assembly of Figure 1 in accordance with embodiments of the present technology.

[0011] Figures 4A–4C are a perspective view, a cross-sectional view, and a bottom view, respectively, of a second cap of the cap assembly of Figure 1 in accordance with embodiments of the present technology.

[0012] Figures 5A and 5B are respective bottom views of the cap assembly of Figure 1 in accordance with embodiments of the present technology.

[0013] Figures 6A–6C are top views of respective second caps in accordance with additional embodiments of the present technology.

[0014] Figure 7 is a top view of a second cap in accordance with additional embodiments of the present technology.

[0015] Figure 8 is a perspective view of a cap-locking valve in accordance with embodiments of the present technology.

DETAILED DESCRIPTION

[0016] The present technology is generally directed to vascular access systems with dilator locking mechanisms, and associated devices and methods. In some of the embodiments described in detail below, a dilator locking mechanism includes a first cap coupled to a dilator and a second cap coupled to a catheter (e.g., an aspiration catheter, an introducer/access sheath) of, for example, a clot treatment system. The first cap can include one or more locking members, and the second cap can include one or more locking features corresponding to one or more of the locking members. Each of the locking members (first cap) can be aligned with and inserted at least partially into the corresponding locking feature (second cap) to, for example, couple the first cap to the second cap. Because the first cap is coupled to the dilator, the interaction between the first and second caps when coupled can secure the dilator relative to the catheter to inhibit or even prevent the dilator from moving proximally and/or distally relative to the catheter.

[0017] In some embodiments, the locking features are configured to deflect the locking members into a locked position when the locking members are inserted therein. In these and other embodiments, the first cap can be rotated relative to the second cap (and/or the second cap rotated relative to the first cap) to move the locking members from the locked position to an unlocked position to uncouple the dilator locking mechanism and allow the dilator to move relative to the catheter of the vascular access system.

[0018] Current dilator locking mechanisms may involve a direct connection between the associated dilator and vascular access system. For example, such locking mechanisms may require that the dilator be fully advanced through the clot treatment system and then rotated to secure the dilator. With this style of mechanism, it may be difficult for an operator to distinguish (e.g., visually) between situations where the dilator is (i) fully inserted into and secured to the clot treatment system and (ii) fully inserted into but not secured to the clot

treatment system. In contrast to these current mechanisms, the dilator locking mechanisms of the present technology can be located at or near a proximal end of the clot treatment system, such that a user of the clot treatment system (e.g., a physician) can easily observe the first and second caps to determine whether the dilator is secured to the clot treatment system by observing the relative positions and/or alignment of the first and second caps.

[0019] Certain details are set forth in the following description and in Figures 1–8 to provide a thorough understanding of various embodiments of the present technology. In other instances, well-known structures, materials, operations, and/or systems often associated with intravascular procedures, clot removal procedures, catheters, and the like are not shown or described in detail in the following disclosure to avoid unnecessarily obscuring the description of the various embodiments of the technology. Those of ordinary skill in the art will recognize, however, that the present technology can be practiced without one or more of the details set forth herein, and/or with other structures, methods, components, and so forth.

[0020] The terminology used below is to be interpreted in its broadest reasonable manner, even though it is being used in conjunction with a detailed description of certain examples of embodiments of the technology. Indeed, certain terms may even be emphasized below; however, any terminology intended to be interpreted in any restricted manner will be overtly and specifically defined as such in this Detailed Description section.

[0021] The accompanying Figures depict embodiments of the present technology and are not intended to be limiting of its scope unless expressly indicated. The sizes of various depicted elements are not necessarily drawn to scale, and these various elements may be enlarged to improve legibility. Component details may be abstracted in the Figures to exclude details such as position of components and certain precise connections between such components when such details are unnecessary for a complete understanding of how to make and use the present technology. Many of the details, dimensions, angles and other features shown in the Figures are merely illustrative of particular embodiments of the disclosure. Accordingly, other embodiments can have other details, dimensions, angles and features without departing from the present technology. In addition, those of ordinary skill in the art will appreciate that further embodiments of the present technology can be practiced without several of the details described below.

[0022] With regard to the terms "distal" and "proximal" within this description, unless otherwise specified, the terms can reference a relative position of the portions of a catheter

subsystem with reference to an operator and/or a location in the vasculature. Also, as used herein, the designations "rearward," "forward," "upward," "downward," and the like are not meant to limit the referenced component to a specific orientation. It will be appreciated that such designations refer to the orientation of the referenced component as illustrated in the Figures; the systems of the present technology can be used in any orientation suitable to the user.

[0023] Figure 1 is a partially schematic side view of a vascular access system 100 ("the system 100") configured in accordance with embodiments of the present technology. The system 100 can also be referred to as an aspiration assembly, a clot treatment system, a clot removal system, a thrombectomy system, an introducer sheath assembly, and/or the like. In the illustrated embodiment, the system 100 includes a tubing assembly 110 fluidly coupled to a catheter 120 via a valve 102. In some embodiments, the catheter 120 is an elongate member configured to be inserted into and through a patient's vasculature and used to, for example, treat clot material therein. In other embodiments, the catheter 120 can be an introducer sheath configured to be inserted through the skin and tissue tract of the patient to provide an access site through which other components (e.g., other catheters used to treat clot material) can traverse to easily access the vasculature. Accordingly, while referred to as "catheter 120," the catheter 120 can comprise an introducer sheath, an access sheath, and/or another type of elongate member configured to be inserted through the skin and tissue tract and/or to traverse the vasculature of a patient. In general, the system 100 (i) can include features generally similar or identical to those of the clot treatment systems described in detail in U.S. Patent Application No. 16/536,185, filed August 8, 2019, and titled "SYSTEM FOR TREATING EMBOLISM AND ASSOCIATED DEVICES AND METHODS," which is incorporated herein by reference in its entirety, and/or (ii) can be used to treat/remove clot material from a patient (e.g., a human patient) using any of the methods described in detail therein.

[0024] In the illustrated embodiment, the catheter 120 includes a proximal region or portion 122 and a distal tip region or portion 124 opposite the proximal region 122. The catheter 120 further defines a lumen 121 (shown in dashed-line in Figure 1) extending entirely therethrough from the proximal region 122 to the distal tip region 124. The lumen 121 and/or the catheter 120 can at least partially define a longitudinal axis X of the system 100. The proximal region 122 can include a proximal terminus 126 of the catheter 120, and the distal tip region 124 can include a distal terminus 128 of the catheter 120.

[0025] The valve 102 is fluidly coupled to the lumen 121 of the catheter 120 and can be integral with or coupled to the proximal region 122 of the catheter 120 such that these components move together. In some embodiments, the valve 102 is a hemostasis valve that is configured to maintain hemostasis during a clot removal procedure by preventing fluid flow in a proximal direction P through the valve 102 as various components such as dilators, delivery sheaths, pull members, guidewires, interventional devices, other aspiration catheters, and so on are inserted through the valve 102 to be delivered through the catheter 120 to a treatment site in a blood vessel. In the illustrated embodiment, for example, a dilator 130 is inserted through the valve 102 and positioned within the catheter 120. The valve 102 includes a branch or side port 106 configured to fluidly couple the lumen 121 of the catheter 120 to the tubing assembly 110. In some embodiments, the valve 102 can be a valve of the type disclosed in U.S. Patent Application No. 16/117,519, filed August 30, 2018, and titled "HEMOSTASIS VALVES AND METHODS OF USE," which is incorporated herein by reference in its entirety.

[0026] In the illustrated embodiment, the tubing assembly 110 fluidly couples the catheter 120 to a pressure source 108, such as a syringe. The pressure source 108 can be configured to generate (e.g., form, create, charge, build-up) a vacuum (e.g., negative relative pressure) and store the vacuum for subsequent application to the catheter 120 (e.g., after the dilator 130 has been removed from the catheter 120). The tubing assembly 110 can include one or more tubing sections 112 (individually labeled as a first tubing section 112a and a second tubing section 112b), at least one fluid control device 114 (e.g., a valve), and at least one connector 116 (e.g., a Toomey tip connector) for fluidly coupling the tubing assembly 110 to the pressure source 108 and/or other suitable components. In some embodiments, the fluid control device 114 is a stopcock that is fluidly coupled to (i) the side port 106 of the valve 102 via the first tubing section 112a and (ii) the connector 116 via the second tubing section 112b. The fluid control device 114 is externally operable by a user to regulate the flow of fluid therethrough and, specifically, from the lumen 121 of the catheter 120 to the pressure source 108. In some embodiments, the connector 116 is a quick-release connector (e.g., a quick disconnect fitting) that enables rapid coupling/decoupling of the catheter 120 and the fluid control device 114 to/from the pressure source 108.

[0027] In the illustrated embodiment, the dilator 130 is inserted through the valve 102 in a distal direction D and extends fully through the lumen 121 and past the distal terminus 128 of the catheter 120, such that a distal tip 132 (e.g., an atraumatic tip) of the dilator 130 is positioned beyond the distal terminus 128 of the catheter 120. The dilator 130 and the system

100 can together define a catheter or introducer assembly 101 that can be inserted into a patient (e.g., a human patient) during a clot treatment procedure. For example, the dilator 130 and the system 100 can be inserted into and advanced together through a blood vessel of the patient to a target location in the blood vessel. The dilator 130 can then be retracted proximally (e.g., in the proximal direction P) through the system 100 to allow for other intravascular medical devices to be introduced into the patient via the system 100 and/or for aspiration of the catheter 120. For example, in some embodiments the system 100 and/or the catheter assembly 101 can be used in any of the clot removal procedures disclosed in U.S. Patent Application No. 16/536,185, filed August 8, 2019, and titled "SYSTEM FOR TREATING EMBOLISM AND ASSOCIATED DEVICES AND METHODS," which is incorporated herein by reference in its entirety.

[0028] The catheter assembly 101 can include a locking mechanism or cap assembly 140 (which can also be referred to as a locking cap assembly, a dilator locking mechanism, a dilator coupling mechanism, and/or the like) configured to releasably couple and secure the dilator 130 to the system 100. The cap assembly 140 can lock the dilator 130 to the valve 102 and the catheter 120 to inhibit or even prevent the dilator 130 from moving within the catheter 120 in the proximal direction P and/or the distal direction D when the catheter assembly 101 is advanced through the vasculature of a patient. More specifically, for example, the cap assembly 140 can inhibit or even prevent the distal tip 132 of the dilator 130 from moving proximally toward the distal terminus 128 of the catheter 120 when the catheter assembly 101 is advanced through the vasculature of the patient.

[0029] In the illustrated embodiment, the cap assembly 140 includes (i) a first or proximal cap 150 coupled to or integrally formed with the dilator 130 (via, e.g., a coupling element or luer connector 134) opposite the distal tip 132 and (ii) a second or distal cap 160 coupled to a proximal portion 104 of the valve 102. The first cap 150 can be releasably coupled/locked to the second cap 160. Accordingly, inserting the dilator 130 into the catheter 120 can include moving the first cap 150 toward the second cap 160. In some embodiments, the first cap 150 can mate with the second cap 160 to lock the dilator 130 to the valve 102 when the dilator 130 is fully seated within the system 100. In some aspects of the present technology, a user can easily determine the state of the dilator 130 (e.g., how far the dilator 130 is inserted into the catheter 120 and/or whether the dilator 130 is secured to the system 100) by viewing the cap assembly 140. Additional details regarding the cap assemblies of the present technology, including the cap assembly 140, are discussed in detail below with reference to Figures 2A–8.

[0030] During a clot treatment procedure, the catheter assembly 101 can be inserted through the vasculature of a patient (e.g., through an introducer sheath that traverses the skin and tissue of the patient to provide an access site) with the cap assembly 140 locking the dilator 130 to the valve 102 and the catheter 120. When the catheter 120 is positioned at a desired position relative to clot material (e.g., a pulmonary embolism, deep vein thrombosis) within the patient, the cap assembly 140 can be unlocked and the dilator 130 withdrawn from the catheter 120. Then, a user can first close the fluid control device 114 before generating a vacuum in the pressure source 108 by, for example, withdrawing the plunger of a syringe coupled to the connector 116. In this manner, a vacuum is charged within the pressure source 108 (e.g., a negative pressure is maintained) before the pressure source 108 is fluidly connected to the lumen 121 of the catheter 120. To aspirate the lumen 121 of the catheter 120, the user can open the fluid control device 114 to fluidly connect the pressure source 108 to the catheter 120 and thereby apply or release the vacuum stored in the pressure source 108 to the lumen 121 of the catheter 120. Opening of the fluid control device 114 instantaneously or nearly instantaneously applies the stored vacuum pressure to the tubing assembly 110 and the catheter 120, thereby generating a suction pulse throughout the catheter 120 that can aspirate the clot material into the catheter 120. In particular, the suction is applied at the distal tip region 124 of the catheter 120 to suck/aspirate at least a portion of the clot material proximate the distal tip region 124 into the lumen 121 of the catheter 120. In other embodiments, where the catheter 120 is an introducer sheath, the introducer assembly 101 can be inserted through the skin and tissue of a patient and partially into a vessel to provide an access point for other medical instruments.

