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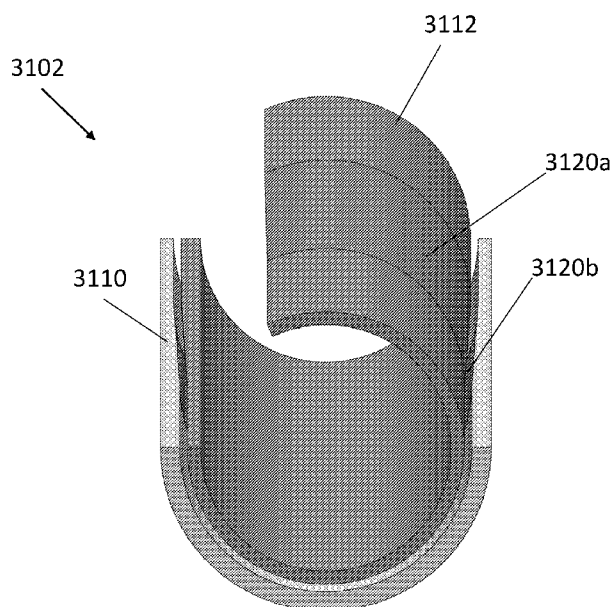


FIG. 30D

(57) Abstract: A dynamic catheter system and methods for use of the dynamic catheter system. The system can comprise a guide catheter, a guide extension catheter positioned within the guide catheter and configured to extend from a distal end of the guide catheter, and a valve (e.g., a hemostatic valve) at a proximal end of the guide catheter. The guide catheter and the guide extension catheter can include varying diameters and wall thicknesses so that an inner diameter of the guide extension catheter can be maximized to receive a variety of different tools or equipment. The system can further include a wire control mechanism configured to separate two or more wires. The wire control mechanism can be integral with or configured to be removably coupled to the valve.



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PATENT

GUIDE CATHETER

[0001] This application claims the priority benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 63/203415, filed July 21, 2021. The entirety of which is hereby incorporated by reference herein.

BACKGROUND

[0002] Embodiments described herein relate to novel dynamic catheter systems and hemostatic valves. The dynamic catheter system can include a guide catheter, a telescoping guide extension catheter, and a catheter control center. In current catheter systems with a guide catheter and a guide extension catheter, the guide extension catheter may reduce the inner diameter of the system such that certain equipment may not be able to pass through the inner diameter of the system. Moreover, current systems may not include a mechanism to easily separate the one or more wires that pass through the catheter control center. Thus, embodiments of the dynamic catheter system can significantly improve the use of the system by addressing these and other issues.

SUMMARY

[0003] In some cases, a dynamic catheter system can comprise a guide catheter and a guide extension catheter. The guide catheter can comprise a first wall. The first wall can comprise a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween. The distal portion can be configured to be positioned within an artery and the proximal end is configured to interact with a valve. A first wall thickness of the first wall can vary from the proximal end to the distal end. The guide extension catheter can comprise a second wall. The second wall can comprise a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween. The guide extension catheter can be positioned within the guide catheter and configured to extend from the distal end of the guide catheter. A second wall thickness of the second wall can vary from the proximal end to the distal end.

[0004] The dynamic catheter system of any preceding paragraphs and/or any of the dynamic catheter system disclosed herein can include one or more of the following features. The variation of the first wall thickness can be inversely related to the variation of the second

wall thickness. The guide catheter can comprise a first transition region comprising a change in the first wall thickness. The guide extension catheter can comprise a second transition region comprising a change in the second wall thickness. The first transition region can be positioned in the middle portion of the guide catheter. The second transition region can be positioned in the middle portion of the guide extension catheter. The first transition region can be positioned in a distal section of the middle portion of the guide catheter. The second transition region can be positioned in a distal section of the middle portion of the guide extension catheter. The first wall thickness can decrease from the maximum wall thickness to the minimum wall thickness in a proximal to distal direction within the first transition region. The second wall thickness can decrease from the maximum wall thickness to the minimum wall thickness in a distal to proximal direction within the second transition region. The first wall thickness can comprise a thickness of between 0.01 mm and 1.0 mm. The first wall thickness can comprise a thickness of between 0.065 mm and about 0.125 mm. The second wall thickness can comprise a thickness of between 0.05 mm and 1.0 mm. The second wall thickness can comprise a thickness of between 0.1 mm and about 0.125 mm. The guide extension catheter can comprise an inner diameter of between 0.50 mm and 2.00 mm. The guide extension catheter can comprise an inner diameter of between 1.60 mm and 1.67 mm. The dynamic catheter system can further comprise an expanded configuration and an unexpanded configuration. The distal portion of the guide extension catheter can extend beyond the distal end of the guide catheter when the dynamic catheter system is in the expanded configuration. The distal end of the guide extension catheter may not extend beyond the distal end of the guide catheter when the dynamic catheter system is in the unexpanded configuration. The second wall thickness of the distal end of the guide extension catheter can comprise a maximum wall thickness. The first wall thickness of the distal end of the guide catheter can comprise a minimum wall thickness. The dynamic catheter system can further comprise a valve and a wire control mechanism. The wire control mechanism can be integrated with the valve. The the wire control mechanism can be configured to be removably coupled to the valve.

[0005] A dynamic catheter system can comprise one or more of the features of the foregoing description. A method of using the dynamic catheter system can comprise one or more features of the foregoing description.

[0006] In some cases, wire control mechanism can comprise a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and a cap configured to engage with the proximal opening of the channel, the cap comprising a first cutout and a second cutout, wherein the cap is configured to uncover and cover the exchange channel without the user removing the two or more wires from the wire control mechanism, wherein each of the first and second cutouts are configured to receive at least one wire of the two or more wires.

[0007] The wire control mechanism of any preceding paragraphs and/or any of the wire control mechanisms disclosed herein can include one or more of the following features. The cap can be configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the cap engages with the proximal opening and covers the exchange channel. The cap can be configured to uncover the exchange channel when the cap is disengaged from the proximal opening so that the user can move the two or more wires between the first portion and the second portion of the proximal opening via the exchange channel. The cap can comprise an open configuration and a closed configuration, wherein the cap is disengaged with the proximal opening and the exchange channel is uncovered when the cap is in the open configuration, and wherein the cap is engaged with the proximal opening and the exchange channel is covered when the cap is in the closed configuration. The first portion of the proximal opening can align with the first cutout of the cap when the cap is engaged with the proximal opening. The second portion of the proximal opening can align with the second cutout of the cap when the cap is engaged with the proximal opening. The distal end can be configured to be removably coupled to a hemostatic valve. The distal end can be configured to be integral with a hemostatic valve.

[0008] A wire control mechanism can comprise one or more of the features of the foregoing description. A method of using the wire control mechanism can comprise one or more features of the foregoing description.

[0009] In some cases, a dynamic catheter system can comprise a hemostatic valve comprising a valve and a wire control mechanism in communication with the valve, the wire control mechanism comprising a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and a cap configured to engage with the proximal opening of the channel, the cap comprising a first cutout and a second cutout, wherein the cap is configured to uncover and cover the exchange channel without the user removing the two or more wires from the wire control mechanism, wherein each of the first and second cutouts are configured to receive at least one wire of the two or more wires.

[0010] The dynamic catheter system of any preceding paragraphs and/or any of the dynamic catheter system disclosed herein can include one or more of the following features. The cap can be configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the cap engages with the proximal opening and covers the exchange channel. The cap can be configured to uncover the exchange channel when the cap is disengaged from the proximal opening so that the user can move the two or more wires between the first portion and the second portion of the proximal opening via the exchange channel. The cap can comprise an open configuration and a closed configuration, wherein the cap is disengaged with the proximal opening and the exchange channel is uncovered when the cap is in the open configuration, and wherein the cap is engaged with the proximal opening and the exchange channel is covered when the cap is in

the closed configuration. The first portion of the proximal opening can align with the first cutout of the cap when the cap is engaged with the proximal opening. The second portion of the proximal opening can align with the second cutout of the cap when the cap is engaged with the proximal opening. The valve can comprise a valve channel configured to align with the central channel of the wire control mechanism. The valve channel can be configured to receive the two or more wires.

[0011] Disclosed herein is a valve system comprising a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion, a second portion, and a third portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel, a first exchange channel, and a second exchange channel, the first and second exchange channels extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the first exchange channel comprises the second portion of the proximal opening and the third exchange channel comprises the third portion of the proximal opening, wherein the first and second exchange channels are configured to allow the two or more wires to be exchanged between the first portion, the second portion, and the third portion of the proximal opening; and a first door and a second door configured to engage with the proximal opening of the channel, wherein the first and second doors are further configured to uncover and cover at least a portion of the first and second exchange channels without a user removing the two or more wires from the wire control mechanism, wherein each of the first, second, and third portions of the proximal opening are configured to receive at least one wire of the two or more wires. The valve system of Claim 44, wherein the valve comprises a hemostasis valve.

[0012] In some implementations, the wire control mechanism forms a single continuous structure. In some implementations, the first door is configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the first door engages with the proximal opening and covers at least a portion of the first exchange channel. In some implementations, the second door is

configured to separate the second portion of the proximal opening from the third portion of the proximal opening and separate the two or more wires when the second door engages with the proximal opening and covers at least a portion of the second exchange channel. In some implementations, the first door is configured to uncover the first exchange channel when the first door is disengaged from the proximal opening allowing the user to move the two or more wires between the first portion and the second portion of the proximal opening via the first exchange channel. In some implementations, the second door is configured to uncover the second exchange channel when the second door is disengaged from the proximal opening allowing the user to move the two or more wires between the second portion and the third portion of the proximal opening via the second exchange channel. In some implementations, the first and second doors comprise an open configuration and a closed configuration, wherein the first and second doors are disengaged with the proximal opening and the first and second exchange channels are uncovered when the first and second doors are in the open configuration, and wherein first and second doors are engaged with the proximal opening and the first and second exchange channels are at least partially covered when the first and second doors are in the closed configuration. In some implementations, the valve comprises a valve channel configured to align with the central channel of the wire control mechanism. In some implementations, valve channel is configured to receive the two or more wires. In some implementations, the first and second doors comprise a rectangular shape. In some implementations, the proximal end comprises one or more hinges, and wherein an end of the first and second doors couples to the one or more hinges.

[0013] Disclosed herein is a dynamic catheter system comprising any of the valve systems disclosed herein, a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with the valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the

guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

[0014] In some implementations, a variation of the first wall thickness is inversely related to a variation of the second wall thickness. In some implementations, the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness. In some implementations, the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter. In some implementations, the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter. In some implementations, the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region. In some implementations, the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

[0015] Disclosed herein is a valve system comprising: a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and a door configured to engage with the proximal opening of the channel, wherein the door is further configured to uncover and cover at least a portion of the exchange channel without a user removing the two or more wires from the wire

control mechanism, wherein the first portion and the second portion of the proximal opening are configured to receive at least one wire of the two or more wires.

[0016] In some implementations, the door is configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the door engages with the proximal opening and covers at least a portion of the exchange channel. In some implementations, the door is configured to uncover the exchange channel when the door is disengaged from the proximal opening allowing the user to move the two or more wires between the first portion and the second portion of the proximal opening via the exchange channel. In some implementations, the door comprises an open configuration and a closed configuration, wherein the door is disengaged with the proximal opening and the exchange channel is uncovered when the door is in the open configuration, and wherein door is engaged with the proximal opening and the exchange channel is at least partially covered when the door is in the closed configuration. In some implementations, the valve comprises a valve channel configured to align with the central channel of the wire control mechanism. In some implementations, the valve channel is configured to receive the two or more wires. In some implementations, the door comprises a rectangular shape. In some implementations, the proximal end comprises one or more hinges, and wherein an end of the door couples to the one or more hinges. In some implementations, the valve and the wire control mechanism form a single continuous structure.

[0017] Disclosed herein is a dynamic catheter system comprising: any of the valve systems disclosed herein; a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with the valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

[0018] Disclosed herein is a valve system comprising: a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween; a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the proximal opening at the proximal end; and a disc configured to engage with the proximal opening of the channel, the disc comprising a cutout defining a first portion, a second portion, and a third portion, wherein the disc is configured to cover at least a portion of the proximal opening, wherein the disc is configured to allow communication between the first portion, the second portion, and the third portion and allow the two or more wires to move between the first portion, the second portion, and the third portion without a user removing the two or more wires from the wire control mechanism, wherein the first, second, and third portions of the cutout are configured to receive at least one wire of the two or more wires.

[0019] In some implementations, a first bridge portion separates the first and second portions of the cutout, and a second bridge portion separates the second and third portions of the cutout. In some implementations, the first and second bridge portions comprise a seal. In some implementations, the second portion of the cutout comprises one or more slits extending from the second portion. In some implementations, the valve comprises a valve channel configured to align with the central channel of the wire control mechanism. In some implementations, the valve channel is configured to receive the two or more wires. In some implementations, the disc comprises a circular shape. In some implementations, the first and third portions of the cutout comprise an arc shape, and wherein the second portion of the cutout comprises a circular shape. In some implementations, the valve and the wire control mechanism form a single continuous structure.

[0020] Disclosed herein is a dynamic catheter system comprising any of the valves disclosed herein; a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide

extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

[0021] In some implementations, a variation of the first wall thickness is inversely related to a variation of the second wall thickness. In some implementations, the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness. In some implementations, the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter. In some implementations, the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter. In some implementations, the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region. In some implementations, the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

[0022] Disclosed herein is a valve system comprising: a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a main portion, a first cutout, and a second cutout, the first and second cutouts extending from the main portion of the proximal opening; a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and a sleeve configured to engage with the distal end, wherein the sleeve is configured to uncover and cover at least a portion of the first and second cutouts, wherein the sleeve is configured to allow communication between the main portion, the first cutout, and the second cutout when the

sleeve uncovers the portion of the first and second cutout and configured to allow the two or more wires to move between the main portion, the first cutout, and the second cutout without a user removing the two or more wires from the wire control mechanism, wherein the main portion, the first cutout, and the second cutout are configured to receive at least one wire of the two or more wires.

[0023] In some implementations, the sleeve includes a first position in which at least a portion of the first and second cutouts are not covered by the sleeve. In some implementations, the sleeve includes a second position in which an end portion of the first and second cutouts is secluded from the main portion of the proximal opening by the sleeve. In some implementations, the sleeve transitions from the first position to the second position by rotating the sleeve along a rotational axis defined by the central channel. In some implementations, the sleeve transitions from the first position to the second position by moving the sleeve along an axial axis defined the central channel. In some implementations, the valve and the wire control mechanism form a single continuous structure.

[0024] Disclosed herein is a dynamic catheter system comprising: any of the valve systems disclosed herein; a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

[0025] In some implementations, a variation of the first wall thickness is inversely related to a variation of the second wall thickness. In some implementations, the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness. In some implementations, the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in

the middle portion of the guide extension catheter. In some implementations, the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter. In some implementations, the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region. In some implementations, the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

[0026] Disclosed herein is a valve system comprising: a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a main portion, a first cutout, and a second cutout, the first and second cutouts extending from the main portion of the proximal opening; a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and a cap comprising a first arm and a second arm and configured to engage with the proximal end, wherein the first and second arms of the cap are configured to uncover and cover at least a portion of the first and second cutouts, wherein the first and second arms are configured to allow communication between the main portion, the first cutout, and the second cutout when the first and second arms uncover the portion of the first and second cutout and configured to allow the two or more wires to move between the main portion, the first cutout, and the second cutout without a user removing the two or more wires from the wire control mechanism, wherein the main portion, the first cutout, and the second cutout are configured to receive at least one wire of the two or more wires. In some implementations, the valve and the wire control mechanism form a single continuous structure.

[0027] Disclosed herein is a dynamic catheter system comprising: any of the valve systems disclosed herein; a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be

positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

[0028] In some implementations, a variation of the first wall thickness is inversely related to a variation of the second wall thickness. In some implementations, the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness. In some implementations, the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter. In some implementations, the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter. In some implementations, the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region. In some implementations, the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

[0029] Disclosed herein is a valve system comprising: a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a main portion and a plurality of cutouts, the plurality of cutouts extending from the main portion of the proximal opening; a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and a plurality of sliding components configured to engage with the plurality of cutouts, wherein the plurality of sliding components are

configured to uncover and cover at least a portion of the plurality of cutouts, wherein the plurality of sliding components are configured to allow communication between the main portion and the plurality of cutouts when the plurality of sliding components uncover the portion of the plurality of cutouts and configured to allow the two or more wires to move between the main portion and the plurality of cutouts without a user removing the two or more wires from the wire control mechanism, wherein the main portion and the plurality of cutouts are configured to receive at least one wire of the two or more wires.

[0030] Disclosed herein is a dynamic catheter system comprising: any of the valve systems disclosed herein; a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

[0031] In some implementations, a variation of the first wall thickness is inversely related to a variation of the second wall thickness. In some implementations, the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness. In some implementations, the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter. In some implementations, the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter. In some implementations, the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region. In some implementations, the second wall thickness decreases from

a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

[0032] Disclosed herein is a valve system comprising: a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel, the exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and a liner configured to engage with the proximal end, the liner comprising a bridge portion at least partially sealing the second portion from the first portion, wherein each of the first and second portions of the proximal opening are configured to receive at least one wire of the two or more wires.

[0033] In some implementations, the liner is partially embedded within a portion of the second portion of the proximal opening. In some implementations, the liner partially covers the second portion of the proximal opening. In some implementations, the bridge portion comprises an opening separating a first segment of the liner and a second segment of the liner. In some implementations, the liner and the valve comprise a single continuous structure. In some implementations, the liner comprises a V-shape. In some implementations, the liner comprises a silicone gel.

[0034] Disclosed herein is a dynamic catheter comprising: any of the valve systems disclosed herein; a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide extension catheter comprising a second wall, the second wall comprising a distal portion

comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

[0035] In some implementations, a variation of the first wall thickness is inversely related to a variation of the second wall thickness. In some implementations, the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness. In some implementations, the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter. In some implementations, the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter. In some implementations, the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region. In some implementations, the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

[0036] Disclosed herein is a valve system comprising: a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel, the exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and an insert configured to engage with the proximal end, the insert comprising a bridge portion at least partially sealing the second portion

from the first portion, wherein each of the first and second portions of the proximal opening are configured to receive at least one wire of the two or more wires.

[0037] In some implementations, the insert is partially embedded within a portion of the second portion of the proximal opening. In some implementations, the insert partially covers the first portion of the proximal opening. In some implementations, the bridge portion comprises an opening separating a first segment of the insert and a second segment of the insert. In some implementations, the insert and the valve comprise a single continuous structure. In some implementations, the insert comprises a circular shape. In some implementations, the insert comprises a silicone gel.

[0038] Disclosed herein is a dynamic catheter comprising: any of the valve systems disclosed herein; a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end. In some implementations, a variation of the first wall thickness is inversely related to a variation of the second wall thickness. In some implementations, the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness. In some implementations, the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter. In some implementations, the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter. In some implementations, the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region. In

some implementations, the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

[0039] Disclosed herein is a wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion, a second portion, and a third portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel, a first exchange channel, and a second exchange channel, the first and second exchange channels extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the first exchange channel comprises the second portion of the proximal opening and the third exchange channel comprises the third portion of the proximal opening, wherein the first and second exchange channels are configured to allow the two or more wires to be exchanged between the first portion, the second portion, and the third portion of the proximal opening; and a first door and a second door configured to engage with the proximal opening of the channel, wherein the first and second doors are further configured to uncover and cover at least a portion of the first and second exchange channels without a user removing the two or more wires from the wire control mechanism, wherein each of the first, second, and third portions of the proximal opening are configured to receive at least one wire of the two or more wires.

[0040] In some implementations, the first door is configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the first door engages with the proximal opening and covers at least a portion of the first exchange channel. In some implementations, the second door is configured to separate the second portion of the proximal opening from the third portion of the proximal opening and separate the two or more wires when the second door engages with the proximal opening and covers at least a portion of the second exchange channel. In some implementations, the first door is configured to uncover the first exchange channel when the first door is disengaged from the proximal opening allowing the user to move the two or more wires between the first portion and the second portion of the proximal opening via the first

exchange channel. In some implementations, the second door is configured to uncover the second exchange channel when the second door is disengaged from the proximal opening allowing the user to move the two or more wires between the second portion and the third portion of the proximal opening via the second exchange channel. In some implementations, the first and second doors comprise an open configuration and a closed configuration, wherein the first and second doors are disengaged with the proximal opening and the first and second exchange channels are uncovered when the first and second doors are in the open configuration, and wherein first and second doors are engaged with the proximal opening and the first and second exchange channels are at least partially covered when the first and second doors are in the closed configuration. In some implementations, the first and second doors comprise a rectangular shape. In some implementations, the proximal end comprises one or more hinges, and an end of the first and second doors couples to the one or more hinges.

[0041] Disclosed herein is a wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and a door configured to engage with the proximal opening of the channel, wherein the door is further configured to uncover and cover at least a portion of the exchange channel without a user removing the two or more wires from the wire control mechanism, wherein the first portion and the second portion of the proximal opening are configured to receive at least one wire of the two or more wires.

[0042] In some implementations, the door is configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the door engages with the proximal opening and covers at least a portion of the exchange channel. In some implementations, the door is configured to uncover the

exchange channel when the door is disengaged from the proximal opening allowing the user to move the two or more wires between the first portion and the second portion of the proximal opening via the exchange channel. In some implementations, the door comprises an open configuration and a closed configuration, wherein the door is disengaged with the proximal opening and the exchange channel is uncovered when the door is in the open configuration, and wherein door is engaged with the proximal opening and the exchange channel is at least partially covered when the door is in the closed configuration. In some implementations, the door comprises a rectangular shape. In some implementations, the proximal end comprises one or more hinges, and wherein an end of the door couples to the one or more hinges.

[0043] Disclosed herein is a wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween; a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the proximal opening at the proximal end; and a disc configured to engage with the proximal opening of the channel, the disc comprising a cutout defining a first portion, a second portion, and a third portion, wherein the disc is configured to cover at least a portion of the proximal opening, wherein the disc is configured to allow communication between the first portion, the second portion, and the third portion and allow the two or more wires to move between the first portion, the second portion, and the third portion without a user removing the two or more wires from the wire control mechanism, wherein the first, second, and third portions of the cutout are configured to receive at least one wire of the two or more wires.

[0044] In some implementations, a first bridge portion separates the first and second portions of the cutout, and a second bridge portion separates the second and third portions of the cutout. In some implementations, the first and second bridge portions comprise a seal. In some implementations, the second portion of the cutout comprises one or more slits extending from the second portion. In some implementations, the disc comprises a circular shape. In some implementations, the first and third portions of the cutout comprise an arc shape, and wherein the second portion of the cutout comprises a circular shape.

[0045] Disclosed herein is a wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length

therebetween, wherein the proximal opening comprises a main portion, a first cutout, and a second cutout, the first and second cutouts extending from the main portion of the proximal opening; a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and a sleeve configured to engage with the distal end, wherein the sleeve is configured to uncover and cover at least a portion of the first and second cutouts, wherein the sleeve is configured to allow communication between the main portion, the first cutout, and the second cutout when the sleeve uncovers the portion of the first and second cutout and configured to allow the two or more wires to move between the main portion, the first cutout, and the second cutout without a user removing the two or more wires from the wire control mechanism, wherein the main portion, the first cutout, and the second cutout are configured to receive at least one wire of the two or more wires.

[0046] In some implementations, the sleeve includes a first position in which at least a portion of the first and second cutouts are not covered by the sleeve. In some implementations, the sleeve includes a second position in which an end portion of the first and second cutouts is secluded from the main portion of the proximal opening by the sleeve. In some implementations, the sleeve transitions from the first position to the second position by rotating the sleeve along a rotational axis defined by the central channel. In some implementations, the sleeve transitions from the first position to the second position by moving the sleeve along an axial axis defined the central channel.

[0047] Disclosed herein is a wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a main portion, a first cutout, and a second cutout, the first and second cutouts extending from the main portion of the proximal opening; a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and a cap comprising a first arm and a second arm and configured to engage with the proximal end, wherein the first and second

arms of the cap are configured to uncover and cover at least a portion of the first and second cutouts, wherein the first and second arms are configured to allow communication between the main portion, the first cutout, and the second cutout when the first and second arms uncover the portion of the first and second cutout and configured to allow the two or more wires to move between the main portion, the first cutout, and the second cutout without a user removing the two or more wires from the wire control mechanism, wherein the main portion, the first cutout, and the second cutout are configured to receive at least one wire of the two or more wires.

[0048] Disclosed herein is a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a main portion and a plurality of cutouts, the plurality of cutouts extending from the main portion of the proximal opening; a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and a plurality of sliding components configured to engage with the plurality of cutouts, wherein the plurality of sliding components are configured to uncover and cover at least a portion of the plurality of cutouts, wherein the plurality of sliding components are configured to allow communication between the main portion and the plurality of cutouts when the plurality of sliding components uncover the portion of the plurality of cutouts and configured to allow the two or more wires to move between the main portion and the plurality of cutouts without a user removing the two or more wires from the wire control mechanism, wherein the main portion and the plurality of cutouts are configured to receive at least one wire of the two or more wires.

[0049] Disclosed herein is a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel, the exchange channel extending radially outward from the central

channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and a liner configured to engage with the proximal end, the liner comprising a bridge portion at least partially sealing the second portion from the first portion, wherein each of the first and second portions of the proximal opening are configured to receive at least one wire of the two or more wires.

[0050] In some configurations, the liner is partially embedded within a portion of the second portion of the proximal opening. In some configurations, the liner partially covers the second portion of the proximal opening. In some configurations, the bridge portion comprises an opening separating a first segment of the liner and a second segment of the liner. In some configurations, the liner comprises a V-shape. In some configurations, the liner comprises a silicone gel.

[0051] Disclosed herein is a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel, the exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and an insert configured to engage with the proximal end, the insert comprising a bridge portion at least partially sealing the second portion from the first portion, wherein each of the first and second portions of the proximal opening are configured to receive at least one wire of the two or more wires.

[0052] In some implementations, the insert is partially embedded within a portion of the second portion of the proximal opening. In some implementations, the insert partially covers the first portion of the proximal opening. In some implementations, the bridge portion comprises an opening separating a first segment of the insert and a second segment of the insert. In some implementations, the insert comprises a circular shape. In some implementations, the insert comprises a silicone gel.

[0053] Disclosed herein is a valve system comprising: a valve; and a wire control mechanism in communication with the valve, the wire control mechanism comprising: a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion; one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and a cap configured to engage with the proximal opening of the channel, the cap comprising a first cutout and a second cutout, wherein the cap is configured to uncover and cover the exchange channel without a user removing the two or more wires from the wire control mechanism, wherein each of the first and second cutouts are configured to receive at least one wire of the two or more wires.

[0054] Disclosed herein is a dynamic catheter system comprising one or more of the features of the foregoing description. Also disclosed herein is a method of using the dynamic catheter system comprising one or more features of the foregoing description. Also disclosed herein is a wire control mechanism comprising one or more of the features of the foregoing description. Also disclosed herein is a method of using the wire control mechanism comprising one or more features of the foregoing description. Also disclosed herein is a dynamic catheter system comprising one or more of the features of the foregoing description for use in interventional cardiology procedures. Also disclosed herein is a method of using the wire control mechanism comprising one or more features of the foregoing description for use

in interventional cardiology procedures. Also disclosed herein is a wire control mechanism comprising one or more of the features of the foregoing description for use in interventional cardiology procedures.

[0055] A dynamic catheter system can comprise one or more of the features of the foregoing description. A method of using the dynamic catheter system can comprise one or more features of the foregoing description.