[0031] Figure 2A is a partially-exploded isometric view of cap assembly 140 of Figure 1 in accordance with embodiments of the present technology. In the illustrated embodiment, the cap assembly 140 is in an unlocked position in which the first cap 150 is not secured to the second cap 160 such that the dilator 130 is free to move relative to the valve 102 and the catheter 120 (Figure 1). The first cap 150 can include one or more coupling or locking members 252 extending (e.g., downwardly, distally, and/or toward the second cap 160) in a direction parallel or generally parallel to the longitudinal axis X. In the illustrated embodiment, the first cap 150 includes two of the locking members 252 (one of the locking members 252 is obscured in Figure 2A) positioned on opposite sides of the first cap 150 (e.g., 180-degrees apart). The second cap 160 can include one or more coupling or locking features 262 that extend through the second cap 160 at least partially about the longitudinal axis X. In the illustrated embodiment, the locking members 252 are projections and the locking features 262

are corresponding grooves or openings. In other embodiments, the first cap 150 can include more or fewer of the locking members 252 and/or the second cap 160 can include more or fewer of the locking features 262. For example, the first cap 150 can include one or more than two of the locking members 252, and the second cap 160 can include the same number of the locking features 262. In the illustrated embodiment, the first cap 150 and the second cap 160 have circular shapes. In other embodiments, the first cap 150 and/or the second cap 160 can have a triangular, square, rectangular, rectilinear, curvilinear, or any other suitable shape. In at least some embodiments, the first cap 150 and the second cap 160 can have a same shape. In other embodiments, the first cap and the second cap can have different shapes.

[0032] Each of the locking members 252 can be relatively flexible and configured to undergo elastic or generally elastic deformations. Additionally, each of the locking features 262 can be configured (e.g., shaped and sized) to bend or deflect the corresponding locking members 252 inwardly (toward the longitudinal axis X) to facilitate locking/coupling of the first cap 150 to the second cap 160. In the illustrated embodiment, individual ones of the locking features 262 are configured (e.g., shaped, sized, positioned) to releasably receive a corresponding one of the locking members 252. In general, to secure (e.g., couple, lock) the first cap 150 to the second cap 160, the locking members 252 can be at least partially aligned with and inserted into the corresponding locking features 262. Once inserted, the outward bias of the locking members 252 can cause the locking members 252 to engage the corresponding locking features 262 (and/or another portion of the valve 102) to secure the first cap 150 to the second cap 160. In some embodiments, aligning the locking members 252 with the corresponding locking features 262 can include rotating the first cap 150 (e.g., about the longitudinal axis X) relative to the second cap 160.

[0033] In operation, inserting the dilator 130 into the valve 102 and the catheter 120 includes moving the first cap 150 toward the second cap 160. While moving the dilator 130 through the valve 102, the user can rotate the first cap 150 such that individual ones of the locking members 252 are at least partially aligned with the corresponding ones of the locking features 262. With the locking members 252 and the corresponding locking features 262 in this orientation, the user can bring the first cap 150 into contact with the second cap 160 to insert the locking members 252 into the corresponding locking features 262 and secure the first cap 150 to the second cap 160.

[0034] More specifically, Figure 2B is a side cross-sectional view of the cap assembly 140 of Figure 2A in accordance with embodiments of the present technology. Figure 2C is an enlarged view of a region 2C of Figure 2B in accordance with embodiments of the present technology. The cap assembly 140 is in a locked position in Figures 2B and 2C in which the first cap 150 is secured to the second cap 160 such that the dilator 130 is locked in position relative to the valve 102 and the catheter 120 (Figure 1). Referring to Figures 2B and 2C together, each of the locking features 262 of the second cap 160 can include a channel or slot 264 defined at least partially by a first or inner wall 263 and a second or outer wall 265 spaced radially apart from the inner wall 263. In the locked position shown in Figures 2B and 2C, the locking members 252 are inserted into the corresponding locking features 262 such that at least a portion of the locking members 252 are positioned in the slots 264 of the corresponding locking features 262 between the inner wall 263 and the outer wall 265.

[0035] Referring to Figure 2B, in some embodiments the second cap 160 includes an opening 261 sized, positioned, and/or otherwise configured to allow the dilator 130 to pass through the second cap 160. The first cap 150 is secured to the dilator 130 and can include an opening 251 configured to receive the dilator 130 and a connected or integral luer connector 134. In the illustrated embodiment, for example, the opening 251 is at least partially defined by one or more luer coupling members 253. Each of the luer coupling members 253 can be positioned radially inward relative to one or more of the locking members 252. Additionally, each of the luer coupling members 253 can be generally flexible and configured to undergo elastic or generally elastic deformations. The luer connector 134 can include a first or distal flange 236 and a second or proximal flange 238 opposite and spaced apart from the distal flange 236. The dilator 130 and the luer connector 134 can be inserted through the opening 251 such that the distal flange 236 contacts individual ones of the luer coupling members 253 to cause the luer coupling members 253 to bend or deflect radially outward away from the luer connector 134. Once the distal flange 236 has moved distally past the luer coupling members 253, the luer coupling members 253 can return to their original (e.g., unbent) configuration, as shown in Figure 2B. With the luer connector 134 and the luer coupling members 253 in the respective positions shown in Figure 2B, at least a portion of the first cap 150 (e.g., the luer coupling members 253) can be positioned between the distal flange 236 and the proximal flange 238 to secure the dilator 130 to the first cap 150. In other embodiments, the dilator 130 can be secured to the first cap 150 in other manners.

[0036] Referring to Figure 2C, each of the locking features 262 in the second cap 160 can further include a first surface 266 (which can also be referred to as a proximal, deflecting, angled, and/or insertion surface) and a second surface 268 (which can also be referred to as a distal, retaining, and/or locking surface). The second surface 268 can extend from the outer wall 265 toward the inner wall 263 in an inward direction perpendicular or generally perpendicular to the inner and/or outer walls 263, 265. The first surface 266 can extend upwardly at an incline from the second surface 268 and away from the inner wall 263, to, for example, form an acute interior angle with the second surface 268. In other embodiments, the first and second surfaces 266, 268 can be positioned on the inner wall 263 opposite the outer wall 265, or have any other suitable configuration.

[0037] Each of the locking members 252 can include a tab 254. Each tab 254 can be positioned at or near a distal end of the associated locking members 252. In the illustrated embodiment, the tab 254 extends outward and/or perpendicularly from the associated locking member 252 (e.g., toward the outer wall 265). In other embodiments, one or more of the tabs 254 can extend inward from the associated locking member 252 (e.g., toward the inner wall 263), or in any other suitable direction. The tab 254 can define a stopping or retaining surface 256. When the first cap 150 is coupled to the second cap 160, as shown in Figure 2C, the retaining surface 256 is at least partially aligned with and/or parallel to the second surface 268. The alignment of the retaining surface 256 with the second surface 268 can prevent, or at least partially prevent, the first cap 150 from moving (e.g., upwardly and/or proximally) relative to the second cap 160 which, in turn, can couple or "lock" the first cap 150 and the second cap 160 to one another. In Figure 2C, the retaining surface 256 and the second surface 268 are shown as being spaced apart for the sake of illustration; those of ordinary skill in the art will understand that, in other embodiments, at least part of the retaining surface 256 can contact at least part of the second surface 268 to prevent, or at least partially prevent, the first cap 150 from moving relative to the second cap 160.

[0038] Referring to Figures 2A–2C together, to couple the dilator 130 to the valve 102, a user can position the locking members 252 of the first cap 150 such that the tabs 254 are at least partially aligned with the slots 264 of the second cap 160 and/or contacting the first surfaces 266 of the corresponding locking features 262. The user can then move the first cap 150 toward the second cap 160 to cause the tabs 254 to translate along the corresponding first surfaces 266 inwardly in a first direction D1 (Figure 2C; e.g., toward the longitudinal axis X in Figure 2A). The movement of the tabs 254 in the first direction D1 can cause a corresponding

bend or deflection in the locking members 252. Continued movement of the first cap 150 toward the second cap 160 can move the tabs 254 past the corresponding first surfaces 266; once past the first surfaces 266, the locking members 252 can move in a second direction D2 (Figure 2C; e.g., away from the longitudinal axis X in Figure 2A) opposite the first direction D1. The movement of the locking members 252 in the second direction D2 can be due at least partially to the elastic or generally elastic deformation properties of the locking members 252. As the locking members 252 move in the second direction D2, each of the retaining surfaces 256 can be at least partially aligned with the second surface 268 of the corresponding locking features 262 to secure the first cap 150 and the second cap 160. That is, the tabs 254 can be advanced past and snap inward behind the corresponding second surfaces 268, which retain the tabs 254 and the first cap 150 in the locked position, e.g., as described previously herein.

[0039] Figures 3A–3C are a perspective view, a cross-sectional view, and a bottom view, respectively, of the first cap 150 in accordance with embodiments of the present technology. Referring to Figures 3A–3C together, the first cap 150 can have a longitudinal axis Y and, when the first cap 150 is coupled to the valve 102 and the catheter 120 (Figure 1), the longitudinal axis Y can be the same as (e.g., colinear with) the longitudinal axis X (Figures 1 and 2A). In the illustrated embodiment, the first cap 150 is bilaterally and/or radially symmetric relative to the longitudinal axis Y. In other embodiments, the first cap 150 can be configured to have any other symmetry and/or be asymmetrical. Referring to Figure 3B, each of the locking members 252 can be deflectable at least in the first direction D1 (e.g., outwardly and/or away from the longitudinal axis Y). Each of the luer coupling members 253 can be oppositely deflectable compared to the locking members 252 (e.g., at least in the second direction D2). Each of the locking members 252 and/or the luer coupling members 253 can extend away from an upper surface 357 of the first cap 150 (e.g., downwardly and/or in a direction parallel or generally parallel to the longitudinal axis Y). Referring to Figure 3C, each of the locking members 252 and/or the luer coupling members 253 can be curved or arcuate and extend at least partially around the longitudinal axis Y. In at least some embodiments, the curvature of one or more of the locking members 252 and/or the luer coupling members 253 is concentric with the opening 251.

[0040] Figures 4A–4C are a perspective view, a cross-sectional view, and a bottom view, respectively, of the second cap 160 of the cap assembly 140 of Figure 1 in accordance with embodiments of the present technology. Referring to Figures 4A–4C together, the second cap 160 can have a longitudinal axis Z and when the second cap 160 is coupled to the valve 102

and the catheter 120 (Figure 1), the longitudinal axis Z can be the same as (e.g., colinear with) the longitudinal axis X (Figures 1 and 2A). Additionally, when the first cap 150 (Figures 1–3C) is coupled to the second cap 160, the longitudinal axis Z can be the same as (e.g., colinear with) the longitudinal axis Y (Figures 3A–3C). Each of the locking features 262 and/or one or more of the elements thereof (e.g., the slot 264, the first surface 266, etc.) can be curved or arcuate and extend at least partially around the longitudinal axis Z.

[0041] Referring to Figures 4A and 4B together, each of the locking features 262 can include an axial removal surface 470. Each of the axial removal surfaces 470 can be adjacent to the slot 264, opposite an end wall 469 of the slot 264 and at least partially between the first surface 266 and the inner wall 263. Additionally, each of the axial removal surfaces 470 can be inclined upwardly (e.g., along the longitudinal axis Z and/or toward an upper surface 467 of the second cap 160). Accordingly, when the locking members 252 are positioned in the slots 264, the axial removal surfaces 470 can drive the locking members 252 axially and/or upwardly there along, as described in detail below with reference to Figures 5A and 5B.