[0056] Any of the features, components, or details of any of the arrangements or embodiments disclosed in this application, including without limitation any of the guide catheter and guide extension catheter system embodiments disclosed below, are interchangeably combinable with any other features, components, or details of any of the arrangements or embodiments disclosed herein to form new arrangements and embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0057] Various embodiments of the devices and methods of the present disclosure are described herein with reference to the drawings wherein:

[0058] Figure 1 illustrates a guide catheter for use in medical procedures;

[0059] Figures 2A-2B illustrate a guide catheter shaft with telescoping guide extension catheter system;

[0060] Figures 3A-5C illustrate a guide catheter shaft with telescoping guide extension catheter system;

[0061] Figures 6A-6F illustrate a guide catheter with a telescoping guide extension catheter that incorporates a branded wire advancement mechanism;

[0062] Figures 7A-7D illustrate a wire advancement mechanism using a slider mechanism;

[0063] Figures 8A-8D illustrate a wire advancement mechanism using a spool mechanism;

[0064] Figures 9A-9D illustrate a wire advancement mechanism using a contact wheel mechanism;

[0065] Figures 10A-10B illustrate a wire advancement mechanism using a screw mechanism;

[0066] Figures 11A-11D illustrate a wire advancement mechanism using a rack and pinion mechanism;

[0067] Figures 12A-12B illustrate a wire advancement mechanism using a non-contact advancement mechanism;

[0068] Figures 13-16 illustrate examples of handles and/or grips that can be used with the any of the guide extension advancement mechanisms and/or guide catheters;

[0069] Figures 17A-22B illustrate examples of a dynamic catheter system with a guide extension advancement mechanism to actuate a guide extension catheter within the guide catheter;

[0070] Figures 23A-23D illustrate an example of a wire control mechanism;

[0071] Figures 24A-24B illustrate side views of the wire control mechanism shown in Figures 23A-23D attached to a valve of a catheter system;

[0072] Figures 25A-25B illustrate a perspective view and a side view of an example of a wire control mechanism attached to a valve of a catheter system;

[0073] Figures 26A-26B illustrate a proximal view and a distal perspective view of an example of a wire control mechanism attached to a valve of a catheter system;

[0074] Figure 26C illustrates a side view of the example wire control mechanism shown in Figures 26A-26B attached to a valve of a catheter system;

[0075] Figure 27 illustrates example guide catheter shafts with a telescoping guide extension catheter system;

[0076] Figure 28A illustrates a cross-sectional view of an example guide catheter shaft with an example telescoping guide extension catheter system and a side view of a portion of a distal end of the example guide catheter shaft shown in Figure 27;

[0077] Figure 28B illustrates the distal end of the guide catheter shaft shown in Figure 28A;

[0078] Figure 28C illustrates a proximal end of the guide catheter shaft shown in Figure 28A;

[0079] Figure 29A illustrates a cross-sectional view of an example guide catheter shaft with an example telescoping guide extension catheter system and a side view of a portion of a distal end of the example guide catheter shaft shown in Figure 27;

[0080] Figure 29B illustrates the distal end of the guide catheter shaft shown in Figure 29A;

[0081] Figure 29C illustrates a proximal end of the guide catheter shaft shown in Figure 29A;

[0082] Figure 30A illustrates a cross-sectional view of an example guide catheter shaft with an example telescoping guide extension catheter system and a side view of a portion of a distal end of the example guide catheter shaft shown in Figure 27;

[0083] Figure 30B illustrates the distal end of the guide catheter shaft shown in Figure 30A;

[0084] Figure 30C illustrates a proximal end of the guide catheter shaft shown in Figure 30A;

[0085] Figure 30D illustrates a perspective view of a transition section of the guide catheter shaft shown in Figure 30A;

[0086] Figure 30E-30F illustrate cross-sectional views of the guide catheter shaft shown in Figure 30A in different configurations;

[0087] Figures 31A-31D illustrate various views of an example spool system;

[0088] Figures 32A-32C illustrate perspective views of an example anchor system;

[0089] Figures 33-38B illustrate various examples of storage mechanisms for a catheter wire;

[0090] Figures 39-41 illustrate various examples of a failsafe mechanism for a catheter system.

[0091] Figures 42A-42G illustrate an example of a wire control mechanism.

[0092] Figures 43A-43C illustrate an example of a wire control mechanism.

[0093] Figures 44A-44F illustrate an example of a wire control mechanism.

[0094] Figures 45A-45C illustrate an example of a wire control mechanism.

[0095] Figures 46A-46F illustrate an example of a wire control mechanism.

[0096] Figures 47A-47C illustrate an example of a wire control mechanism.

[0097] Figures 48A-48C illustrate an example of a wire control mechanism.

[0098] Figures 49A-49F illustrate an example of a wire control mechanism.

[0099] Figures 50A-50G illustrate an example of a wire control mechanism.

[0100] Figures 51A-51F illustrate an example of a wire control mechanism.

[0101] Figures 52A-52H illustrate an example of a wire control mechanism.

DETAILED DESCRIPTION

[0102] Embodiments described herein relate to a novel dynamic catheter system. The dynamic catheter system can include a guide catheter, a telescoping guide extension catheter, and a catheter control center. The catheter control center can include various elements such as an advancement mechanism, a hemostatic valve, and a wire storage compartment. Devices and methods that can be used to significantly improve use of the guide catheter and guide extension catheter without adding significant manufacturing and/or assembly cost. Embodiments of guide catheter devices and methods can be particularly impactful on accessing vasculature. In addition to coronary vascular procedures, any technology described herein (i.e. novel dynamic catheter system) can be applied to any vascular procedures, including but not limited to neurovascular, renovascular, and other peripheral vascular procedures.

[0103] The dynamic catheter system described herein can eliminate the need to place guide extension catheter during the middle of a procedure. The dynamic catheter system can allow for easier movement of the guide extension catheter. The dynamic catheter system can provide for less wire confusion and wire wrap and the extension wire can be neatly contained within catheter control center and/or advancement mechanism. In some cases, the guide extension catheter can be easy to move forward and preserves tactile feedback and the guide extension wire can avoid wrapping with other wires. The dynamic catheter system can allow for simpler hand placement for the practitioner and can enable more control and ease of use for the practitioner compared to existing guide catheter and guide extension catheter products. The dynamic catheter system creates opportunities to improve the design and performance of guide catheters and guide extension catheters. For example, the dynamic catheter system with the integrated guide extension catheter and/or advancement mechanism can allow for a guide extension catheter tip that can be as soft or softer than existing guide catheter extensions. In some cases, the upgraded guide extension catheters can have an outer surface that allows for easier movement within the guide catheter and vasculature without adding significant manufacture and/or assembly cost. In another example embodiment, the dynamic catheter system can allow for an increased inner diameter of the guide extension catheter to allow for more space for equipment to pass through. Additionally, the integrated

guide extension catheter can allow for easier placement of the guide catheter by creating more stiffness within the guide catheter.

[0104] Current guide catheters can be used to make it easier to enter a vessel with other devices or instruments. Guide catheters can be used to facilitate placement of balloons and stents for angioplasty and stenting or other procedures.

[0105] Current guide extension catheters, separate catheters that are placed within guide catheters, can be used during a medical procedure. Guide extension catheters can be inserted through the catheter past a hemostatic valve and in coordination with other wires or equipment delivered through the catheter. The guide extension catheter can often help as it provides more support to the guide catheter and can make it easier to deliver equipment such as a stent and/or balloon to a target area. Prior to inserting current guide extension catheters, other equipment being used during the procedure might need to be adjusted or removed. The wire portion of the current guide extension catheters, used to advance or withdraw it, can have a uniform cross-sectional shape and also be exiting through the hemostatic valve post-insertion. The uniform cross sectional shape of the wire can be rectangular and bulky (flat wire). As a result, current guide extension catheter wires can be in the way when handling other wires within the guide catheter and challenging to insert during a procedure.

[0106] The procedure for delivering equipment for a percutaneous coronary intervention can include various steps. The radial artery or femoral artery can be accessed and a sheath can be placed. A diagnostic angiogram can be performed using a diagnostic catheter showing a lesion in the particular territory (e.g. mid right coronary artery [RCA]). The diagnostic catheter can be removed and the operator can prepare for percutaneous coronary intervention. A Tuohy-Borst valve or similar hemostatic valve device can be connected to the back of the guide catheter; a manifold is then connected to the hemostatic valve and the guide catheter is flushed. A standard J-tipped guide wire (typically 0.035 to 0.038 inch diameter) can then be fed into the hemostatic valve and guide catheter. The hemostatic valve can be opened slightly to allow the wire to slide in. A wire can be advanced in the vessel to the ascending aorta following with the guide catheter. Once the guide catheter is near the aortic root the wire can be removed and the operator can aspirate and flush the catheter.

[0107] The right coronary artery ostium can be engaged with the guide catheter. A standard 0.014 inch coronary guidewire can be advanced into the hemostatic valve, into the

guide catheter, and advanced beyond the mid RCA lesion to the distal vessel. If the operator is able to, a compliant balloon can be advanced over the coronary guidewire to the lesion and inflated to pre-dilate the lesion. Then the balloon can be removed and the operator can assess that the balloon has adequately expanded the lesion. If able to, the operator can advance a stent to the lesion. However, in some cases, the operator may not be able to deliver equipment due to the calcified and/or tortuous nature of the lesion/vessel or lack of adequate guide catheter support.

[0108] At this point, the operator can insert a guide extension catheter for additional support after first removing the stent (or balloon). After inserting the guide extension catheter over the coronary guidewire, the stent or balloon can then be re-advanced over the coronary guidewire. It is recommended, with existing guide extension catheter devices, the operator slide the guide extension catheter over the shaft of a balloon or stent delivery system in the coronary artery to provide more of a rail and reduce risk of injuring the proximal vessel. In some circumstances, the operator may determine that it is not ideal to have to insert a guide extension catheter as a separate device due to the need to remove the balloon/stent, having multiple wires exiting the hemostatic valve, and cost considerations. Therefore, the operator may try several alternative techniques to avoid the use of a guide extension catheter. The decision can be based on operator comfort and experience, time, and cost. As described above, the dynamic catheter system described herein can be helpful to allow for a single device that can provide the guide catheter, guide extension catheter, and/or an advancement mechanism that can provide control of the dynamic catheter system and routing of wires and devices within the dynamic catheter system.

Dynamic Catheter System

[0109] It can be beneficial to have a dynamic catheter system that utilizes a guide catheter, a telescoping guide extension catheter, and a catheter control center. The catheter control center can include an integrated control center with an advancement mechanism, wire storing and/or holding device, and an integrated hemostatic valve.

[0110] It can be beneficial to have a guide catheter that utilizes an integrated guide extension catheter that can allow for easy deployment of the guide extension catheter when

needed. In such cases, the procedure would follow the steps above but if the operator is not able to deliver equipment due to the calcified/tortuous nature of the lesion/vessel, then the operator can utilize the integrated guide extension catheter for additional support. In such cases, the guide extension catheter portion of the device can be advanced over the coronary guide wire and balloon or stent. Then the balloon or stent can be advanced to the lesion. The guide extension catheter portion can often help as it provides more support from the guide catheter and makes it easier to deliver equipment. In traditional cases, if the stent does not cross the lesion, the operator may have to remove the stent, re-advance a non-compliant or compliant balloon and re-balloon. With the integrated guide extension catheter device as described in more detail below, the operator can still have the options of a buddy wire or wiggle wire. In other cases, the operator can take the balloon (compliant) past the lesion and inflate at low pressure (approximately 4atm) to anchor the guide catheter. Then the operator can slide the guide extension catheter past the lesion, remove the balloon, and advance the stent. Then the operator can un-sheath the stent in the lesion.

[0111] The integrated guide extension catheter can provide extra support without needing additional equipment (i.e. a separate guide extension catheter). Additionally, the integrated guide extension catheter can allow for a wire advancing mechanism that does not go through the hemostatic valve so it can be easier to identify, manipulate, and keep separate from the coronary wire and/or balloon or stent wires. The integrated guide extension catheter can have design differences that can allow for less trauma to the proximal vessel and more support, for example, in the subclavian region. Additionally, the integrated guide extension catheter can save steps during a procedure and can save time. In some cases, the integrated guide extension catheter device can allow for easy guide catheter engagement as opposed to using more challenging guide catheters for coronary engagement. For example, for the RCA, the operator can opt to use a Judkins Right 4 (JR4) guide catheter rather than an integrated guide extension catheter than an Amplatz Left 0.75 guide catheter, which provides more support than the JR4 but is harder to engage and has a higher risk of proximal vessel dissection. This can be important in an acute, time-critical setting. It can also be useful for engaging coronary arteries post transcatheter aortic valve implantation, which can be challenging with currently available guide catheters.

[0112] The dynamic catheter system device described herein can include a guide catheter to be placed into human arteries for vascular (including but not exclusive to coronary artery, peripheral vascular or neurovascular) procedures, to act as a guide for more effective support and delivery of devices such as stents and balloons through the guide catheter and into the artery (for example, within the coronary arteries). The dynamic catheter system can include two key elements, a guide catheter design that contains within it a plastic tube or a guide extension catheter that is able to telescope out and in of the distal end of the guide catheter. The guide catheter can include a telescoping feature for the guide extension catheter. In some cases, the guide catheter with an integrated guide extension catheter can be used for a percutaneous coronary intervention or a coronary angioplasty. The dynamic catheter system can include a catheter control center that is integral with the guide catheter and can house an advancement mechanism including the guide catheter wire and a hemostatic valve, which can include or be configured to couple to a wire control mechanism, as described in more detail below.

Guide Catheter

[0113] A standard guide catheter 100 is depicted in Figure 1. A guide catheter can be a round and hollow plastic tube. The plastic can be braided with metal for added stability. The hollow tube can be inserted percutaneously into arteries, for example, through the wrist or groin, and can be navigated to an opening of a coronary artery where the distal end of the guide catheter and/or guide extension catheter can sit. Hence, the guide catheter and/or guide extension catheter can be very small in diameter, ranging from 0.05-0.10 inches (about 0.05-0.10 inches) in diameter. The guide catheter can be used as a conduit or protective placeholder to facilitate delivery of other materials into the coronary artery. For example, a thin metal wire (or coronary wire) can be placed in the middle of the guide catheter over which one or more stents or balloons can be passed within the inner diameter of the guide catheter.

Guide Extension Catheter

[0114] Current guide extension catheter designs can be inserted into a guide catheter after the guide catheter has already been seated into the coronary artery. The distal section of the guide extension catheter can be pushed beyond the distal end of the guide catheter

into tortuous and/or heavily calcified arteries to extend the support offered by the guide catheter by providing additional support for delivery of balloons/stents. However, as described herein, the use of a separate guide extension catheter device can create additional complications and difficulties throughout the medical procedure. Therefore, a separate guide extension catheter device that is inserted during the procedure may not be ideal.

[0115] The guide catheter and telescoping guide extension catheter described herein can incorporate the guide extension catheter into the guide catheter device.

[0116] Current guide extension catheters used with guide catheters must travel through a hemostatic valve and through the guide catheter. In contrast, an integrated guide extension catheter is integrated within the guide catheter and thus does not need to travel through the hemostatic valve.

[0117] The guide extension catheter can have a distal end and a proximal end. The guide extension catheter can be arranged to extend from the distal end of the guide catheter into the necessary vasculature, for example, the arteries. The proximal end of the guide extension catheter can be in communication with the proximal end of the guide catheter and/or any actuation device that can be used to move or actuate the guide extension catheter.

[0118] Figure 2A illustrates a cross section of an embodiment of a guide catheter shaft 210 with a telescoping guide extension catheter 212 arranged in a proximal to distal arrangement. As illustrated in Figure 2A, the guide extension catheter 212 can include a cylindrical portion 214 and a wire portion 216. The wire portion 216 is on the proximal portion of the guide extension catheter. The wire portion 216 can allow for control and manipulation of the guide extension catheter. In some cases, the wire portion can be a flat wire. The guide extension catheter 212 can be incorporated into the guide catheter 210 to allow for the guide extension catheter to move in a proximal to distal and a distal to proximal direction within the inner diameter of the guide catheter.

[0119] As illustrated in Figure 2A, the guide extension catheter 212 can have a proximal portion 216 that has a smaller diameter and a distal portion 214 that has a larger inner and outer diameter than current guide extension catheters. In some cases, the guide catheter 210 and the distal portion 214 of the guide extension catheter 212 can be concentric. In some cases, the outer diameter of the distal portion 214 of the guide extension catheter 212 can be sized to fit within the inner diameter of the guide catheter 210. In some cases, the outer

diameter of the distal portion 214 of the guide extension catheter 212 can be sized to be small enough to allow movement of the guide extension catheter 212 within the guide catheter but can be large enough to allow the inner diameter of the guide extension catheter to allow delivery of instruments or other devices. The outer diameter of the distal portion 214 of the guide extension catheter 212 only needs to be less than the inner diameter of the guide catheter. For example, in some cases, the guide catheter can have an inner diameter of about 2cm. In some cases, the inner diameter of the distal portion 214 of the guide extension catheter 212 can be about 2cm or less.

[0120] The dynamic catheter system can integrate the guide catheter and guide extension catheter devices. This pre-procedure integration can allow the guide catheter and guide catheter extension designs to be improved. For example, the guide extension catheter within the dynamic catheter system can have the largest possible inner diameter, given the guide extension catheter does not have to be passed from the proximal most to distal most portion of the guide catheter after the guide catheter has already been placed within the patient's body. In some cases, the guide catheter and guide extension catheter can have a variety of sizes and the inner diameter of the guide extension catheter can be similar to the inner diameter of an equivalently sized guide catheter.

[0121] In some cases, given the guide catheter and guide extension catheter are pre-loaded together, both can be made with thinner walls to achieve the same guide catheter behavior. The result is a larger inner diameter within the guide extension catheter, which results in additional space for practitioners, relative to current guide extension catheters. Smaller wall thickness can be achieved by various means, such as using smaller braiding patterns or using the latest materials tailored to thin walled catheters (e.g., teflon liners, thermoplastic outer extrusions, and high tensile wires). The guide extension catheter 212 can have a transitional portion 218 between the proximal portion 216 and the distal portion 214. The transitional portion 218 can transition from the smaller diameter wire of the proximal portion 216 to the larger diameter distal portion 214. In some cases, the inner wall of the distal portion 214 of the guide extension catheter 212 can be thinner than traditional guide extension catheter devices allowing the guide extension catheter 212 to be softer.

[0122] Figure 2B illustrates an embodiment of a guide catheter shaft 210 with some portions of the guide catheter cut out to show the guide extension catheter 212 within the guide

catheter 210. Figure 2A illustrates a horizontal cross section through line A-A shown in Figure 2B.

[0123] In some cases, the distal portion of the guide extension catheter could be designed to be formed from a softer material or re-shaped to promote functionality. For example, the distal tip of the guide extension catheter can be formed from materials such as a thermoplastic nylons and Pebax. In some cases, the guide extension catheter can be formed from Polytetrafluoroethylene (PTFE). In some cases, the guide extension catheter can have a hydrophilic coating to aid deliverability. In some cases, the transitional portion 218 of the cylindrical part of the guide extension catheter could be stiffer (more tightly braided) to promote control/movement (couple with the softer distal portion). In some cases, the guide extension catheter can be a coil-reinforced device that provides flexibility and kink resistance during delivery through vessels.

[0124] In some cases, the guide catheter can include a rail or channel that the guide extension catheter can move along within the guide catheter. The rail or channel can provide a path for the guide extension catheter to move along to prevent any twisting or tangling of a guide extension wire and/or the guide extension catheter while it moves within the guide catheter.

[0125] In some cases, the mother/child design of the guide catheter and guide extension catheter system can provide additional benefits. Ease of placement and position maintenance of the guide catheter can be improved. For example, the overall stiffness of the mother/child combination can be higher than just a guide catheter alone. In another embodiment, adding stiffness to the guide catheter could provide key support. The portion of the guide catheter that traverses the subclavian artery can have extra braiding creating a stiffer component. In some cases, preloading or integrating of the guide extension catheter can change the properties of the guide catheter as it enters the aorta and cardiac anatomy. When the guide extension catheter is integrated with the guide catheter, the distal end of the guide extension catheter may be able to be softer than traditional guide extension catheters as it does not have to go over a wire, through the hemostatic valve, and/or up the aorta. However, the guide extension catheter and the distal tip of the guide extension catheter may still need to maintain some similar level of thickness to provide support.

[0126] In some cases, the device can provide tactile feedback that allows the operator to feel the guide extension catheter movement and pressure feedback. The tactile feedback can be important and allow for ease of use by the operator. In some cases, a wire based mechanism on the proximal portion 216 of the guide extension catheter can be used to provide this tactile feedback. Actuator mechanisms can also be used that allow for similar feedback. For example, the advancement mechanisms described herein (for example the sliding knob mechanism described in detail below) for sliding or moving the guide extension catheter forward can provide the same desirable tactile feedback operators are accustomed to with atherectomy devices (rotational and orbital atherectomy) and provide a familiar user experience for the operator. In some embodiments, in lieu of or in addition to an advancement mechanism within the catheter control center, the guide extension catheter proximal portion wire itself can be adjusted to allow for greater control and tactile feedback.

[0127] Figures 3A-5C illustrate a guide catheter and a guide extension catheter. As shown in Figures 3A-3D the guide extension catheter 212 can include a proximal portion 216 including a guide extension wire and a distal portion 214 with a cylindrical braided section. Figure 3A illustrates a view of the transitional portion 218 of the guide extension catheter 212 that allows a transitional feature between the proximal portion 216 including the guide extension wire and the distal portion 214 with the cylindrical braided section. Figures 3B-3C illustrates a view of the guide extension catheter 212. Figure 3D illustrates a cross section for the guide catheter 210 and guide extension catheter 212 that is a cross section of line 3D-3D in Figure 3C. Figure 3D illustrates the concentric nature of the guide extension catheter 212 within the guide catheter 210. As shown in Figure 3D, the inner diameter of the guide catheter is sized to fit an outer diameter of the guide extension catheter that is as close as possible to the inner diameter of the guide catheter. This arrangement can allow for a close fitting concentric arrangement as shown in Figure 3D while still allowing for the guide extension catheter to be advanced within the guide catheter without resistance.

[0128] Figures 4A-4C illustrate a guide catheter 210 and a concentric guide extension catheter 212 device. Figure 4C illustrates a cross section for the guide catheter 210 and guide extension catheter 212 that is a cross section of line 4C-4C in Figure 4B.

[0129] Figures 5A-5C illustrated an embodiment of the guide extension catheter with a flat wire. Figure 5C illustrates a cross section for the guide catheter 210 and guide extension catheter 212 that is a cross section of line 5C-5C in Figure 5B.

Catheter Control Center

[0130] As described herein, the dynamic catheter system can include a catheter control center which can incorporate an advancement mechanism, a guide extension catheter wire, and/or a hemostatic valve. In some cases, the catheter control center can incorporate one or more of these components within a housing or other enclosure providing a user friendly device that can be controlled and manipulated by the operator. The distal end of the catheter control center can be attached to the proximal end of the guide catheter and the guide extension catheter and guide extension catheter wire can move in a proximal to distal or distal to proximal direction within both the guide catheter and the catheter control center.

Advancement Mechanisms

[0131] The dynamic catheter system can incorporate an actuator for advancing and/or retracting the telescoping guide extension catheter. The actuator at the proximal end of the guide catheter can incorporate various actuation features. The actuator can be incorporated within a catheter control center. In some embodiments, the catheter control center can incorporate an advancement mechanism that uses an actuation device or mechanism that can provide distal and proximal movement, preserve tactile feedback, prevent wire wrapping, have little change to existing components, and allow simple manufacturing and setup.

[0132] In some cases, the valve in communication with the advancement mechanism for extending or actuating the telescoping guide extension catheter within the guide catheter and the hemostatic valve are not incorporated into the same housing. In these cases, the valve can be positioned as a pre-hemostatic valve or a post-hemostatic valve depending on the positioning of the hemostatic valve in relation to the positioning of the advancement mechanism. The pre- hemostatic valve can include a device with a secondary valve or branched valve positioned proximal to the hemostatic valve. This configuration can incorporate the guide catheter, guide extension catheter, and advancement mechanism into one piece and allow for no interruptions and encourage use of the guide extension catheter which can make it easier to

use. With a branched valve configuration there could be no seal required in the mechanism, however, in some cases, it can require the addition of a second valve adjustment process because the two valves are in two locations. In other cases, the pre-hemostatic valve can include an enclosed mechanism enclosed within the guide catheter device and positioned proximal to the hemostatic valve. The enclosed mechanism may not require an independent open/close mechanism of the valve to advance the guide extension catheter. In some cases, the enclosed mechanism can have diminished tactile feedback.

[0133] In some cases, the guide catheter can incorporate the telescoping guide extension catheter using a valve that is incorporated distal to the hemostatic valve or post-hemostatic valve. The post-hemostatic valve may not require an additional seal. Additionally, the post-hemostatic valve can be formed from two pieces, may require setup assembly, and/or may impede wire manipulation area for other devices.

[0134] In some cases, the guide extension catheter wire can have multiple cross-sectional shapes and sizes. For example, the distal portion of the wire could have a rectangular cross section (i.e., flat wire) and the proximal portion of the wire could have a circular cross section (i.e., round wire). The proximal portion of the wire is near or within the catheter control center. Customizing the proximal portion of the wire maximizes the catheter control center's ability to store the wire, actuate the guide extension catheter, and optimize feedback for the practitioner. Customizing the distal portion of the wire allows for optimal wire bending characteristics within the guide catheter, which impacts advancement and retraction behavior of the guide extension catheter.

[0135] Figures 6A-6E illustrate an embodiment of a guide catheter with a telescoping guide extension catheter that incorporates a guide extension advancement mechanism. In some cases, the guide extension advancement mechanism can be a branched wire advancement mechanism which can include a branched slider.

[0136] Figure 6B illustrates a branched device 601 with a 20 degree branch. The first branch 602 of the branched device can include a hemostasis valve 606. The second branch 604 can include a guide extension advancement mechanism 608. For example, as illustrated in Figure 6A-6F, a guide extension advancement mechanism 608 can be a slider mechanism 620 that can actuate the guide extension catheter. In some cases, the slider mechanism 620 can have a 5 – 10cm (about 5 – 10cm) distance of slider travel per single slider movement. In some

cases, the full movement of the slider (over one or more slider movements) can be 5cm, 10cm, 15cm, 20 cm, 25cm, 30cm, 35cm, 40cm, 45cm, 50cm, 55cm, 60cm, 65cm, 70cm, or more (about 5cm, about 10cm, about 15cm, about 20 cm, about 25cm, about 30cm, about 35cm, about 40cm, about 45cm, about 50cm, about 55cm, about 60cm, about 65cm, about 70cm, or more). In some cases, the full movement of the slider (over one or more slider movements) can be between about 5cm and about 70cm, about 10cm and about 65cm, about 15cm and about 60cm, about 20cm and about 55cm, about 25cm and about 50cm, about 30cm and about 45cm, or about 35cm and about 40cm. In some cases, the full movement of the slider (over one or more slider movements) can be at least 25cm (about at least 25cm) or more. In some cases, the slider mechanism 620 can have a 15.5mm diameter or can be any diameter that is comfortable for the operator to hold and/or manipulate. Figure 6C shows a wire 626 for manual pushing or longer advancement. Figures 6D-6F illustrate a cross section of the branched wire guide catheter device 601. The branched wire guide catheter device 601 can have a silicone retaining ring 622 for added support between the first and second branches of the device. In some cases, the slider mechanism 620 can include a wire clamp 624 as shown in Figures 6F.

[0137] Figures 7A-7B illustrates an embodiment of a guide extension advancement mechanism 700 using a slider mechanism 702. The slider mechanism 702 can include an actuator that can be moved along a horizontal axis that runs from a proximal to distal direction of the slider mechanism 702. The slider mechanism 702 can be attached to a wire 704 to actuate the wire 704 within the guide catheter. As the slider mechanism 702 is moved along the horizontal axis, the wire 704 is moved in a distal to proximal and proximal to distal direction parallel to the horizontal axis. Figure 7A illustrates a first position of the slider mechanism 702 with the wire retracted into the mechanism in a proximal most direction. Figure 7B illustrates a second position of the slider mechanism 702 with the wire 704 extended to a position distal to the first position and the guide extension catheter can be extended in a distal direction. The slider mechanism can include a casing 706 that forms an enclosed structure surrounding the wire 704. The slide mechanism 702 can provide tactile feedback for the operator. The guide extension advancement mechanism 700 may require a specific grip that can use a thumb to move the slider mechanism 702. In some cases, if the slider mechanism 702 needs to be moved past the thumb length the operator may need to readjust the grip on the device.

[0138] Figures 7C-7D illustrate guide extension advancement mechanisms that can be used. Figure 7C illustrates an o-ring sliding cylinders that can be used within the guide extension advancement 700. The o-ring sliding cylinders of the guide extension advancement 700 can include a slider mechanism 702 and a wire 704 that can be moved in the proximal to distal or distal to proximal direction by the movement of the slider mechanism 702. Figure 7D illustrates another example of a guide extension advancement mechanism 700 with a slider mechanism 702 that can be used and would require no seal. The guide extension advancement mechanism 700 can include a slider mechanism 702 and a wire 704 that can be moved in the proximal to distal or distal to proximal direction by the movement of the slider mechanism 702.