[0042] Referring to Figure 4C, each of the locking features 262 can further include a radial removal surface 472. Each of the radial removal surfaces 472 can be positioned at least partially within the associated slot 264 and extend (e.g., downwardly, distally) from the associated second surface 268 (from the perspective shown in Figure 4C, the radial removal surfaces 472 extend away from the page toward the viewer). Additionally, each of the radial removal surfaces 472 can be angled relative to the outer wall 265 and/or the inner wall 263. In the illustrated embodiment, for example, each of the radial removal surfaces 472 extend inward away from the outer wall 265 and toward the inner wall 263 and/or the longitudinal axis Z. Accordingly, when the locking members 252 are positioned in the slots 264 and brought into contact with the radial removal surfaces 472, the radial removal surfaces 472 can drive the locking members 252 inwardly there along, as described in detail below with reference to Figures 5A and 5B.

[0043] The slots 264 can have a slot dimension S defined at least partially by the slot end wall 469 and the axial removal surface 470. The slot dimension S can be an angle, an arc length, or any other suitable dimension. Because the locking members 252 can be inserted along the length of the slot 264, an increased slot dimension S can reduce the difficulty of aligning the first cap 150 with the second cap 160. Additionally, or alternatively, the slot dimension S can at least partially define an amount that the first cap 150 can rotate while at least partially

coupled to the second cap 160. For example, a relatively high slot dimension (e.g., a greater arc length) can correspond to a relatively increased degree of rotation of the first cap 150, and a relatively low slot dimension can correspond to a relatively decreased degree of rotation of the first cap 150.

[0044] Figures 5A and 5B are respective bottom views of the cap assembly of Figure 1 in accordance with embodiments of the present technology. In Figure 5A, the cap assembly 140 is in the locked position with the locking members 252 of the first cap 150 positioned in the corresponding locking features 262 of the second cap 160 such that the first cap 150 is coupled to the second cap 160. In Figure 5B, the cap assembly 140 is in the unlocked position in which the first cap 150 has been rotated in a direction R relative to the second cap 160 and/or about the longitudinal axes Y and/or Z to uncouple the first cap 150 from the second cap 160. In the illustrated embodiment, the direction R is a clockwise direction when viewed from the bottom of the cap assembly 140 (e.g., a counter-clockwise direction when viewed from the top of the cap assembly 140). In other embodiments, the first cap 150 and/or the second cap 160 can be configured such that the direction R is a counter-clockwise direction when viewed from the bottom of the cap assembly 140 (e.g., a clockwise direction when viewed from the top of the cap assembly 140).

[0045] Referring to Figures 5A and 5B together, rotating the first cap 150 in the direction R (Figure 5B) can move the tabs 254 toward the corresponding radial removal surfaces 472 until one or more of the tabs 254 at least partially contact the corresponding radial removal surface 472. In response to the rotation in the direction R, the radial removal surfaces 472 can deflect each of the tabs 254 inward in the direction D1, as shown in Figure 5B. This deflection of the tabs 254 causes a corresponding inward deflection in the associated locking members 252. In some aspects of the present technology, the radial removal surfaces 472 at least partially prevent the first cap 150 from being accidentally or unintentionally disconnected from the second cap 160 until a force (e.g., torque) sufficient to deflect the locking members 252 inward is applied to the first cap 150.

[0046] With the tabs 254 in the position shown in Figure 5B, continued rotation of the first cap 150 in the direction R causes the tabs 254 to contact the corresponding axial removal surfaces 470 (Figures 4A and 4B). Each of the locking members 252 can translate upwardly across the corresponding axial removal surface 470 and cause the first cap 150 to move away from the second cap 160 in a direction generally along the longitudinal axis Z (e.g., to the unlocked

position shown in Figure 2A). Continued rotation of the first cap 150 can fully uncouple the first cap 150 and the second cap 160. However, it will be appreciated that, with the tabs 254 deflected inwardly in the position shown in Figure 5B, the first cap 150 can be moved away from the second cap 160 without further rotation to decouple the first cap 150 from the second cap 160.

[0047] Accordingly, in some aspects of the present technology the locking features 262 include (i) the insertion surface 266 for deflecting one or more of the tabs 254 inward during insertion and/or in response to axial movement, (ii) the radial removal surface 472 for deflecting the tabs 254 inward (e.g., radially inward) during removal and/or in response to rotary movement, and (iii) the axial removal surface 470 for moving the tabs 254 upward (e.g., axially upward) during removal and/or in response to rotary movement. The insertion surface 266 can be positioned to align with the corresponding tab 254 when the cap assembly 140 is in the unlocked position. During insertion, the tab 254 can move toward, contact, and translate inwardly along the insertion surface 266. The radial removal surface 472 can be positioned proximate the tab 254 when the cap assembly 140 is in the locked position. During removal, the tab 254 can move (e.g., rotate) toward, contact, and translate inwardly along the radial removal surface 472. The cap assembly 140 can transition from the locked position toward the unlocked position as the tab 254 translates along the radial removal surface 472. Additionally, the tab 254 can move toward the axial removal surface 470 as it translates along the radial removal surface 472. The axial removal surface 470 can be angled upwardly, away from the radial removal surface 472. Accordingly, during removal, the tab 254 can move (e.g., rotate) toward, contact, and translate upward along the axial removal surface 470. Translating the tab 254 along the axial removal surface 470 can return the cap assembly 140 to the unlocked position.

[0048] Figures 6A–6C are top views of respective second caps in accordance with additional embodiments of the present technology. Each of the second caps 660a-c can be generally similar to the second cap 160 of Figures 1–2C and 4A-5B. However, referring to Figure 6A, the second cap 660a includes a reduced slot dimension S1, such that the second cap 660a does not allow the first cap (not shown) to rotate while remaining coupled to the second cap 660a and/or any rotation of the first cap begins the decoupling process described above. Referring to Figure 6B, the second cap 660b includes an increased slot dimension S2 that allows the first cap (not shown) to rotate up to 60 degrees relative to the second cap 660b while still remaining coupled to the second cap 660b and/or before the rotation of the first cap begins the decoupling

process described above. Referring to Figure 6C, the second cap 660c does not include one or more of inner walls 263 (Figures 2B, 2C, and 4A–4C), such that the opening 661 and one or more of the slots 664 are connected or are otherwise not separated by inner walls.

[0049] Figure 7 is a top view of a second cap 760 configured in accordance with additional embodiments of the present technology. At least some aspects of the second cap 760 can be at least generally similar or identical in structure and/or function to one or more of the second caps 160, 660a-c described in detail previously herein. In the illustrated embodiment, the second cap 760 further includes one or more rotationally agnostic locking features 762 ("locking features 762"). In the illustrated embodiment, each of the locking features 762 includes an outer wall 765 and two radial removal surfaces 772 positioned e.g., on left and right sides of the outer wall 765. The second cap 760 can further include axial removal surfaces 770 positioned on the left and right sides of the locking features 762 and/or aligned with the radial removal surfaces 772 thereof. Accordingly, when a locking member of a first cap (e.g., the locking members 252 of the first cap 150 of Figure 2A) is received within one of the locking features 762, the first cap can be rotated in the direction R or opposite the direction R (e.g., counterclockwise or clockwise) to drive the locking member against one of the radial removal surfaces 772 and uncouple the first cap and the second cap 760. Continued rotation of the first cap can translate the locking members of the first cap along the axial removal surfaces 770. This rotationally agnostic configuration of the locking features 762 is expected to allow the first cap to be quickly and easily uncoupled from the second cap 760. The locking features 762 can be aligned with and/or positioned distally of a respective first surface 766, and the locking members of a first cap (e.g., the locking members 252 of the first cap 150 of Figure 2A) can contact and be driven radially inward by the first surfaces 766 to couple with the locking features 762.

[0050] In some embodiments, the second cap 760 can include one or more support surfaces 774positioned radially inward of one of the first surfaces 766, e.g., between the axial removal surfaces 770 associated with one of the locking features 762. Each of the support surfaces 774 can be configured to contact at least part of a coupling member of a first cap, e.g., after the first cap is coupled/locked to the second cap 760. In some embodiments, one or more of the support surfaces 774 can be curved or concave. Accordingly, when the first cap is coupled to the second cap 760 and/or the coupling members of the first cap contact the support surfaces 774, the curvature/concavity of the support surfaces 774 can at least partially prevent rotation of the

first cap relative to the second cap 760, e.g., in addition to or in lieu of the resistance to rotation of the first cap provided by the radial removal surfaces 772.

[0051] Figure 8 is a perspective view of a cap-locking valve 880 configured in accordance with embodiments of the present technology. The cap-locking valve 880 can include a valve 802 and an integrated locking feature 860. The valve 802 can include at least some aspects that are at least generally similar or identical in structure and/or function to the valve 102 of Figure 1. In at least some embodiments, for example, the valve 802 can be a hemostasis valve that is configured to maintain hemostasis during a clot removal procedure by preventing fluid flow in a proximal direction through the valve 802 as various components such as dilators, delivery sheaths, pull members, guidewires, interventional devices, other aspiration catheters, and so on are inserted through the valve 802.

[0052] The integrated locking feature 860 can be formed in the valve at or near a proximal end of the valve 802 or at another suitable position on/in the valve 802. The integrated locking feature 860 can include at least some aspects that are at least generally similar or identical in structure and/or function to one or more of the second caps 160, 660a-c, 760 described herein. In the illustrated embodiment, for example, the integrated locking feature 860 includes at least some features that are at least generally similar in structure and/or function to the second cap 760 of Figure 7. In other embodiments, the integrated locking feature 860 can have another suitable configuration. In these and other embodiments, the integrated locking feature 860 can be directly integrated into the valve 802 rather than being included in a separate cap or other component releasably couplable to the valve 802.

[0053] Several aspects of the present technology are set forth in the following examples:

1. A cap assembly for a catheter, the cap assembly comprising:

a first cap including a locking member, wherein the locking member includes an end portion and a tab positioned proximate the end portion; and

a second cap including a locking feature, wherein the locking feature includes a slot extending at least partially through the second cap, and wherein—

the first cap is configured to be secured to the second cap in a locked position,

in the locked position, the locking feature is configured to receive the locking member through the slot such that the tab engages a portion of the

second cap to inhibit movement of the first cap relative to the second cap, and

the first cap is configured to rotate relative to the second cap to move the tab out of engagement with the second cap to move the first cap from the locked position to an unlocked position.

2. The cap assembly of example 1 wherein the first cap includes an upper surface, and wherein the locking member extends from the upper surface in a direction generally perpendicular to the upper surface, and wherein the end portion of the locking member is opposite the upper surface.

3. The cap assembly of example 1 or example 2 wherein the tab extends perpendicularly from the locking member.

4. The cap assembly of any one of examples 1–3 wherein the tab defines a retaining surface positioned to contact at least a portion of the second cap when the first cap is coupled to the second cap.

5. The cap assembly of any one of examples 1–4 wherein the locking member is flexible, and wherein the second cap is configured to bend the locking member when the first cap moves between the unlocked position and the locked position.

6. The cap assembly of any one of examples 1–5 wherein the locking feature includes a locking surface positioned to at least partially contact the tab of the locking member when the first cap is coupled to the second cap.

7. The cap assembly of any one of examples 1–6 wherein the locking feature includes an angled insertion surface positioned to engage and deflect the locking member when the first cap moves from the unlocked position toward the locked position.

8. The cap assembly of example 7 wherein the cap assembly includes a longitudinal axis, and where the insertion surface is angled to bend the locking member inward toward the longitudinal axis.

9. The cap assembly of any one of examples 1–8 wherein the locking feature includes a radial removal surface, and wherein the radial removal surface is angled to deflect the tab inward when the first cap is rotated relative to the second cap.

10. The cap assembly of any one of examples 1–9 wherein the locking feature includes an axial removal surface positioned proximate the slot and angled to move the first cap away from the second cap when the first cap is rotated relative to the second cap.

11. The cap assembly of any one of examples 1–10 wherein:

the first cap includes an upper surface, and the locking member extends from the upper surface in a direction perpendicular to the upper surface;

the locking member is flexible and configured to deflect when the first cap moves between the unlocked position and the locked position;

the tab defines a retaining surface positioned to contact at least a portion of the second cap in the locked position; and

the locking feature includes—

a locking surface positioned to at least partially contact the retaining surface of the tab in the locked position,

an insertion surface positioned to be at least partially aligned with the locking member and angled to deflect the locking member inward when the first cap moves from the unlocked position toward the locked position,

a radial removal surface positioned proximate the tab of the locking member in the locked position, wherein the radial removal surface is angled to move the tab radially inward when the first cap moves from the locked position toward the unlocked position, and

an axial removal surface positioned proximate the slot and angled to move the first cap longitudinally away from the second cap when the first cap moves from the locked positioned toward the unlocked position.