[0139] The guide extension advancement mechanism 700 using the slider mechanism 702 of Figures 7A-7D can be used with the system described with reference to Figures 6A-6F and can be used in place of the guide extension advancement mechanism 608 in Figures 6A-6F.

[0140] Figures 8A-8B illustrate an embodiment of a guide extension advancement mechanism 800 using a spool mechanism 802. The guide extension advancement mechanism 800 with the spool mechanism 802 can be actuated with a one-handed fixed grip. The wire 804 connected to the guide extension catheter can be wrapped around the spool and the spool can be actuated to move the guide extension catheter from a proximal to distal and a distal to proximal configuration. Figure 8A illustrates a first position of the spool mechanism 802 with the wire 804 retracted into the mechanism in a proximal most direction. Figure 8B illustrates a second position of the spool mechanism 802 with the wire 804 extended at a position distal to the first position. The guide extension advancement mechanism 800 with the spool mechanism 802 can provide a compact length since the wire is wrapped around the spool 806 instead of extending from the proximal end of the guide extension advancement mechanism.

[0141] Figures 8C-8D illustrate an exploded view of a guide extension advancement mechanism with a spool mechanism 802. Figure 8C illustrates the components of the spool mechanism 802 on the guide catheter device in a distal position to the hemostatic valve 806. The wire 804 can be wound around a wheel 832 and a cap 834 with grooves that can be used to move the wheel 832 and therefore actuate the wire 804. The features of the

spool mechanism can include a seal at the distal end to prevent fluid from entering the spool mechanism.

[0142] Figures 9A-9B illustrate an embodiment of a guide extension advancement mechanism 900 using a contact wheel mechanism 902. The contact wheel mechanism 902 can include two wheels 932, 934 and one or both wheels can move to allow the movement of the wire 904 and the guide extension catheter at the distal end of the wire. The contact wheel mechanism 902 can be more compact than other devices and can allow for a one-handed user friendly fixed grip that can simplify operation for the operator. The wire is arranged to move within the two wheels in a proximal to distal and distal to proximal direction which can move the guide extension catheter within the guide catheter and/or arteries. In some cases, an area of the wire that is positioned to move between the wheels can be thicker than the remainder of the wire or can be formed from a material with additional grip to allow for the wire to better contact the wheels. Figure 9A illustrates a first position of the contact wheel mechanism 902 with the wire 904 in a first position. Figure 9B illustrates a second position of the contact wheel mechanism 902 with the wire 904 extended at a position distal to the first position.

[0143] Figures 9C and 9D illustrate other examples of a guide extension advancement mechanism 900 with a contact wheel mechanism 902. The contact wheel mechanisms 902 in Figures 9C-9D are similar to the contact wheel mechanism 902 in Figures 9A-9B. However, the contact wheel mechanisms 902 is enclosed within a housing 906. The first wheel 934 can be positioned within the housing and the second wheel 932 can be partially positioned within the housing 906. As shown in Figures 9C and 9D the second wheel 932 can rotate and can be used to move the wire 904 within the contact wheel mechanism 902.

[0144] Figures 10A-10B illustrate an embodiment of a guide extension advancement mechanism 1000 using a screw mechanism 1002. The screw mechanism can be in communication with a housing 1006 and a wire 1004 that can be attached to the guide extension catheter to move the guide extension catheter within the guide catheter. The screw mechanism 1002 can be designed with a screw-like device 1032 with threads that can move along complementary threads in the inner diameter of the housing 1006. As the screw 1032 is moved from the proximal to distal or distal to proximal direction the wire and guide extension catheter is also moved from the proximal to distal or distal to proximal direction. Figure 10A illustrates a first position of the screw mechanism 1002 with the wire 1004 in a first position.

Figure 10B illustrates a second position of the screw mechanism 1002 with the wire 1004 extended at a position distal to the first position. The guide extension advancement mechanism 1000 using the screw mechanism 1002 can allow for a fixed grip as the operator can twist the proximal end 1008 of the screw 1032 to move the screw within the housing and thereby move the wire 1004 and guide extension catheter. In some cases, the wire can be attached to points in the housing or run along a guide or rail to prevent the wire from twisting when the screw is rotated.

[0145] Figures 11A-11B illustrate an embodiment of a guide extension advancement mechanism 1100 using a rack and pinion mechanism 1102. The rack and pinion mechanism 1102 can be used to move a wire 1104 and attached guide extension catheter within the guide catheter. The rack and pinion mechanism 1102 can include a circular gear 1132 (pinion) that engages with a linear gear 1134 (rack) which can operate to translate the rotational motion of the circular gear 1132 into linear motion. The operator can move the circular gear 1132. The rotation of the circular gear 1132 can move the linear gear 1134 in a proximal to distal or distal to proximal direction. The movement of the linear gear 1134 can then move the wire 1104 and thereby move the guide extension catheter in a proximal to distal or distal to proximal direction. Figure 11A illustrates a first position of the rack and pinion mechanism 1102 with the wire 1104 in a first position. Figure 11B illustrates a second position of the rack and pinion mechanism 1102 with the wire 1104 extended at a position distal to the first position. Figures 11C-11D illustrate other examples of guide extension advancement mechanisms 1100 using a rack and pinion mechanism 1102. Figure 11C illustrates a rack and pinion mechanism 1102 with a finger wheel which can allow the operator to move the circular gear 1132 with their finger. Figure 11D illustrates a rack and pinion mechanism 1102 with a thumb wheel which can allow the operator to move the circular gear 1132 with their finger.

[0146] As shown in Figures 11A-11D, at least a portion of the linear gear 1134 can be positioned within a housing 1106 and the circular gear 1132 can extend from the housing 1106. The operator can rotate the circular gear 1132 that extends from the housing 1106 and thereby move the linear gear 1132 and the wire/guide extension catheter in the proximal to distal or distal to proximal direction. The rack and pinion mechanism 1102 can use a well constrained channel to prevent the wire from buckling. The rack and pinion mechanism 1102 can be a fixed grip device that can be actuated with a finger or thumb of the operator.

[0147] Figures 12A-12B illustrate an embodiment of a guide extension advancement mechanism 1200 using a non-contact advancement mechanism 1202. In some cases, the non-contact advancement mechanism can use magnets. A non-contact advancement mechanism 1202 can allow for the guide extension advancement mechanism 1200 to be actuated with a closed system where the housing 1206 encloses the inner component 1232 and the wire 1204 while the outer component 1234 can be positioned outside the housing 1206. Figure 12A illustrates a first position of the non-contact advancement mechanism 1202 with the wire 1204 in a first position. Figure 12B illustrates a second position of the non-contact advancement mechanism 1202 with the wire 1204 extended at a position distal to the first position.

[0148] Figures 13-16 illustrate various handle and/or grips that can be used with the any of the guide extension advancement mechanisms and/or guide catheters described herein. Various grips can be used, including but not limited to, ball grip, bike handle grip, trigger handle grip, and/or a pencil grip. Figure 13 illustrates examples of guide extension advancement mechanisms with a thumb wheel. The thumb wheel can allow for the operator to hold the handle of the guide extension advancement mechanism within their hand with a natural grip. Figure 14 illustrates examples of guide extension advancement mechanisms with a finger wheel. The finger wheel can allow for the operator to grip the handle in their hand while actuating the wire and guide extension catheter by moving the wheel with their finger. Figure 15 illustrates a handle grip that allows under body control while resting the housing on a hand grip. Figure 16 illustrates a handle grip that can be rotated with a thumb or finger. For example, as illustrated in Figure 16 the thumb of an operator can be used to push on a tab which will then rotate the handle 180 degrees to move any associated components, for example a wire and guide extension catheter.

[0149] Figures 17A-22B illustrate examples of a dynamic catheter system with a guide catheter, guide extension catheter, and a catheter control center that incorporates a guide extension advancement mechanism to actuate a guide extension catheter and wire within the guide catheter, a guide extension catheter wire, and a hemostatic valve. As described herein the guide extension catheter can be designed to be incorporated into the guide catheter as it is inserted into the patient and passed through the arteries.

[0150] Figures 17A-17H illustrate a dynamic catheter system 1700 with a guide extension advancement mechanism 1702 to actuate a guide extension catheter (not shown) within the guide catheter (not shown). The guide extension advancement mechanism 1702 can include a housing 1706 with a finger pinch wire advancement 1732 that is used to advance or actuate a guide extension catheter wire 1704. Figures 17A-17B illustrate side views of the dynamic catheter system 1700 and Figure 17B shows the housing 1706 in transparent as to allow viewing of the inner components. The proximal end 1736 of guide extension catheter wire 1704 can be folded or bent within a wire channel 1780 within the housing as illustrated in Figure 17B. In some cases, the guide extension catheter wire 1704 can have different properties or characteristics throughout the length of the wire. For example, the guide extension catheter wire 1704 can have different diameters at the proximal end that is folded or bent within the channel 1780 than the diameter of a more distal part of the guide extension catheter wire 1704 that is passed through the guide catheter. In some cases, the guide extension catheter wire 1704 can be more malleable or flexible at the proximal end that is folded or bent within the channel 1780 to allow the wire to move, fold, and bend within the channel. In contrast, the guide extension catheter wire 1704 can be less flexible at the more distal portions that are extended through the guide catheter to prevent the guide extension catheter wire 1704 from twisting, tangling, bending, or otherwise preventing movement of the guide extension catheter wire 1704 within the guide catheter. In some cases, the proximal end of the guide extension catheter wire 1704 can be a different shape than the guide extension catheter wire 1704 at the more distal end. In other cases, the guide extension catheter wire 1704 at the proximal end is the same shape and material as the guide extension catheter wire 1704 at the more distal ends of the device.

[0151] The guide extension advancement mechanism 1702 can also have a seal 1734 within the housing 1706 to prevent fluid or other contaminants from entering into the guide extension advancement mechanism 1702. In some cases, the seal 1734 can be a double seal or any seal necessary to prevent fluid ingress into the housing or any component of the mechanism. The dynamic catheter system 1700 can include a hemostatic valve 1710 positioned proximal to the guide extension advancement mechanism 1702 and a swivel valve 1712 positioned between the hemostatic valve 1710 and the guide extension advancement mechanism 1702. The hemostatic valve 1710 can be used as described herein to deliver

instruments or other wires through the guide catheter and/or guide extension catheter to the target area.

[0152] In some cases, the hemostatic valve 1710 and/or valve 1712 can be integrated into the guide extension advancement mechanism 1702 itself and can be formed as one piece. For example, the valve 1712 can be positioned on the distal end of the guide extension advancement mechanism 1702 and the hemostatic valve 1710 can be positioned on the proximal end of the guide extension advancement mechanism 1702. This arrangement can allow for the dynamic catheter system 1700 to have the guide extension advancement mechanism 1702 with an integrated hemostatic valve 1710 and/or valve 1712 in one component to allow a length of the components that is similar to that of existing hemostatic valve systems.

[0153] Figures 17C-17D illustrate front views of the dynamic catheter system 1700 with a guide extension advancement mechanism 1702 with the guide extension catheter wire 1704 extending out of the device distally (out of the page). Figure 17D shows the housing 1706 in transparent as to allow viewing of the inner components. As shown in Figures 17C-17D, the finger pinch advancement mechanism 1732 can have two tabs (described in more detail with reference to Figures 20A-20B) that can be pushed together at the top 1738 by the operator in order to pinch the guide extension catheter wire 1704 and move the guide extension catheter wire 1704. For example, when the tabs are pushed together at the top 1738, the bottom portions 1739 can pinch the guide extension catheter wire 1704 and move the wire in a proximal to distal or distal to proximal direction. When the tabs are not pushed together at the top 1738 (left separated), the top portions and bottom portions 1739 can be in a resting state with the tabs flexed outward and not exerting a force on the guide extension catheter wire 1704.

[0154] Figures 17E-17F illustrate top views of the dynamic catheter system 1700 with a guide extension advancement mechanism 1702 with the guide extension catheter wire 1704 extending out of the device distally and the finger pinch wire advancement 1732 extending out of the page. Figure 17F shows the housing 1706 in transparent as to allow viewing of the inner components.

[0155] Figures 17G-17H illustrate perspective views of the dynamic catheter system 1700 with a guide extension advancement mechanism 1702. Figure 17F shows the housing 1706 in transparent as to allow viewing of the inner components of the device. In some

cases the guide extension catheter wire can be advanced for between about 5cm and about 20cm, about 10cm and about 15cm, or about 7cm. In some cases, the storage capacity of the bend or folded wire within the housing can be between about 5cm and about 40cm, about 10cm and about 35cm, about 15cm and about 30cm, about 20cm and about 25cm, or about 20cm of wire. In some cases, the guide extension advancement mechanism 1702 can comprise a length of between about 5cm and about 30cm, about 10cm and about 25cm, or about 15cm and about 20cm. In some cases, the guide extension advancement mechanism 1702 can comprise a width of between about 1cm and about 20cm, or about 5cm and about 15cm. In some cases, the guide extension advancement mechanism 1702 can comprise a height of between about 1cm and about 20cm, or about 5cm and about 15cm.

[0156] Figures 18A-18H illustrate a dynamic catheter system 1800 with a guide extension advancement mechanism 1802 to actuate a guide extension catheter (not shown) within the guide catheter (not shown). The dynamic catheter system 1800 of Figures 18A-18H is similar to the dynamic catheter system 1700 of Figures 17A-17H. However, the dynamic catheter system 1800 of Figures 18A-18H can use a spool mechanism 1840 to store the proximal end portion of the guide extension catheter wire 1804. The guide extension catheter wire 1804 is actuated to extend the guide extension catheter wire 1804 and the corresponding guide extension catheter (not shown) at the distal end of the guide extension catheter wire 1804. As the finger pinch advancement mechanism 1832 is pushed together at the top portions 1838, the guide extension catheter wire 1804 is pinched and the finger pinch advancement mechanism 1832 can be moved in a distal direction and the guide extension catheter wire is uncoiled from the spool mechanism 1840 to extend the guide extension catheter wire 1804 in the distal direction. In some cases, the spool can be used passively with finger advancement.

[0157] In some cases the guide extension catheter wire can be advanced for between about 5cm and about 20cm, about 10cm and about 15cm, or about 6cm. In some cases, the spool mechanism can store between about 5cm and about 60cm, about 10cm and about 55cm, about 15cm and about 50cm, about 20cm and about 45cm, about 25cm and about 40cm, about 30cm and about 35cm, or about 36cm of wire. In some cases, the guide extension advancement mechanism 1802 can comprise a length of between about 1cm and about 30cm, about 5cm and about 25cm, or about 10cm and about 20cm. In some cases, the guide extension advancement mechanism 1802 can comprise a width of between about 1cm and about 20cm,

or about 5cm and about 15cm. In some cases, the guide extension advancement mechanism 1802 can comprise a height of between about 1cm and about 20cm, or about 5cm and about 15cm.

[0158] Figures 19A-19B illustrate an embodiment of an interior of a guide extension advancement mechanism 1902. As illustrated in Figures 19A-19B the guide extension advancement mechanism 1902 can include a double seal system. The guide extension advancement mechanism 1902 can have a first seal 1946 positioned on the outer surface of a main channel 1947 between the main channel 1947 and a guide extension catheter wire channel 1948 to seal the opening that the guide extension catheter wire 1904 passes through. The first seal 1946 can prevent fluid or other contaminants from entering the guide extension catheter wire channel 1948. The guide extension advancement mechanism 1902 can have a second seal 1949 positioned within the guide extension catheter wire channel 1948. The second seal 1949 can be perpendicular to the guide extension catheter wire 1904. The second seal 1949 can be a dynamic radial seal that seals against the guide extension catheter wire 1904. The main channel 1947 can include a passive filter 1950 that can be used to prevent pooling of fluid or other contaminants in the branch between the main channel 1947 and the guide extension catheter wire channel 1948.

[0159] Figures 20A-20B illustrate a zoomed in view of a finger pinch wire advancement 2032. The finger pinch wire advancement 2032 can be a flexible, plastic finger-pinching grip. As shown in Figure 20A, the resting state of the finger pinch wire advancement 2032 is for the tabs 2052, 2054 to be flexed outward (as shown by the arrows in Figure 20A). As the tabs 2052, 2054 are pushed inward as shown in Figure 20B, the wire 2004 can be pinched by the bottom portion 2039 of the finger pinch wire advancement 2032. The finger pinch wire advancement 2032 can then be moved in a distal direction along a track 2056 which will also move the wire 2004 that is pinched by the finger pinch wire advancement 2032. The finger pinch wire advancement 2032 can then be released and moved back to a resting state. The wire advancement can be repeated as needed to move the guide extension catheter wire in a distal to proximal or a proximal to distal direction within the dynamic catheter system.

[0160] Figures 21A-21F illustrate a dynamic catheter system 2100 with a guide extension advancement mechanism 2102 to actuate a guide extension catheter (not shown) within the guide catheter (not shown). The dynamic catheter system 2100 of Figures 21A-21F

is similar to the dynamic catheter system 2100 of Figures 17A-17H and 18A-18H. However, the dynamic catheter system 2100 of Figures 21A-21F can use a finger knob advancement mechanism 2132 to actuate the guide extension catheter wire 2104 (shown in Figures 21C and 21D).

[0161] The guide extension catheter wire 2104 is actuated to extend the guide extension catheter wire 2104 and the corresponding guide extension catheter 2152 at the distal end of the guide extension catheter wire 2104 from the distal end of the guide catheter 2150. Additionally, the dynamic catheter system 2100 of Figures 21A-21F also incorporates the functionality of the hemostatic valve 2110. Further, the dynamic catheter system 2100 of Figures 21A-21F incorporates a rotating connector 2136 within the housing 2106 of the catheter control center of the finger knob advancement mechanism 2132. The rotating connector 2136 can allow the guide catheter 2150 to rotate independent of the remainder of the dynamic catheter system 2100. This feature can allow the guide catheter to be able to rotate independent of the components of the catheter control center and enable movement of the guide catheter during and post insertion. This feature also allows a practitioner to rotate the catheter control center without moving the guide catheter, resulting in greater flexibility of equipment positioning throughout a high-intensity, time-critical procedure.

[0162] The integration of the hemostatic valve 2110 and the valve 2136 within the housing 2106 of the catheter control center can allow for an integrated and easy to use device that the operator can control during use.

[0163] Figures 21A-21B illustrate views of the dynamic catheter system 2100 with a finger knob advancement mechanism 2132. Figures 21C-21D illustrate a side view of the dynamic catheter system 2100 with a finger knob advancement mechanism 2132. The housing 2106 is shown in transparent to allow visibility of the interior components within the housing 2106. The housing 2106 can have two compartments, the guide extension catheter wire compartment 2192 and the main valve compartment 2194. The guide extension catheter wire 2104 can be seen in a double bend within the guide extension catheter wire compartment 2192 of the housing 2106 as described with reference to Figures 17A-17H. The guide extension catheter wire compartment 2192 can accommodate the guide extension catheter wire 2104 and the advancement mechanism 2132. In some cases, the main valve compartment 2194 can act similar to a hemostatic valve described herein and can allow for all other wires and/or devices

to pass through the main valve compartment 2194 from the valve to the guide catheter. In some embodiments, the guide extension catheter wire compartment 2192 and the main valve compartment 2194 can be connected by a seal 2134. The seal 2134 can prevent fluid from entering the guide extension catheter wire compartment 2192.

[0164] Figure 21E-21F illustrates a top view of the dynamic catheter system 2100 with a finger knob advancement mechanism 2132. The finger knob advancement mechanism 2132 can move along a track 2156 as illustrated in Figures 21E-21F to actuate the guide extension catheter wire 2104 (shown in Figures 21C and 21D) and the guide extension catheter 2152 (shown in Figures 21A-21B). Figures 21E-21F illustrates the side port 2154 which can be incorporated into the housing 2106. The side port 2154 can be used to provide additional support. For example, the side port 2154 can be used to flush the catheter, attach a manifold, and/or measure pressure or take other measurements. Although, the side port 2154 is shown on the side of the housing 2106, the port 2154 can be positioned on any portion of the housing 2106. Additionally, the hemostatic valve 2110 is shown on the proximal end of the housing 2106. However, the hemostatic valve 2110 can be positioned on any portion of the housing 2106 that allows the instrumentation or other devices to be delivered through the valve and/or into the guide catheter 2150.

[0165] Figures 22A-22B illustrates the finger knob advancement mechanism 2232 that can be used to actuate the guide extension catheter wire 2104 (shown in Figures 21C and 21D) and move the guide extension catheter 2152. As the finger knob advancement mechanism 2232 is depressed at the top portions 2238 to move the finger knob advancement mechanism 2232 along the track 2156. For example, the finger knob advancement mechanism 2232 can be depressed and moved along the track 2156 in a distal direction and the guide extension catheter wire can be moved within the housing to extend the guide extension catheter wire in the distal direction. The finger knob advancement mechanism 2232 can have a round knob slider with a spring-loaded push-button as shown in Figures 22A-22B. In the default state (released or not depressed state) the finger knob advancement mechanism 2232 is un-pinched from the guide extension catheter wire. Once the top portion 2238 is depressed, the finger knob advancement mechanism 2232 can pinch and grab onto the guide extension catheter wire for advancement or retraction of the guide extension catheter wire. In some cases, the outer shape of the catheter control center can be designed to be placed or rested on a table and to be easy

to grab or manipulate by the operator. The catheter control center can be gripped easily with one hand so that the second hand can be used to hold another device or is otherwise free. In some cases, the dynamic catheter system can include finger indentations to indicate how the operator is to hold the device. In some cases, the catheter control center can be weighted on the main valve compartment side to promote a certain orientation. In some cases, the dynamic catheter system can have legs or a tacky or sticky underside of the catheter control center to allow the catheter control center to stay in one spot.

Wire Control Mechanism

[0166] It can be beneficial to have a wire control mechanism that can separate and/or combine two or more wires at the beginning, middle, or end of a procedure to allow the user to easily identify and manipulate the wires. For example, the wire control mechanism can keep a guide wire separate from a device wire. Any of the wire control mechanisms described herein can be integral with or attached to a valve (*e.g.* hemostatic valve). For example, a wire control mechanism and a valve can be part of a unibody (*e.g.*, single structure) device such that the wire control mechanism and the valve are not removable from each other. A unibody wire control mechanism and valve can be integral with or attached to any of the dynamic catheter systems described herein or can be used with any other catheter system, device, or procedure that utilizes one or more wires. Any features of the wire control mechanisms, including, but not limited to, doors (*e.g.*, 4916a, 4916b, 5016), discs (*e.g.*, 5116), liners (*e.g.*, 5216), insert (*e.g.*, 5316), sleeves (*e.g.*, 5416, 5516), caps (*e.g.*, 2316, 5616), and/or the sliding components (*e.g.*, 5716a-d) can be integral or attached to a valve. The valve described herein can include a tuohy force valve, a tuohy valve system, a hemostasis valve, a y-connector valve, or any other valve system used with or without a catheter system.

[0167] Figures 23A-26C illustrate example wire control mechanisms that can be integral with or attached to a proximal end of a dynamic catheter system. For example, the wire control mechanisms can couple to or be integral with a valve at the proximal end of the dynamic catheter system, such as one of the dynamic catheter systems 1700, 1800, 2100 described above. Further, the dynamic catheter system can include a guide catheter, guide extension catheter, and a hemostatic valve incorporating the wire control mechanism. In some cases, a catheter control system is not required. Although the wire control mechanisms are

described as being used with a dynamic catheter system, the wire control mechanisms can be used with any device or procedure that utilizes one or more wires. For example, all hemostatic valves in use today could benefit from the incorporation of a wire control mechanism as described herein.

[0168] Figures 23A-24B illustrate an implementation of a wire control mechanism 2300. The wire control mechanism 2300 can comprise a distal end 2302, a proximal end 2304, and a channel 2306 (shown in Figure 2306) extending between the distal end 2302 and the proximal end 2304. The wire control mechanism 2300 can include a cap 2316 configured to separate two or more wires. For example, the cap 2316 can include a hinge so that the cap can include a closed configuration with the cap 2316 coupled to the proximal end 2304 and an open configuration with the cap 2316 removed from the proximal end 2304. When the cap 2316 is in the closed configuration, the cap 2316 can separate the two or more wires without removing the two or more wires from the wire control mechanism 2300 and without removing the wire control mechanism 2300 from the catheter system, as further described below. In other configurations, the cap 2316 can include a rotatable mechanism, a pivotable mechanism, or any other mechanism that can separate the two or more wires without removing the wire control mechanism 2300 from the dynamic catheter system.

[0169] As shown in Figures 24A-24B, the distal end 2302 can be integral with or configured to be removably coupled to the proximal end 2412 of a dynamic catheter system. For example, Figures 24A-24B illustrates a valve 2410 of a dynamic catheter system as transparent to show the internal components. The dynamic catheter system can include the valve 2410, such as a hemostatic valve, at the proximal end 2412 configured to couple to the distal end 2302 of the wire control mechanism 2300. In some configurations, the valve 2410 can include and be integral with the wire control mechanism 2300. The valve 2410 can be the same or similar to any of the valve 1710, 1712, 1810, 2110 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 2410 can include any valve, such as a hemostatic valve. For example, the valve 2410 can comprise a rotatable component configured to open or close a seal of the valve 2410. In some configurations, the valve 2410 can comprise a button configured to be pressed to open or close the seal of the valve 2410. In some aspects, the valve 2410 can comprise a rotatable component and a button configured to open or close the seal of the valve 2410.

[0170] The distal end 2302 of the wire control mechanism 2300 can be configured to receive or be received by the proximal end 2412 of the valve 2410. During a procedure, the user may couple the wire control mechanism 2300 to the valve 2410 or remove the wire control mechanism 2300 from the valve 2410. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 2300 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control mechanism 2300 to the valve 2410 prior to a procedure. In some configurations, the distal end 2302 can be integral with the valve 2410. The illustrated configuration shows the distal end 2302 comprising a greater diameter than the proximal end 2412 of the valve 2410 such that the proximal end 2412 of the valve 2410 can be received by the distal end 2302 of the wire control mechanism 2300. The distal end 2302 of the wire control mechanism 2300 can couple to the valve 2410 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0171] As shown in Figures 23A-23D, the proximal end 2304 can comprise an opening 2308. The opening 2308 can align with the channel 2306 such that the opening 2308 can be in communication with an inner channel of the valve 2410 and/or the dynamic catheter system. In some configurations, the proximal end 2304 can include a plurality of openings (e.g., two, three, four, five). The opening 2308 can include a first portion 2312 and a second portion 2310. In some aspects, the opening 2308 can include a single portion or more than two portions (e.g., three, four, five, six). The first portion 2312 can align with the channel 2306 and the second portion 2310 can be angled from the channel 2306. The angle between the second portion 2310 and the first portion 2312 can be between about 5 degrees and about 60 degrees, about 10 degrees and about 50 degrees, about 20 degrees and about 40 degrees, or about 15 degrees. This angle can control the distance between two or more wires extending through the wire control mechanism 2300, as further described below. The second portion 2310 can extend from the first portion 2312 such that an exchange channel 2314 extends between the first and second portions 2310, 2312. The exchange channel 2314 can extend from the opening 2308 to the channel 2306 such that the exchange channel 2314 can be in communication with the channel 2306. The exchange channel 2314 can be configured to allow the two or more wires to move between the first and second portions 2310, 2312, as further described below. In some

configurations, the wire control mechanism 2300 can include a plurality of channels (e.g., two, three, four, five). In some aspects, each of the plurality of channels can be independently closed and opened.

[0172] The wire control mechanism 2300 can include the cap 2316 configured to engage with the proximal end 2304 of the wire control mechanism 2300. The cap 2316 may be attached to the proximal end 2304 (e.g., via a hinge) or the cap 2316 may be completely removable from the proximal end 2304. The cap 2316 can comprise a first cutout 2318 and a second cutout 2320. In some aspects, the cap 2316 can include a single cutout or more than two cutouts (e.g., three, four, five, six). In some configurations, the first cutout 2318 may be larger than the second cutout 2320. In other configurations, the first cutout 2318 may be smaller than or the same size as the second cutout 2320. In some configurations, the first cutout 2318 and/or the second cutout 2320 can include a seal. For example, the first cutout 2318 and/or the second cutout 2320 can include a silicone gel that can partially seal the cutout 2318, 2320 so that one or more wires or other equipment can be pushed through the silicone gel. The first cutout 2318 and/or the second cutout 2320 can include a material, including a flexible material, other than silicone gel that allows one or more wires or other equipment to be pushed through the material.