12. The cap assembly of any one of examples 1–11 wherein the locking member is a first locking member, wherein the locking feature is a first locking feature, wherein the first cap includes one or more second locking members, wherein the second cap includes one or more second locking features, and wherein individual ones of the second locking members are

configured to receive and secure corresponding ones of the second locking members in the locked position.

13. The cap assembly of any one of examples 1-12 wherein the locking feature is configured to be rotationally agnostic such that rotation of the first cap relative to the second cap in a first direction and a second direction opposite the first direction moves the tab out of engagement with the second cap to move the first cap from the locked position to an unlocked position.

14. A vascular access system, comprising:

a valve having a proximal end and a distal end;

a catheter defining a lumen and coupled to the distal end of the valve, the catheter defining a longitudinal axis of the vascular access system;

a dilator configured to extend at least partially through the valve and the lumen; and

a cap assembly movable between a locked configuration and an unlocked configuration, wherein the cap assembly includes (i) a valve cap connected to the proximal end of the valve and including a coupling feature, and (ii) a dilator cap coupled to the dilator and including a coupling tab insertable into the coupling feature, wherein—

in the locked configuration, the coupling feature is configured to receive the coupling tab such that the coupling tab engages a portion of the valve cap to inhibit movement of the dilator relative to the valve along the longitudinal axis, and

the dilator cap is configured to rotate relative to the valve cap to move the coupling tab out of engagement with the valve cap to move the cap assembly from the locked configuration toward the unlocked configuration.

15. The vascular access system of example 14 wherein the coupling tab is flexible, wherein the coupling feature is configured to deflect the coupling tab toward the longitudinal axis when the cap assembly moves from the unlocked configuration toward the locked configuration.

16. The vascular access system of example 14 or example 15 wherein the dilator cap includes a coupling member extending in a direction generally parallel to the dilator and having a distal end, and wherein the coupling tab is positioned proximate the distal end of the coupling member.

17. The vascular access system of any one of examples 14–16 wherein valve cap has a valve cap longitudinal axis, and wherein the coupling feature is curved circumferentially at least partially about the valve cap longitudinal axis.

18. The vascular access system of any one of examples 14–17 wherein the coupling feature includes a coupling surface positioned to at least partially contact the coupling tab of the dilator cap when the cap assembly is in the locked configuration.

19. The vascular access system of example 18 wherein the coupling feature includes an insertion surface positioned to engage and deflect the coupling tab toward the longitudinal axis when the cap assembly moves from the unlocked configuration toward the locked configuration.

20. The vascular access system of example 19 wherein the insertion surface is positioned proximally from the coupling surface.

21. The vascular access system of example 19 or example 20 wherein the insertion surface forms an acute interior angle relative to the coupling surface.

22. The vascular access system of any one of examples 14–21 wherein the coupling feature includes a radial removal surface configured to move the coupling tab radially inward toward the longitudinal axis when the cap assembly moves from the locked configuration toward the unlocked configuration.

23. The vascular access system of any one of examples 14–22 wherein the coupling feature includes (i) a slot configured to receive the coupling tab, and (ii) an axial removal surface positioned proximate the slot and angled to move the dilator cap away from the valve cap along the longitudinal axis when the dilator cap is rotated relative to the valve cap.

24. The vascular access system of any of examples 14-22 wherein the coupling feature includes an outer wall and a pair of radial removal surfaces positioned on left and right sides of the outer wall, and wherein—

in the locked configuration, the coupling tab is positioned between the pair of radial removal surfaces, and

rotation of the dilator cap in a left or right direction relative to the valve cap moves the cap assembly from the locked configuration toward the unlocked configuration.

25. The vascular access system of any one of examples 14-24 wherein the valve cap is integrally formed with proximal end of the valve.

26. The vascular access system of any one of examples 14-24 wherein the valve cap is releasably coupled to the proximal end of the valve.

27. A method of using a vascular access system, the method comprising:

aligning a first cap of the vascular access system with a second cap of the vascular access system, wherein the first cap is coupled to a dilator of the vascular access system, wherein the second cap is coupled to a catheter of the vascular access system, and wherein aligning the first cap with the second cap includes aligning at a locking member of the first cap with a locking feature of the second cap; and

coupling the first cap to the second cap to inhibit the dilator from moving relative to the catheter of the vascular access system, wherein coupling the first cap to the second cap includes inserting the locking member into the locking feature such that the locking feature drives the locking member past a locking surface of the locking feature, and wherein the locking surface is configured to engage the locking member to inhibit longitudinal movement of the first cap relative to the second cap.

28. The method of example 27 wherein coupling the first cap to the second cap further includes positioning the dilator at least partially within the catheter.

29. The method of example 27 or example 28 wherein coupling the first cap to the second cap further includes inserting the dilator fully through the catheter.

30. The method of any one of examples 27–29 wherein aligning the locking member of the first cap with the locking feature of the second cap includes aligning a tab of the locking member with an insertion surface of the locking feature.

31. The method of example 30 wherein moving the first cap toward the second cap includes (i) positioning the tab of the locking member to contact the insertion surface of the locking feature and (ii) translating the tab across the insertion surface to deflect the tab.

32. The method of any one of examples 27–31, further comprising rotating the first cap relative to the second cap to uncouple the first cap from the second cap after coupling the first cap to the second cap.

33. The method of example 32 wherein rotating the first cap includes translating at least a portion of the locking member across a radial removal surface of the locking feature, wherein the radial removal surface is angled to deflect the locking member when the first cap is rotated relative to the second cap.

34. The method of example 32 or example 33 wherein rotating the first cap includes moving the first cap longitudinally away from the second cap.

35. The method of example 34 wherein moving the first cap away from the second cap includes translating the locking member across an axial removal surface of the locking feature, wherein the axial removal surface is angled to move the first cap away from the second cap as the locking member translates across the axial removal surface.

36. The method of any one of examples 32-35 wherein rotating the first cap relative to the second cap to uncouple the first cap from the second cap includes rotating the first cap in a first direction or a second direction opposite the first direction to uncouple the first cap from the second cap.

[0054] The above detailed descriptions of embodiments of the technology are not intended to be exhaustive or to limit the technology to the precise form disclosed above. Although specific embodiments of, and examples for, the technology are described above for illustrative purposes, various equivalent modifications are possible within the scope of the technology as those skilled in the relevant art will recognize. For example, although steps are presented in a given order, alternative embodiments may perform steps in a different order. The various embodiments described herein may also be combined to provide further embodiments.

[0055] From the foregoing, it will be appreciated that specific embodiments of the technology have been described herein for purposes of illustration, but well-known structures and functions have not been shown or described in detail to avoid unnecessarily obscuring the description of the embodiments of the technology. Where the context permits, singular or plural terms may also include the plural or singular term, respectively.

[0056] Moreover, unless the word "or" is expressly limited to mean only a single item exclusive from the other items in reference to a list of two or more items, then the use of "or" in such a list is to be interpreted as including (a) any single item in the list, (b) all of the items in the list, or (c) any combination of the items in the list. Additionally, the term "comprising" is used throughout to mean including at least the recited feature(s) such that any greater number of the same feature and/or additional types of other features are not precluded. It will also be appreciated that specific embodiments have been described herein for purposes of illustration, but that various modifications may be made without deviating from the technology. Further, while advantages associated with some embodiments of the technology have been described in the context of those embodiments, other embodiments may also exhibit such advantages, and not all embodiments need necessarily exhibit such advantages to fall within the scope of the technology. Accordingly, the disclosure and associated technology can encompass other embodiments not expressly shown or described herein.

CLAIMS

I/We claim:

1. A cap assembly for a catheter, the cap assembly comprising:

a first cap including a locking member, wherein the locking member includes an end portion and a tab positioned proximate the end portion; and

a second cap including a locking feature, wherein the locking feature includes a slot extending at least partially through the second cap, and wherein—

the first cap is configured to be secured to the second cap in a locked position,

in the locked position, the locking feature is configured to receive the locking member through the slot such that the tab engages a portion of the second cap to inhibit movement of the first cap relative to the second cap, and

the first cap is configured to rotate relative to the second cap to move the tab out of engagement with the second cap to move the first cap from the locked position to an unlocked position.

2. The cap assembly of claim 1 wherein the first cap includes an upper surface, and wherein the locking member extends from the upper surface in a direction generally perpendicular to the upper surface, and wherein the end portion of the locking member is opposite the upper surface.

3. The cap assembly of claim 1 wherein the tab extends perpendicularly from the locking member.

4. The cap assembly of claim 1 wherein the tab defines a retaining surface positioned to contact at least a portion of the second cap when the first cap is coupled to the second cap.

5. The cap assembly of claim 1 wherein the locking member is flexible, and wherein the second cap is configured to bend the locking member when the first cap moves between the unlocked position and the locked position.

6. The cap assembly of claim 1 wherein the locking feature includes a locking surface positioned to at least partially contact the tab of the locking member when the first cap is coupled to the second cap.

7. The cap assembly of claim 1 wherein the locking feature includes an angled insertion surface positioned to engage and deflect the locking member when the first cap moves from the unlocked position toward the locked position.

8. The cap assembly of claim 7 wherein the cap assembly includes a longitudinal axis, and where the insertion surface is angled to bend the locking member inward toward the longitudinal axis.

9. The cap assembly of claim 1 wherein the locking feature includes a radial removal surface, and wherein the radial removal surface is angled to deflect the tab inward when the first cap is rotated relative to the second cap.

10. The cap assembly of claim 1 wherein the locking feature includes an axial removal surface positioned proximate the slot and angled to move the first cap away from the second cap when the first cap is rotated relative to the second cap.

11. The cap assembly of claim 1 wherein:

the first cap includes an upper surface, and the locking member extends from the upper surface in a direction perpendicular to the upper surface;

the locking member is flexible and configured to deflect when the first cap moves between the unlocked position and the locked position;

the tab defines a retaining surface positioned to contact at least a portion of the second cap in the locked position; and

the locking feature includes—

a locking surface positioned to at least partially contact the retaining surface of the tab in the locked position,

an insertion surface positioned to be at least partially aligned with the locking member and angled to deflect the locking member inward when the first cap moves from the unlocked position toward the locked position,

a radial removal surface positioned proximate the tab of the locking member in the locked position, wherein the radial removal surface is angled to move the tab radially inward when the first cap moves from the locked position toward the unlocked position, and

an axial removal surface positioned proximate the slot and angled to move the first cap longitudinally away from the second cap when the first cap moves from the locked positioned toward the unlocked position.

12. The cap assembly of claim 1 wherein the locking member is a first locking member, wherein the locking feature is a first locking feature, wherein the first cap includes one or more second locking members, wherein the second cap includes one or more second locking features, and wherein individual ones of the second locking members are configured to receive and secure corresponding ones of the second locking members in the locked position.

13. The cap assembly of claim 1 wherein the locking feature is configured to be rotationally agnostic such that rotation of the first cap relative to the second cap in a first direction and a second direction opposite the first direction moves the tab out of engagement with the second cap to move the first cap from the locked position to an unlocked position.

14. A vascular access system, comprising:

a valve having a proximal end and a distal end;

a catheter defining a lumen and coupled to the distal end of the valve, the catheter defining a longitudinal axis of the vascular access system;

a dilator configured to extend at least partially through the valve and the lumen; and

a cap assembly movable between a locked configuration and an unlocked configuration, wherein the cap assembly includes (i) a valve cap connected to the proximal end of the valve and including a coupling feature, and (ii) a dilator cap coupled to the dilator and including a coupling tab insertable into the coupling feature, wherein—

in the locked configuration, the coupling feature is configured to receive the coupling tab such that the coupling tab engages a portion of the valve cap to inhibit movement of the dilator relative to the valve along the longitudinal axis, and

the dilator cap is configured to rotate relative to the valve cap to move the coupling tab out of engagement with the valve cap to move the cap assembly from the locked configuration toward the unlocked configuration.

15. The vascular access system of claim 14 wherein the coupling tab is flexible, wherein the coupling feature is configured to deflect the coupling tab toward the longitudinal axis when the cap assembly moves from the unlocked configuration toward the locked configuration.

16. The vascular access system of claim 14 wherein the dilator cap includes a coupling member extending in a direction generally parallel to the dilator and having a distal end, and wherein the coupling tab is positioned proximate the distal end of the coupling member.