[0173] Figures 23A, 23C, and 24A illustrate the cap 2316 in an open configuration and Figures 23B, 23D, and 24B illustrate the cap 2316 in a closed configuration. In the open configuration, the cap 2316 may be disengaged from the proximal end 2304 such that the wire control mechanism 2300 includes a single channel and a user may freely move one or more wires between the first and second portions 2310, 2312 of the opening 2308 via the exchange channel 2314. For example, Figures 23C and 24A show two wires extending through the wire control mechanism 2300 while the cap 2316 is in the open configuration. The user may move one or both of the wires between the first and second portions 2310, 2312 of the opening 2308 via the exchange channel 2314. The user may also insert more wires into the opening 2308 while the cap 2316 is in the open configuration.

[0174] In the closed configuration, the cap 2316 may be coupled to the proximal end 2304 of the wire control mechanism 2300 such that the exchange channel 2314 can be covered and the cap 2316 forms two channels via the first and second cutouts 2318, 2320. For example, the cap 2316 can removably couple with the proximal end 2304 of the wire control

mechanism 2300 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable coupling that allows a user to easily open and close the cap 2316 as needed. For example, a first wire may extend through the first cutout 2318 and a second wire may extend through the second cutout 2320. The user can open the cap 2316 and move the first and second wires via the exchange channel 2314 so that when the user closes the cap 2316 the first wire can extend through the second cutout 2320 and the second wire can extend through the first cutout 2318. Advantageously, the wires and the wire control mechanism 2300 do not need to be removed from the catheter system in order for the user to move each wire to a different cutout 2318, 2320. As shown in Figure 23B and 23D, while in the closed configuration, the first cutout 2318 can align with the first portion 2312 of the opening 2308 and the second cutout 2320 can align with the second portion 2310 of the opening 2308. The cap 2316 can separate two or more wires while in the closed configurations. For example, as shown in Figures 23D and 24B, a first wire may extend through the first cutout 2318 and a second wire may extend through the second cutout 2320. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire).

[0175] In other embodiments, no cap or cutouts are required. The exchange channel(s) that separate the portions can be open and closed using a rotational mechanism, a push-button mechanism, or any other well-known design technique. For example, wire control mechanism depicted in Figures 23A-D could be configured to rotate the proximal portion of the wire control mechanism 2300 to block and unblock the exchange channel 2314. An additional push-button could be added to the wire control mechanism 2300 to block or unblock the exchange channel 2314.

[0176] In further embodiments, the wire control mechanism 2300 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the cap or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation.

[0177] Figures 25A-25B illustrate another configuration of an example wire control mechanism 2500 and a valve 2610 as transparent to show the internal components. The wire control mechanism 2500 can be the same as or similar to the wire control mechanism 2300 and the valve 2610 can be the same as or similar to the valve 2410 described above in relation to Figures 23A-24B except as described below. Reference numerals of the same or substantially the same features may share the same last two digits.

[0178] The proximal end 2504 of the wire control mechanism 2500 may include an opening (not shown) that can be covered by a cap 2516. The cap 2516 can be any shape including a circle, an oval, a square, a rectangle, or any suitable shape. The illustrated cap 2516 shown in Figures 25A-25B has a circular shape. The cap 2516 can include the first cutout 2518 spaced apart from the second cutout 2520. The first and second cutouts 2518, 2520 can include any shape including a circle, an oval, a square, a rectangle, or any suitable shape. The first and second cutouts 2518, 2520 can include the same or different shapes. For example, the first and second cutouts 2518, 2520 can both have circular shapes. In some configurations, the cap 2516 can be integrated with the proximal end 2504 of the wire control mechanism 2500. In some configurations, the cap 2516 can be removable from the proximal end 2504 of the wire control mechanism 2500.

[0179] Figures 26A-26C illustrate another configuration of an example wire control mechanism 2700 and valve 2810. The wire control mechanism 2700 can be the same as or similar to the wire control mechanism 2300, 2500 and the valve 2810 can be the same as or similar to the valve 2410, 2610 described above in relation to Figures 23A-25B except as described below. Reference numerals of the same or substantially the same features may share the same last two digits.

[0180] Figures 26A-26B illustrate a proximal view and a distal perspective view of the cap 2716 of the wire control mechanism 2700. The cap 2716 can include a thickness measured in the distal to proximal direction such that the first and second cutouts 2718, 2720 of the cap 2716 are positioned proximally of the proximal end 2504 of the wire control mechanism 2700. In some configurations, the cap 2716 can have a funnel-like shape such that the distal end of the cap 2716 has a larger diameter than the proximal end of the cap 2716.

[0181] Figure 26C illustrates a side view of the wire control mechanism 2700 attached to the valve 2810 with the wire control mechanism 2700 and the valve 2810 as

transparent to show the internal components. In the illustrated configuration, the distal end 2702 of the wire control mechanism 2700 has a greater diameter than the proximal end 2812 of the valve 2810 such that the proximal end 2812 of the valve 2810 can be received by the distal end 2702 of the wire control mechanism 2700. In some configurations, the cap 2716 can be integrated with the proximal end 2704 of the wire control mechanism 2700. In some configurations, the cap 2716 can be removable from the proximal end 2704 of the wire control mechanism 2700.

[0182] In some configurations, the wire control mechanism 2700 can include a blocking mechanism 2722, such as a button, a lever, or the like, configured to block the channel 2706. For example, the blocking mechanism 2722 can be positioned at the proximal end 2704 of the wire control mechanism 2700 adjacent the cap 2716 when the cap 2716 is attached to the proximal end 2704. When a user engages the blocking mechanism 2722 (e.g., pushes the button), the blocking mechanism 2722 moves to partially or wholly block the channel 2706. When the user disengages the blocking mechanism 2722 (e.g., moves the button outward), the blocking mechanism 2722 moves to partially or wholly open the channel 2706. In use, for example, a user may move the blocking mechanism 2722 to partially block the channel 2706 such that the first cutout 2718 is not in communication with the channel 2706, which allows the user to load the guide wire through the second cutout 2720 and into the channel 2706. The user can move the blocking mechanism 2722 such that the channel 2706 is open and the user can load the device wire(s) through the first cutout 2718 into the channel 2706.

[0183] In some configurations, the wire control mechanism 2700 can be configured to be pushed or depressed distally to open the seal of the valve 2810 to allow fluid, such as blood, to exit the valve 2810 and/or to allow the user to insert or remove equipment. When the wire control mechanism 2700 is released, the seal of the valve 2810 may close.

Integrated Catheter Design To Maximize Space, Support, and Function

[0184] The dynamic catheter system enables optimal guide catheter and guide extension catheter designs. By integrating the guide catheter and guide extension catheter into a single system, the dynamic catheter system unlocks an entirely new set of design options to maximize space and guide support. For practitioners, the inner diameter space within the

catheter system can be critical, because the inner diameter space can dictate the type of advanced equipment that can be used while keeping the catheters in place. For example, stents, balloons, intravascular ultrasound (IVUS) equipment, and optical coherence tomography (OCT) equipment are some examples of equipment used by interventional cardiologists. The greater inner diameter space can be a significant advantage. For example, an inner diameter space of between 0.03 mm to 0.30 mm (about 0.03 mm to 0.30 mm) can be beneficial.

[0185] Balancing inner diameter space with the ability of the guide catheter and guide extension catheters to hold their form can be a challenge. Thinner walls and less material can lead to a reduction in the strength of the catheter walls but allow for more space for the equipment to pass. The integrated catheter approach can allow for the guide extension catheter to act as built in support for the guide catheter, hence enabling unique flexibility to re-engineer each catheter for optimal functionality.

[0186] Figure 27 illustrates cross-sections of three example configurations of a guide catheter shaft 2910, 3010, 3110 with a telescoping guide extension catheter 2912, 3012, 3112. The guide catheter shafts 2910, 3010, 3110 and the telescoping guide extension catheters 2912, 3012, 3112 can be the same as or similar to any of the guide catheter shafts and the telescoping guide extension catheters as described herein. The guide catheter shafts 2910, 3010, 3110 can be used in any vascular artery. As described herein, the entirety or almost the entirety of the guide catheter shaft (as well as the guide extension catheter shaft) can be positioned within an artery during a procedure. The guide catheter shafts 2910, 3010, 3110 can include a distal end 2904, 3004, 3104 (or leading end) that is first introduced into and extends through the artery and a proximal end 2906, 3006, 3106 (or trailing end) that transitions into a wire of the guide catheter.

[0187] The integrated catheter approach allows for more space by reducing the wall thickness of either catheter shaft (or both). Figures 28A-28C illustrate an example implementation of a guide catheter shaft 2910 integrated with a telescoping guide extension catheter 2912. In this implementation, the guide catheter 2910 wall thickness has been reduced slightly while the guide extension catheter 2912 wall thickness has been reduced more drastically. The guide catheter 2910 can have a constant wall thickness extending from a distal end 2904 to a proximal end 2906. In an example embodiment, this guide catheter 2910 wall thickness is anywhere from 5-15% thinner than the equivalent sized guide catheters on the

market. The reduction in wall thickness can be accomplished by, for example, changes to the coating layers, braiding pattern, or material selection. Depending on the French size of the integrated catheter system (e.g., 4F, 5F, 6F, etc.), the wall thickness of each catheter can range between about 0.1 mm and about 3 mm, about 0.5 mm and about 2.5mm, about 1.0 mm and about 2.0 mm, or about 0.125 mm. Depending on the French size of the integrated catheter system, the wall thickness of the guide catheter can be larger or smaller than the sizes described herein. The guide extension catheter 2912 can have a constant wall thicknesses extending from a distal end 2914 of a shaft of the guide extension catheter 2912 to a proximal end 2916 of the shaft of the guide extension catheter 2912. In an example embodiment, the guide extension catheter 2912 is anywhere from 15-30% thinner than the equivalent sized guide extension catheter on the market. Depending on the French size of the integrated catheter system (e.g., 4F, 5F, 6F, etc.), the wall thickness can be between about 0.05 mm and about 3 mm, about 0.5 mm and about 2.5mm, about 1.0 mm and about 2.0 mm, or about 0.1 mm. Depending on the French size of the integrated catheter system, the wall thickness of the guide extension catheter can be larger or smaller than the sizes described herein. In the illustrated configuration, the wall thickness of the guide catheter 2910 can be greater than the wall thickness of the guide extension catheter 2912. In other configurations, the wall thickness of the guide catheter 2910 can be less than the wall thickness of the guide extension catheter 2912.

[0188] In some configurations, the guide extension catheter 2912 can have a diameter that is less than an inner diameter of the guide catheter 2910 such that the guide extension catheter 2912 can be positioned within the guide catheter 2910. For example, an inner diameter of the guide extension catheter 2912 can be between about 0.5 mm and about 5 mm, about 1.0 mm and about 4.5mm, about 1.5 mm and about 4.0 mm, about 2.0 mm and about 3.5 mm, or about 2.5 mm and about 3.0 mm. In some configurations, the inner diameter of the guide extension catheter 2912 can be about 1.17 mm, about 1.45 mm, about 1.6 mm, or about 1.80 mm.

[0189] In some aspects, the guide extension catheter 2912 can include a transition region 2918. At the transition region 2918, a wire of the guide extension catheter 2912 can transition into the shaft of the guide extension catheter 2912.

[0190] Figures 29A-29C illustrate an example implementation of a guide catheter shaft 3010 integrated with a telescoping guide extension catheter 3012. In this implementation,

the guide catheter 3010 wall thickness has been reduced drastically while the guide extension catheter 3012 wall thickness has been reduced more slightly. The guide catheter 3010 can have a constant wall thickness extending from a distal end 3004 to a proximal end 3006. In an example embodiment, this guide catheter 2910 wall thickness is anywhere from 15-40% thinner than the equivalent sized guide catheters on the market. For example, the wall thickness can be between about 0.01 mm and about 3 mm, about 0.5 mm and about 2.5mm, about 1.0 mm and about 2.0 mm, or about 0.065 mm. Depending on the French size of the integrated catheter system, the wall thickness of the guide catheter can be larger or smaller than the sizes described herein. The guide extension catheter 3012 can have a constant wall thicknesses extending from a distal end 3014 of a shaft of the guide extension catheter 3012 to a proximal end 3016 of the shaft of the guide extension catheter 3012. In an example embodiment, the guide extension catheter 2912 is anywhere from 5-15% thinner than the equivalent sized guide extension catheter on the market. For example, the wall thickness can be between about 0.05 mm and about 3 mm, about 0.5 mm and about 2.5mm, about 1.0 mm and about 2.0 mm, or about 0.125 mm. Depending on the French size of the integrated catheter system, the wall thickness of the guide extension catheter can be larger or smaller than the sizes described herein. In some configurations, the wall thickness of the guide catheter 3010 can be greater than the wall thickness of the guide extension catheter 3012. In the illustrated configuration, the wall thickness of the guide catheter 3010 can be less than the wall thickness of the guide extension catheter 3012.

[0191] In some configurations, the guide extension catheter 3012 can have a diameter that is less than an inner diameter of the guide catheter 3010 such that the guide extension catheter 3012 can be positioned within the guide catheter 3010. For example, an inner diameter of the guide extension catheter 3012 can be between about 0.5 mm and about 5 mm, about 1.0 mm and about 4.5mm, about 1.5 mm and about 4.0 mm, about 2.0 mm and about 3.5 mm, or about 2.5 mm and about 3.0 mm. In some configurations, the inner diameter of the guide extension catheter 3012 can be about 1.17 mm, about 1.45 mm, about 1.67 mm, or about 1.80 mm. In some configurations, the guide extension catheter shaft length can be extended to provide additional support to the guide catheter. For example, for use in the coronary artery, the guide extension catheter length can range from 15 cm to 200 cm, depending on the additional support desired.

[0192] As shown in Figure 27, the guide extension catheter 3012 can include a transition region 3018. At the transition region 3018, a wire of the guide extension catheter 3012 can transition into the shaft of the guide extension catheter 3012.

[0193] Figures 30A-30F illustrate an example implementation of an integrated catheter system with the catheters made with variable wall thickness. The variable wall thickness serves to further optimize inner diameter space and guide support. As shown in Figure 27, the guide catheter shaft 3110 and the guide extension catheter 3112 can each have a distal portion comprising a distal end 3104, 3114, a proximal portion comprising a proximal end 3106, 3116, and a middle portion 3105, 3115 extending between the ends 3104, 3106, 3114, 3116. In this implementation, the guide catheter 3110 and the guide extension catheter 3112 can each have a varying wall thickness throughout the length of the device. The wall thickness can either lead to a variable inner diameter or a variable outer diameter of each catheter within the integrated catheter system. For example, as shown in Figures 30A-30F, the system can include a guide catheter 3110 with a constant outer diameter and a variable inner diameter. The system further includes a guide extension catheter 3112 with a constant inner diameter and a variable outer diameter. The critical dimension for practitioner space can be the inner diameter of the guide extension catheter 3112, given that it is the smallest dimension that can limit space for equipment to pass.