17. The vascular access system of claim 14 wherein valve cap has a valve cap longitudinal axis, and wherein the coupling feature is curved circumferentially at least partially about the valve cap longitudinal axis.

18. The vascular access system of claim 14 wherein the coupling feature includes a coupling surface positioned to at least partially contact the coupling tab of the dilator cap when the cap assembly is in the locked configuration.

19. The vascular access system of claim 18 wherein the coupling feature includes an insertion surface positioned to engage and deflect the coupling tab toward the longitudinal axis when the cap assembly moves from the unlocked configuration toward the locked configuration.

20. The vascular access system of claim 19 wherein the insertion surface is positioned proximally from the coupling surface.

21. The vascular access system of claim 19 wherein the insertion surface forms an acute interior angle relative to the coupling surface.

22. The vascular access system of claim 14 wherein the coupling feature includes a radial removal surface configured to move the coupling tab radially inward toward the longitudinal axis when the cap assembly moves from the locked configuration toward the unlocked configuration.

23. The vascular access system of claim 14 wherein the coupling feature includes (i) a slot configured to receive the coupling tab, and (ii) an axial removal surface positioned proximate the slot and angled to move the dilator cap away from the valve cap along the longitudinal axis when the dilator cap is rotated relative to the valve cap.

24. The vascular access system of claim 14 wherein the coupling feature includes an outer wall and a pair of radial removal surfaces positioned on left and right sides of the outer wall, and wherein—

in the locked configuration, the coupling tab is positioned between the pair of radial removal surfaces, and

rotation of the dilator cap in a left or right direction relative to the valve cap moves the cap assembly from the locked configuration toward the unlocked configuration.

25. The vascular access system of claim 14 wherein the valve cap is integrally formed with proximal end of the valve.

26. The vascular access system of claim 14 wherein the valve cap is releasably coupled to the proximal end of the valve.

27. A method of using a vascular access system, the method comprising:

aligning a first cap of the vascular access system with a second cap of the vascular access system, wherein the first cap is coupled to a dilator of the vascular access system, wherein the second cap is coupled to a catheter of the vascular access system, and wherein aligning the first cap with the second cap includes aligning at a locking member of the first cap with a locking feature of the second cap; and

coupling the first cap to the second cap to inhibit the dilator from moving relative to the catheter of the vascular access system, wherein coupling the first cap to the

second cap includes inserting the locking member into the locking feature such that the locking feature drives the locking member past a locking surface of the locking feature, and wherein the locking surface is configured to engage the locking member to inhibit longitudinal movement of the first cap relative to the second cap.

28. The method of claim 27 wherein coupling the first cap to the second cap further includes positioning the dilator at least partially within the catheter.

29. The method of claim 27 wherein coupling the first cap to the second cap further includes inserting the dilator fully through the catheter.

30. The method of claim 27 wherein aligning the locking member of the first cap with the locking feature of the second cap includes aligning a tab of the locking member with an insertion surface of the locking feature.

31. The method of claim 30 wherein moving the first cap toward the second cap includes (i) positioning the tab of the locking member to contact the insertion surface of the locking feature and (ii) translating the tab across the insertion surface to deflect the tab.

32. The method of claim 27, further comprising rotating the first cap relative to the second cap to uncouple the first cap from the second cap after coupling the first cap to the second cap.

33. The method of claim 32 wherein rotating the first cap includes translating at least a portion of the locking member across a radial removal surface of the locking feature, wherein the radial removal surface is angled to deflect the locking member when the first cap is rotated relative to the second cap.

34. The method of claim 32 wherein rotating the first cap includes moving the first cap longitudinally away from the second cap.

35. The method of claim 34 wherein moving the first cap away from the second cap includes translating the locking member across an axial removal surface of the locking feature, wherein the axial removal surface is angled to move the first cap away from the second cap as the locking member translates across the axial removal surface.

36. The method of claim 32 wherein rotating the first cap relative to the second cap to uncouple the first cap from the second cap includes rotating the first cap in a first direction or a second direction opposite the first direction to uncouple the first cap from the second cap.

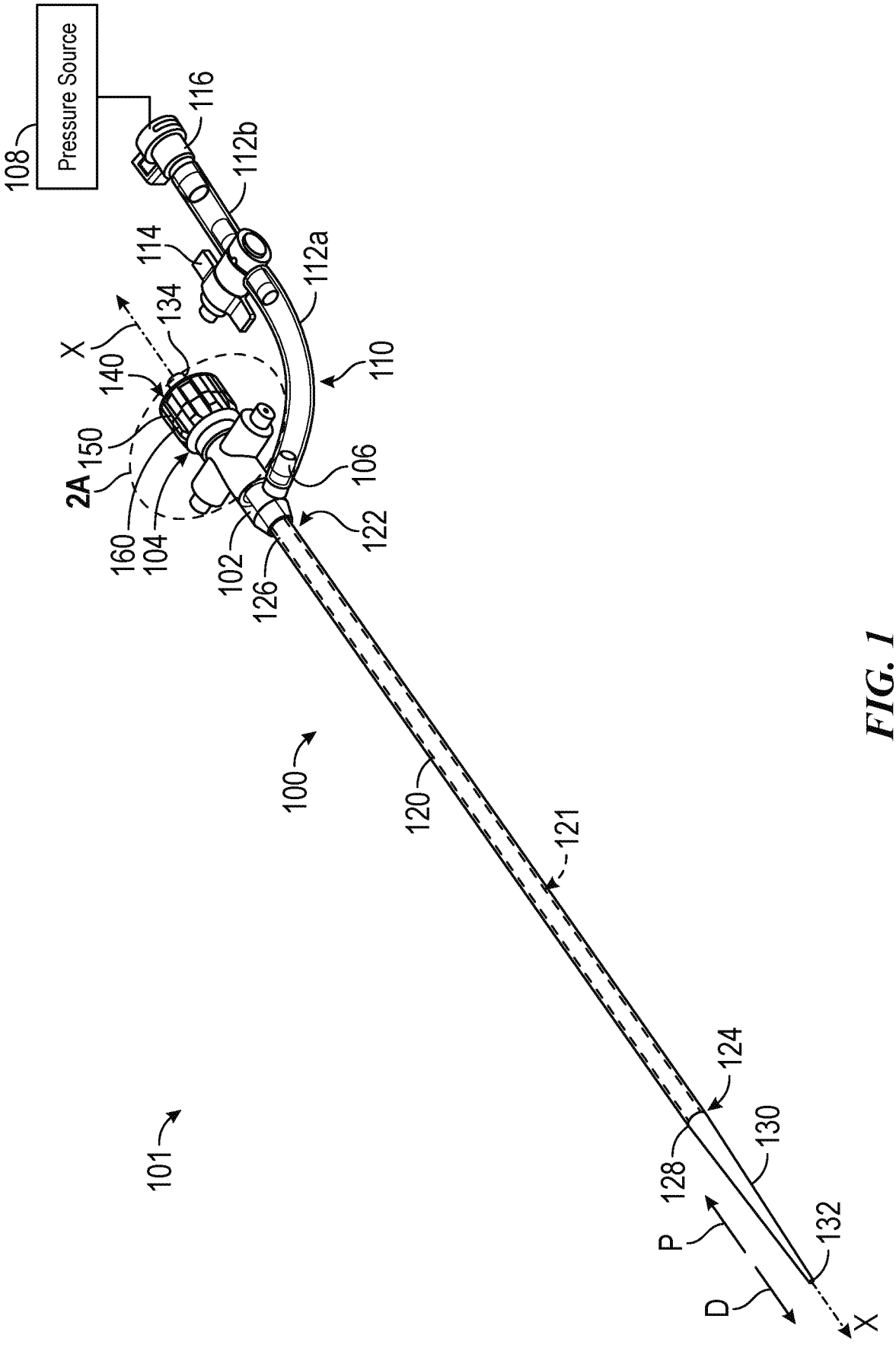

Pressure Source
108
116
112b
114
112a
134
X
140
110
150
2A
106
160
104
122
102
126
100
120
121
124
130
128
132
P
D
X
101

FIG. 1

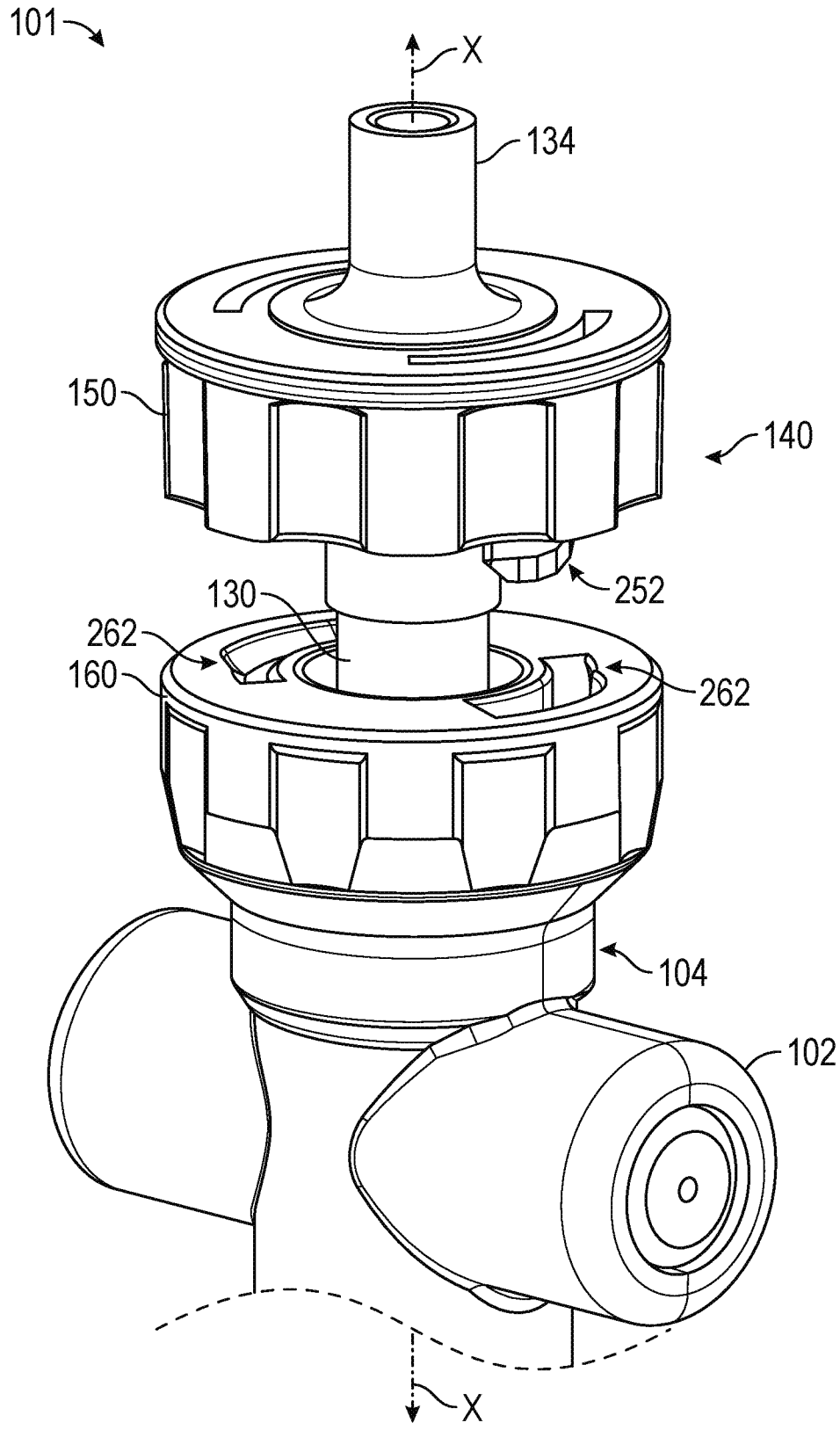


FIG. 2A

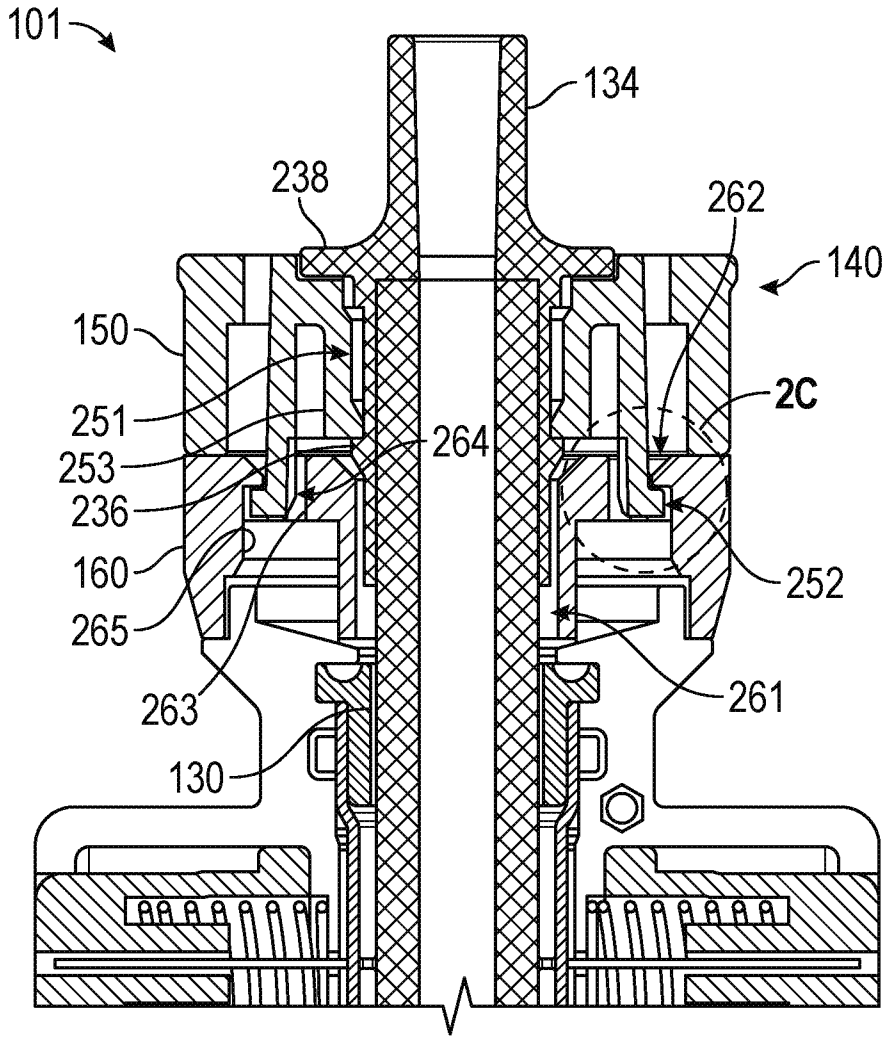

101
134
238
262
140
150
2C
251
264
253
236
252
160
265
261
263
130

FIG. 2B

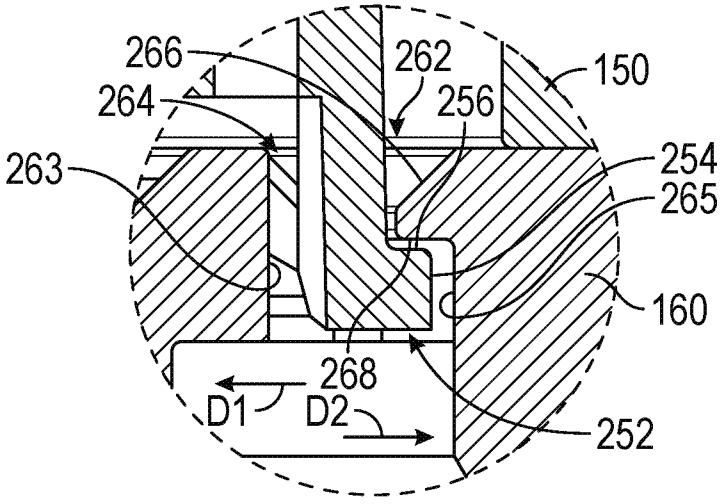

266
262
150
264
256
254
263
265
160
268
D1
D2
252

FIG. 2C

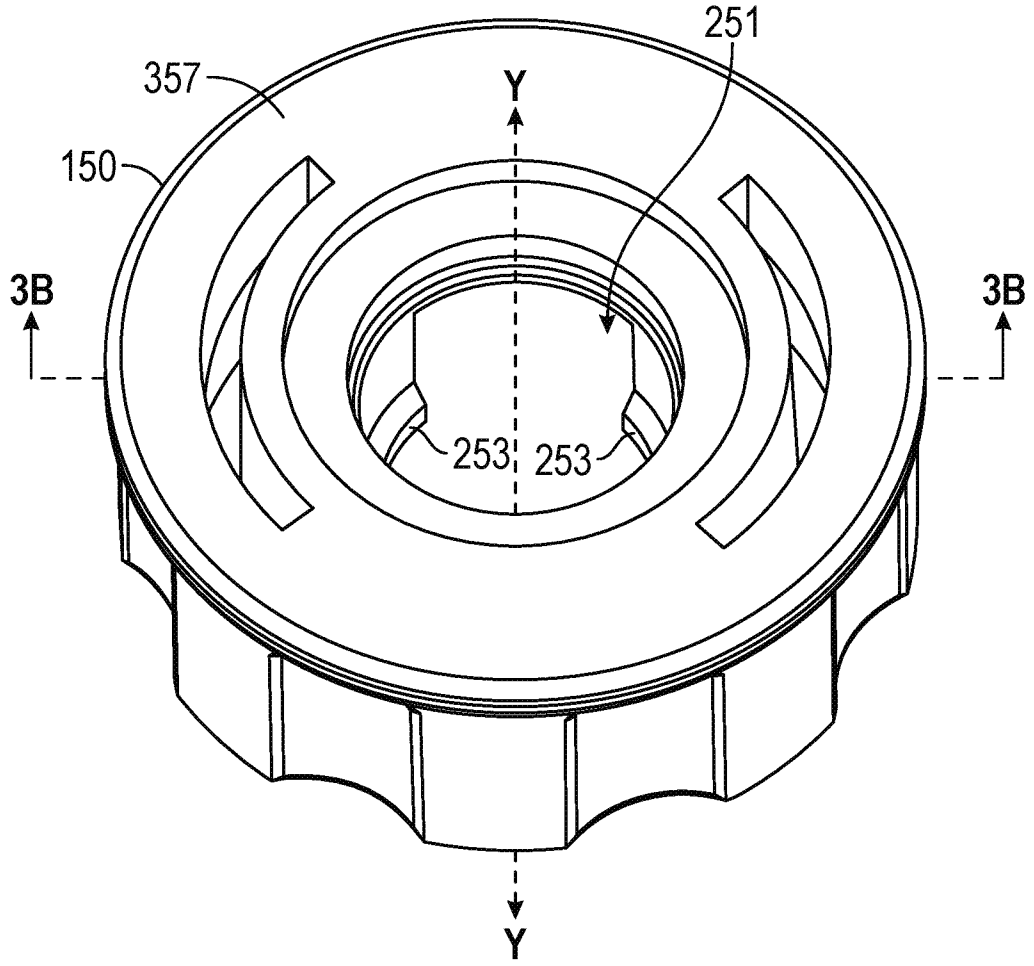

251
357
Y
150
3B
3B
253
253
Y

FIG. 3A

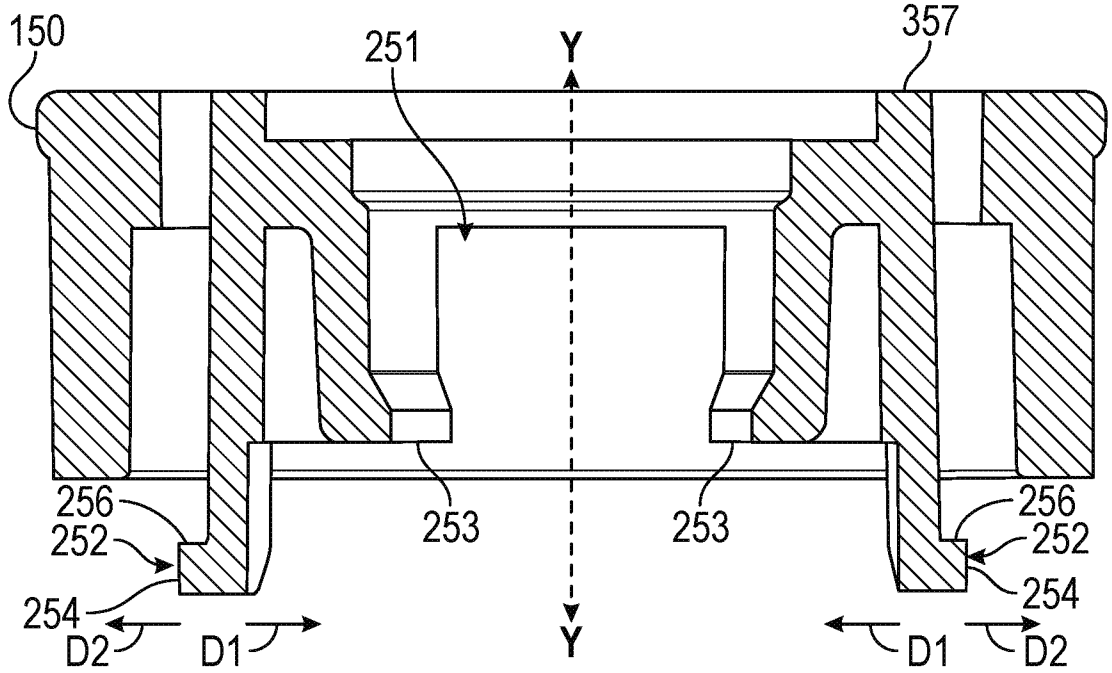

150
251
Y
357
256
252
254
253
253
256
252
254
D2
D1
Y
D1
D2

FIG. 3B

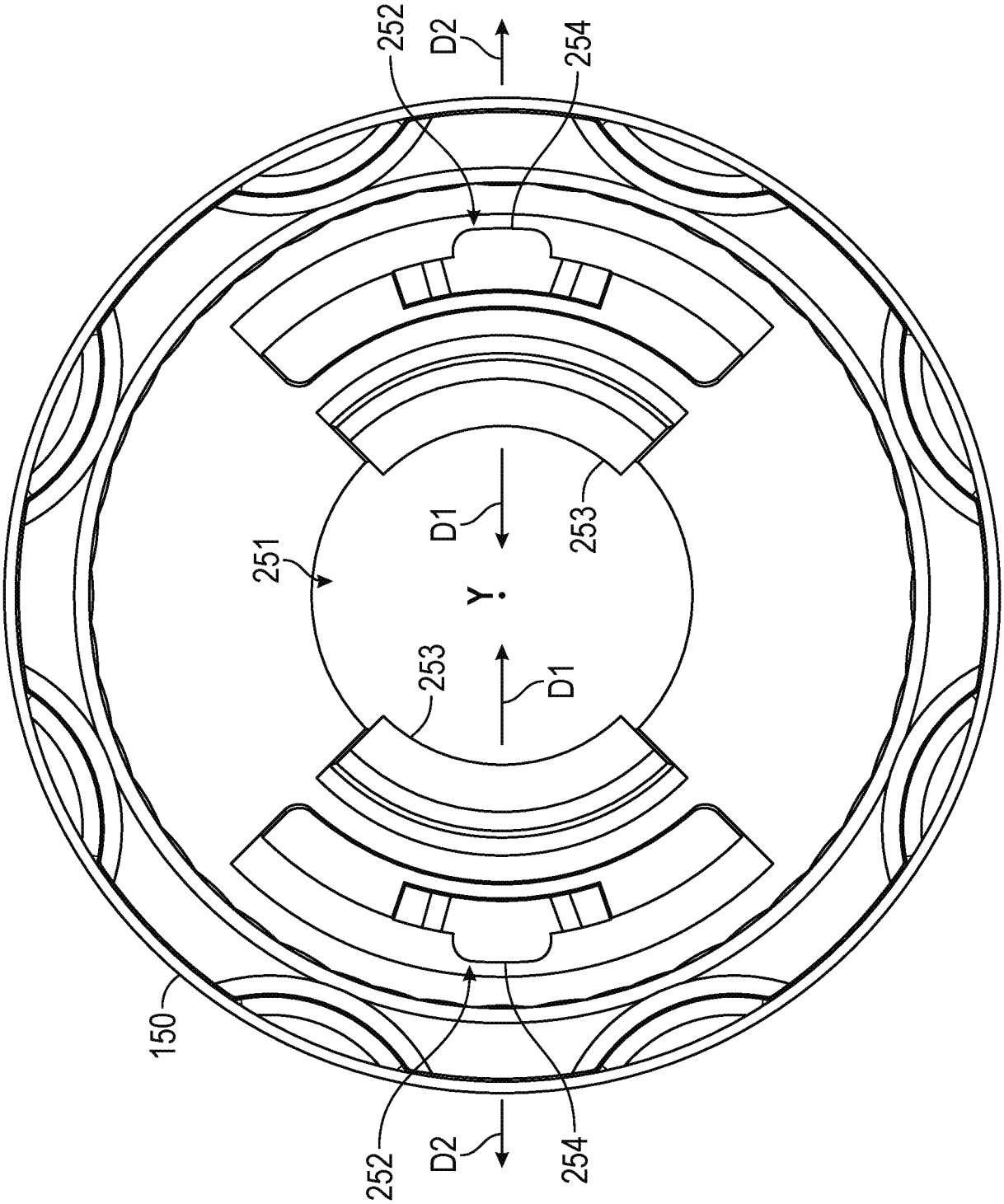


FIG. 3C

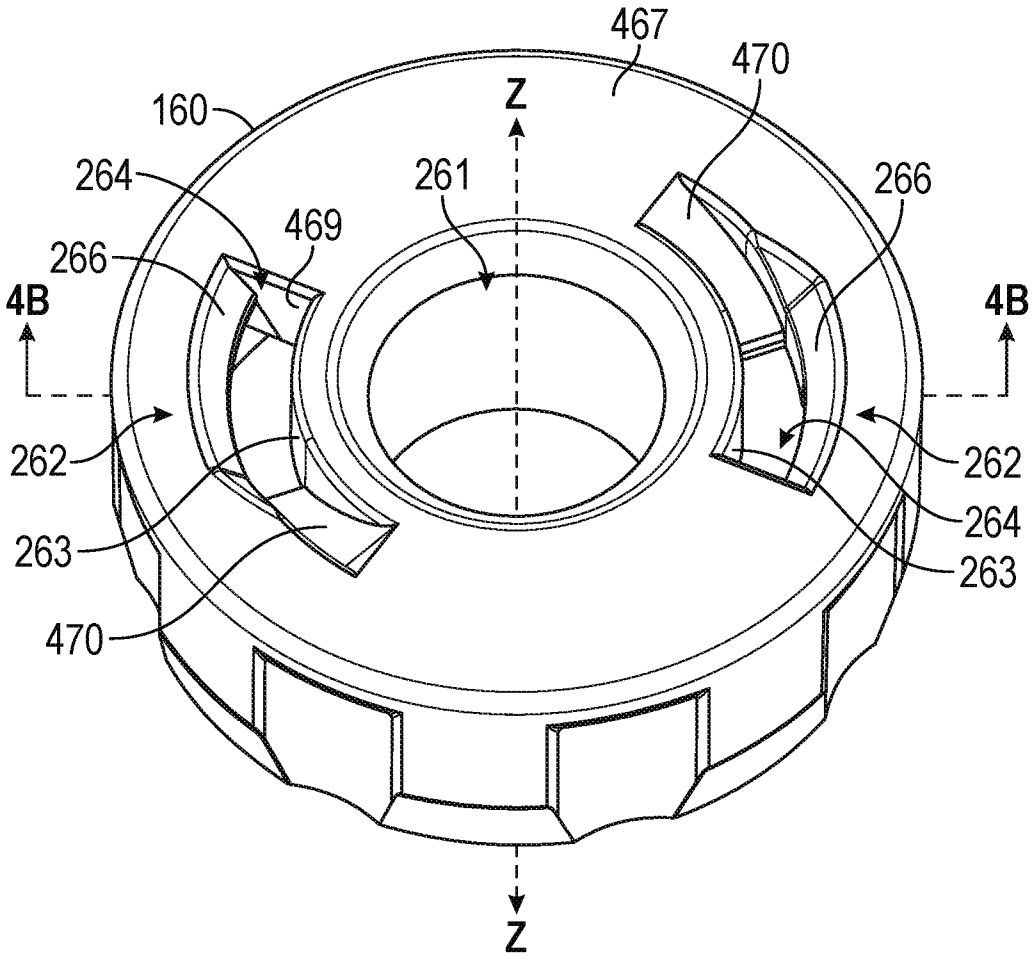

467
470
160
Z
264
261
266
469
266
4B
4B
262
262
264
263
263
470
Z

FIG. 4A

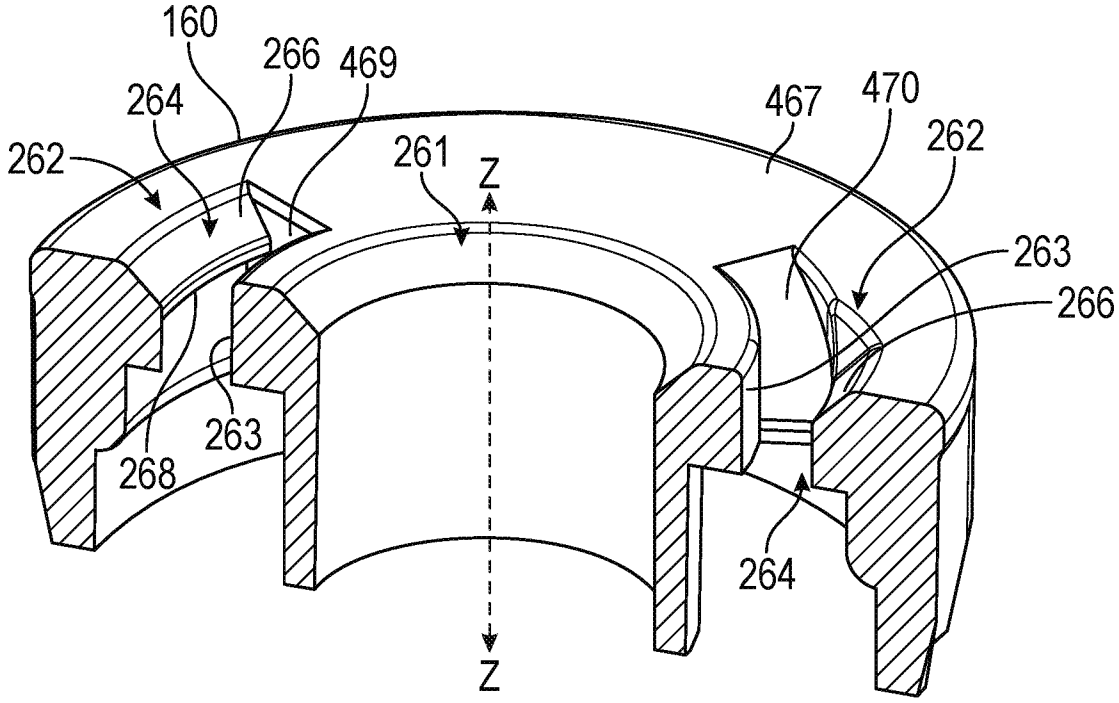

160
266
469
264
467
470
262
262
261
Z
263
266
263
268
264
Z

FIG. 4B

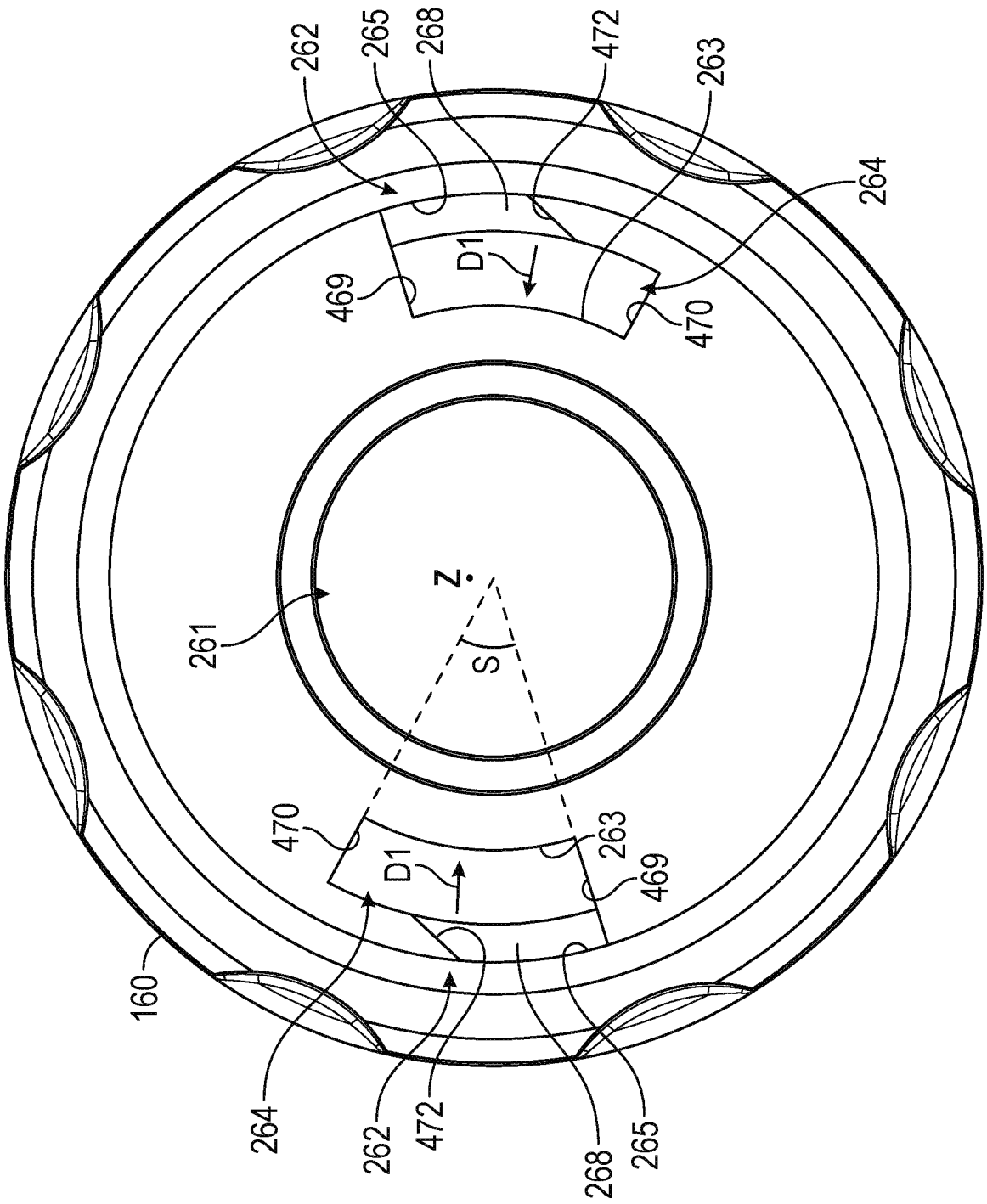

262
265
268
472
263
264
469
D1
470
261
Z
S
470
D1
263
469
160
264
262
472
268
265

FIG. 4C

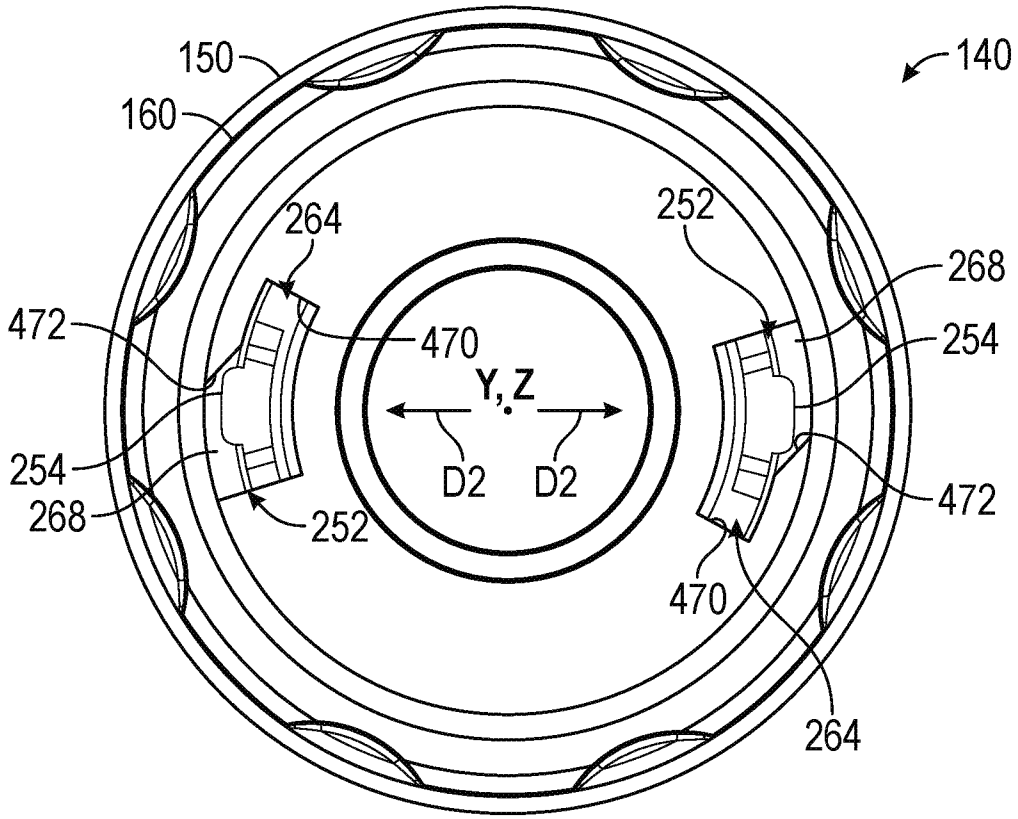

150
160
140
264
252
268
472
470
254
Y, Z
D2
D2
254
268
252
472
470
264

FIG. 5A

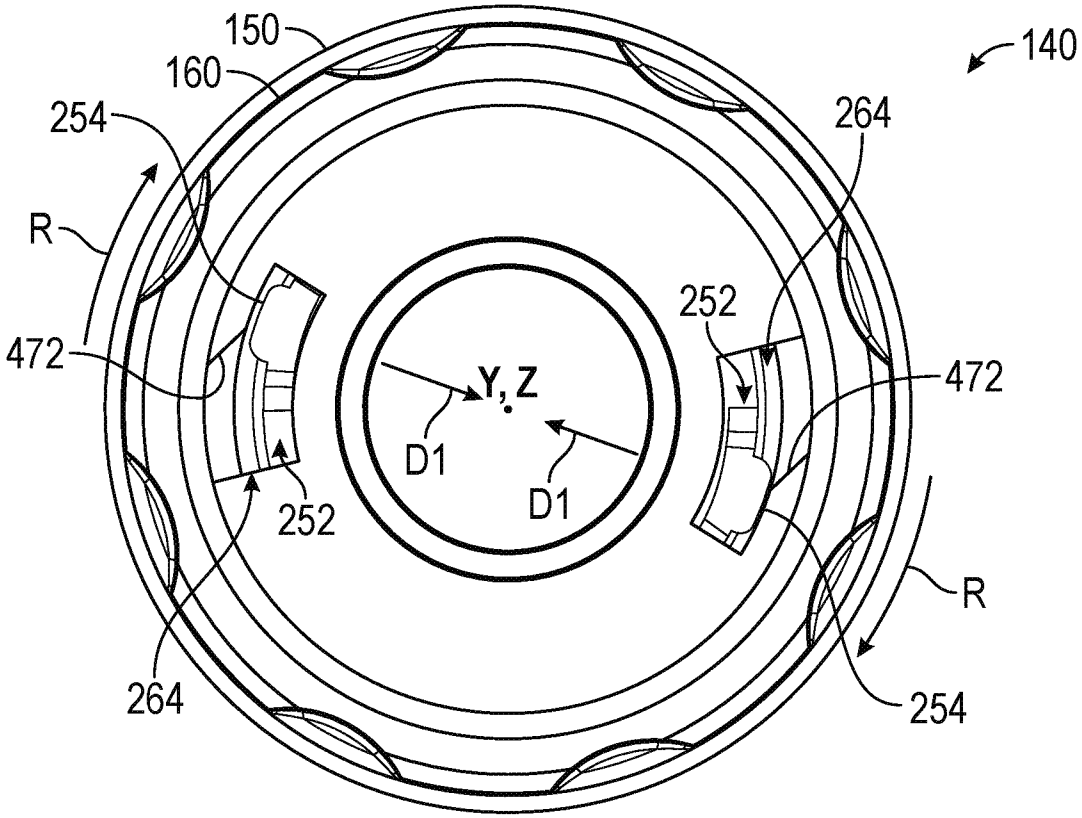

150
160
140
254
264
R
252
472
472
Y, Z
D1
D1
252
R
264
254

FIG. 5B

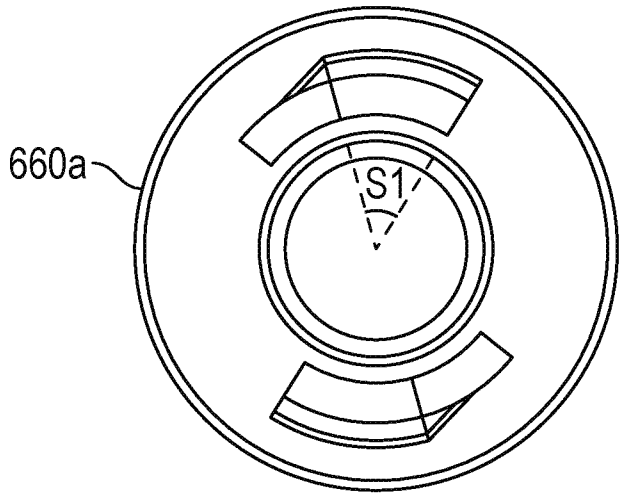


FIG. 6A

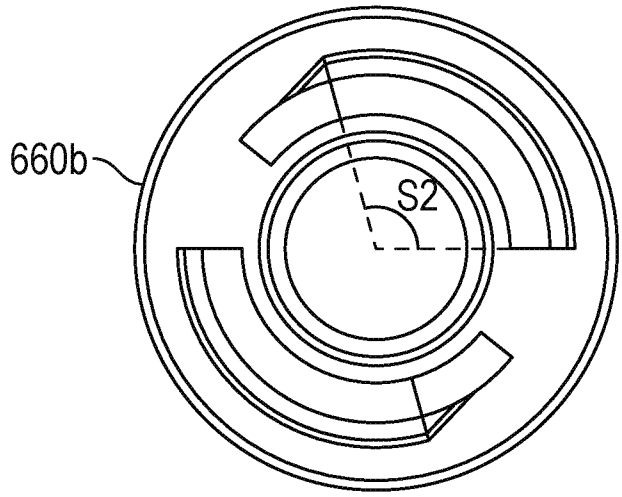


FIG. 6B

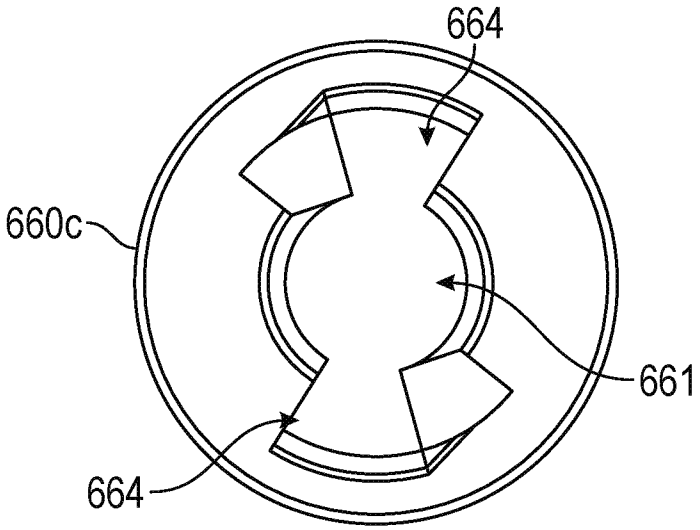


FIG. 6C

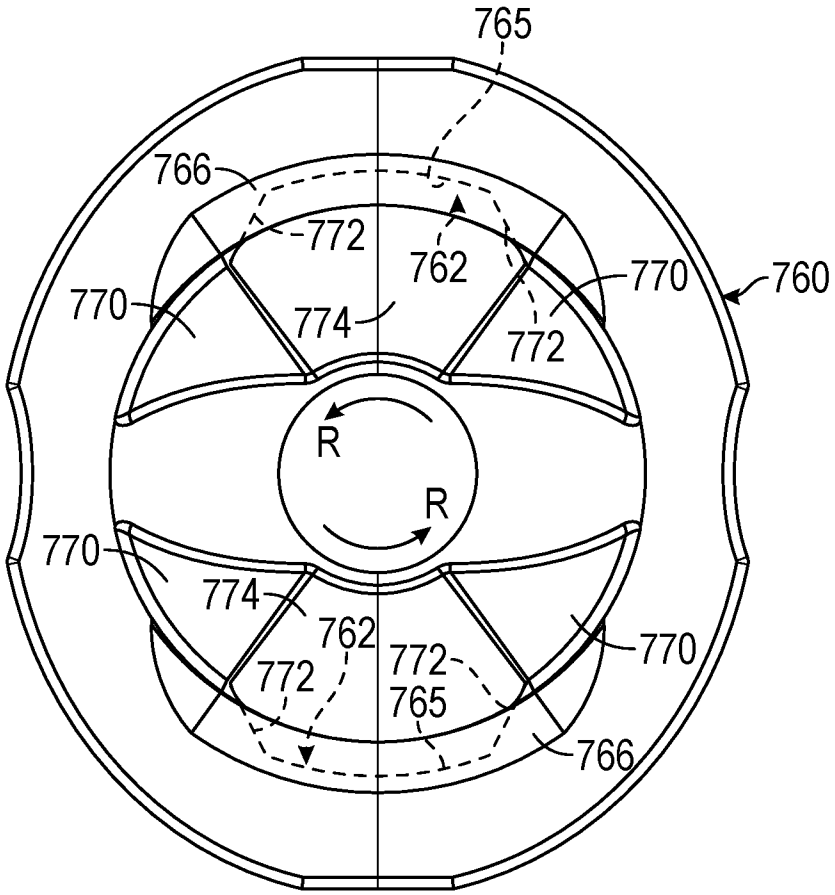

765
766
772
762
770
760
770
774
772
R
R
770
774
762
772
772
765
770
766

FIG. 7

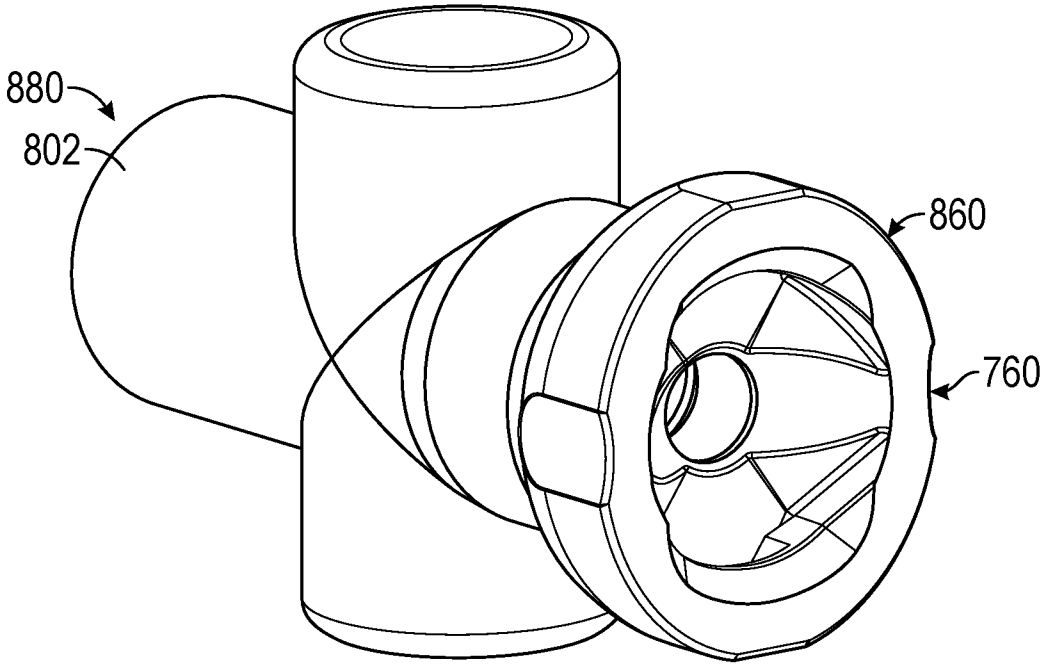

880
802
860
760

FIG. 8