[0194] Figures 30A-30F further depict examples of wall thickness transitions. The guide catheter 3110 transitions from a maximum wall thickness to a minimum wall thickness in the proximal to distal direction while the guide extension catheter 3112 has the inverse wall thickness transition. As shown in Figures 30A and 30D-30F, the guide catheter 3110 and the guide extension catheter 3112 can each have a first transition region 3120a, 3120b. For example, as shown in Figure 30D, the first transition regions 3120a, 3120b can overlap when the guide catheter 3110 and the guide extension catheter 3112 are in a closed or unexpanded configuration, as further described below in relation to Figure 30F.

[0195] In some configurations, the maximum wall thickness of the guide catheter 3110 can be between about 0.01 mm and about 3 mm, about 0.5 mm and about 2.5mm, about 1.0 mm and about 2.0 mm, or about 0.125 mm. The minimum wall thickness of the guide catheter 3110 can be between about 0.01 mm and about 3 mm, about 0.5 mm and about 2.5mm, about 1.0 mm and about 2.0 mm, or about 0.085 mm. For example, the maximum wall

thickness of the guide extension catheter 3112 can be between about 0.01 mm and about 3 mm, about 0.5 mm and about 2.5mm, about 1.0 mm and about 2.0 mm, or about 0.125 mm. The minimum wall thickness of the guide extension catheter 3112 can be between about 0.01 mm and about 3 mm, about 0.5 mm and about 2.5mm, about 1.0 mm and about 2.0 mm, or about 0.085 mm. In one embodiment, the maximum wall thickness of the guide extension catheter 3112 can be about 0.125 mm and the minimum wall thickness of the guide extension catheter 3112 can be about 0.085 mm.

[0196] In some configurations, the varying wall thicknesses of the guide catheter 3110 and the guide extension catheter 3112 can be inversely related. For example, the wall thickness of the guide extension catheter 3112 can decrease from the maximum wall thickness to the minimum wall thickness in a distal to proximal direction while the wall thickness of the guide catheter 3110 can decrease from the maximum wall thickness to the minimum wall thickness in a proximal to distal direction. There are at least two distinct characteristics of these configurations. First, the catheter space 3120 between each catheter can be optimized and constant. In some embodiments, the catheter space 3120 is up to 20% less than the catheter space when non-integrated catheters are used in tandem. The catheter space 3120 can be critical in determining the frictional interaction between catheters as well as impacting the optimal inner diameter of the guide extension catheter 3112. Second, the total combined thickness of the catheters remains constant (in the closed position, as described with reference to the closed position versus extended position described herein).

[0197] In some configurations, the guide extension catheter 3112 can have a diameter that is less than an inner diameter of the guide catheter 3110 such that the guide extension catheter 3112 can be positioned within the guide catheter 3110. For example, an inner diameter of the guide extension catheter 3112 can be between about 0.5 mm and about 5 mm, about 1.0 mm and about 4.5mm, about 1.5 mm and about 4.0 mm, about 2.0 mm and about 3.5 mm, or about 2.5 mm and about 3.0 mm. In some configurations, the inner diameter of the guide extension catheter 3112 can be about 1.17 mm, about 1.45 mm, about 1.63 mm, or about 1.80 mm. Advantageously, the increased inner diameter of the guide extension catheter 3112 can allow larger tools or equipment to be inserted through the guide extension catheter 3112 without requiring the user to remove the guide extension catheter 3112 from the guide catheter 3110.

[0198] As shown in Figure 27, the guide extension catheter 3112 can include a second transition region 3118. At the transition region 3118, a wire of the guide extension catheter 3112 can transition into the shaft of the guide extension catheter 3112.

[0199] Figure 30F illustrates a closed or unexpanded configuration with the distal end 3114 of the guide extension catheter 3112 positioned concentrically in the guide catheter 3110 and the distal end 3114 of the guide extension catheter 3112 is flush with and does not extend beyond the distal end 3104 of the guide catheter 3110. In some configurations, the first transition regions 3120a, 3120b can be positioned in the middle portion 3105, 3115 (Figure 27) of the guide catheter 3110 and the guide extension catheter 3112, respectively. For example, the middle portion 3105, 3115 (Figure 27) can include a distal section 3102 (Figures 30D-30F) and the first transition regions 3120a, 3120b can be located within the distal section 3102 when the guide catheter 3110 and the guide extension catheter 3112 are in the closed or unexpanded configuration. While in the closed or unexpanded configuration, the maximum wall thickness of the guide extension catheter 3112 can be positioned concentrically in the minimum wall thickness of the guide catheter 3110 at distal ends 3104, 3114 of the guide catheter 3110 and the guide extension catheter 3112 as well as distal to the distal section 3102. Additionally, the minimum wall thickness of the guide extension catheter 3112 can be positioned concentrically in the maximum wall thickness of the guide catheter 3110 proximal to the distal section 3102.

[0200] Figure 30E illustrates an extended or expanded configuration with the distal end 3114 of the guide extension catheter 3112 extending beyond the distal end 3104 of the guide catheter 3110. In the extended or expanded configuration, the maximum wall thickness of the guide extension catheter 3112 can extend beyond the distal end 3104 of the guide catheter 3110 such that the minimum wall thickness of the guide extension catheter 3112 is positioned concentrically in the minimum wall thickness of the guide catheter 3110. The maximum wall thickness of the guide extension catheter 3112 can provide support for any tools or other objects that are inserted through the guide extension catheter 3112 while in the extended or expanded configuration. Additionally, the alignment of the minimum wall thicknesses for both the guide catheter 3110 and the guide extension catheter 3112 provides a double wall arrangement to support the thinner wall sections of the guide catheter 3110 and the guide extension catheter 3112 during use. Additionally, in the extended or expanded

configuration, the maximum wall thickness of the guide catheter 3110 will be proximal to the double wall arrangement and the maximum wall thickness of the guide catheter 3110 can be sufficient to provide support to the proximal end of the catheter system. Advantageously, all portions of the guide catheter 3110 and guide extension catheter 3112 in the extended or expanded configuration can provide support for any tools or other objects that are inserted through the catheter system. Additionally, varying the wall thicknesses along the length of the guide catheter 3110 and the guide extension catheter 3112 maximizes the inner diameter of the guide catheter 3110 and the guide extension catheter 3112 for tools or other objects to be inserted through while maintaining a small overall diameter such that the guide catheter 3110 can be maneuvered through the artery. During a procedure, a length of the guide catheter 3110 can extend through the tortuosity of the vascular artery and the guide extension catheter 3112 can extend from distal end 3104 of the guide catheter 3112 when the distal end 3104 of the guide catheter 3112 is adjacent the treatment site.

[0201] There are various advantages of the integrated catheter system that lead to a more dynamic catheter system. An integrated guide catheter and guide extension catheter removes the need for the guide extension catheter 3112 to be placed mid-procedure. For example, in a typical percutaneous coronary intervention case with non-integrated catheters, the practitioner must push the guide extension catheter through the hemostatic valve and into a bendy, already placed guide catheter. This process can cause various problems. First, the practitioner must remove other equipment to make space for the guide extension catheter to be placed. Second, the guide extension catheter must be designed to fit through the valve and pass through the entire guide catheter, which places limitations on material selection, wall thickness, shaft length, and wire design.

[0202] In the integrated catheter system described herein, the guide extension catheter 3112 can be pre-loaded into the guide catheter 3110 and configured to be flush with the guide catheter 3110 on the distal most end. This allows for a practitioner to start a case by placing the integrated catheter system into the patient at one time and then simply extended the guide extension catheter 3112 when needed. This advantage allows for a broader choice of materials, braiding, coating, wall thickness, shaft length, and wire design for the guide extension catheter to broaden the use, function, safety, and effectiveness of the combined catheters. For example, for percutaneous coronary intervention procedures, a soft guide

extension catheter tip can be preferred to avoid arterial dissections and enable equipment like balloons to easily exit the catheter. With the integrated catheter system described herein, the tip materials and dimension can be customized to a greater degree.

[0203] The integrated catheter system can be more dynamic in that the integrated catheter system can be used for various vascular uses beyond extending a catheter into a coronary artery. Given the flexibility in design, the dynamic catheter system can be used in various peripheral vascular procedures around the body. For example, the dynamic catheter system described herein can be used in sheath-less procedures. The dynamic catheter system described herein can be used to extend the guide catheter 3110 within the aorta or other arteries where more guide catheter support can be required (not necessarily within smaller arteries). Fewer guide catheter sizes can be manufactured and utilized with confidence, which can lead to safer and faster procedures and ultimately, better patient outcomes.

Different configurations of wire storage mechanisms

[0204] In some embodiments, the dynamic catheter system can be replaced with an additional wire port on the hemostatic valve for the guide extension catheter wire. The wire port allows for the guide extension catheter and/or the guide catheter wire to remain separate to reduce wire confusion and entanglement. The wire port could be built distal or proximal to the hemostatic valve seal. If the wire port is distal to the valve seal, the same sealing technology (or equivalent) discussed above could be applied. If the wire port is proximal to the valve seal, no additional sealing would be required. The guide extension catheter wire port can be configured to accept the guide extension catheter wire and maximize efficiency of wire movement. In some embodiments, the dynamic catheter system can consist of the additional wire port on the hemostatic valve described above as well as a wire storage mechanism. Figures 31A-38B illustrate different configurations of wire storage mechanisms and assorted accessories. This embodiment can prevent extra wire from cluttering the limited space for the practitioner. As further discussed below in relation to Figures 32A-32C, an anchor 4006 can offer the practitioner the option to anchor the guide extension catheter wire to the table, thereby preventing unintended movement of the guide extension wire.

[0205] Figures 31A-31D illustrate a compact spool mechanism 4000 configured to store a wire 4002. The compact spool mechanism 4000 can have a bend radius of between

about 2 mm and about 20 mm, about 5 mm and about 15 mm, or about 10 mm. The compact spool mechanism 4000 can have a total diameter of between about 0.5 inches and about 5 inches, about 1 inch and about 4 inches, about 2 inches and about 3 inches. The compact spool mechanism 4000 can have a friction opening 4004 configured to increase the resistance on the wire 4002 when the wire 4002 is pulled through the opening 4004 or retracts through opening 4004. In use, wire 4002 can be stored within the spool mechanism 4000 (Figure 31B). When a user needs more length, the user can pull the wire 4002 from the spool mechanism 4000 (Figure 31C). When a pulling force is not being applied to the wire 4002, the wire 4002 can retract into the spool mechanism 4000.

[0206] Figures 32A-32C illustrate an example anchor 4006. The anchor 4006 can include a friction pad on a bottom surface of the anchor 4006. The anchor 4006 can be configured to weigh down the spool mechanism 4000 on a surface in use. Advantageously, the anchor 4006 can allow a user to pull the wire 4002 from the spool mechanism 4000 without needing to hold or otherwise handle the spool mechanism 4000. In some configurations, the anchor 4006 can include one or more prongs 4008a, 4008b. The illustrated configuration of the anchor 4006 has two prongs 4008a, 4008b. As shown in Figure 32B, the spool mechanism 4000 can be attached to the anchor 4006. For example, the spool mechanism 4000 can include an opening 4001. In some aspects, the opening 4001 can be configured to receive the one or more prongs 4008a, 4008b. Alternatively, as shown in Figure 32C, the wire 4002 can be pulled through a portion of the anchor 4006. In some aspects, the prongs 4008a, 4008b are configured to be moveable. For example, the prongs 4008a, 4008b can be moved toward one another to tighten a grip on the wire 4002. Alternatively, the prongs 4008a, 4008b can be moved apart to loosen a grip on the wire 4002.

[0207] Figure 33 illustrates a configuration of a spool mechanism 4100. Similar to the spool mechanism 4000, the spool mechanism 4100 can be configured to store a wire 4102. The spool mechanism 4100 can include a housing 4106. The housing 4106 can have a length of between about 5 cm and about 20 cm, about 10 cm and about 15 cm, or about 8 cm. The housing 4106 can have a width of between about 5 cm and about 20 cm, about 10 cm and about 15 cm, or about 8 cm. The housing 4106 can include a friction opening 4104 configured to keep the wire 4102 in place when the user is not pulling the wire 4102 or when the wire 4102 is not retracting into the spool mechanism 4100. The wire 4102 can form a single loop within

the housing 4106. For example, the loop can have a diameter of between about 1 cm and about 20 cm, about 5 cm and about 15 cm, or about 4 cm. In some configurations, the wire 4102 can form multiple loops within the housing 4106.

[0208] Figures 34A-34B illustrate a configuration of a spool mechanism 4200. The spool mechanism 4200 can include a housing 4206 configured to be opened (Figure 34A) and closed (Figure 34B). The spool mechanism 4200 can include a spool 4208 stored within the housing 4206. The spool 4208 can be configured to store a wire 4202. In use, the wire 4202 can be pulled through an opening 4204 of the housing 4206. When a user pulls the wire 4202 from the housing 4206, the spool 4208 can rotate a first direction. When the wire 4202 is being retracted into the housing 4206, the spool 4208 can rotate the opposite direction. In some configurations, the spool 4208 can be disposable. Advantageously, the housing 4206 can be opened and closed for ease of loading a new spool 4208 and removing an old spool 4208. In some configurations, the spool 4208 can be reusable.

[0209] Figure 35 illustrates a spool base 4210. The spool base 4210 can be used to combine multiple spool mechanisms 4200. For example, the illustrated configuration shows three spool mechanisms 4200. In some configurations, the spool base 4210 can hold two spool mechanisms 4200 or more than three spool mechanisms 4200 (e.g., four, five, six, seven).

[0210] Figure 36 illustrates a configuration of a spool mechanism 4300. The spool mechanism 4300 can include a spool 4304, a sliding guide 4306, a sliding rail 4310, and a pulley 4308. A wire 4302 can be wrapped around the spool 4304, pulled through the sliding guide 4306, and over the pulley 4308. The sliding guide 4306 can be positioned on the sliding rail 4310 such that the sliding guide 4306 can be moved along the length of the sliding rail 4310.

[0211] Figures 37 illustrates a configuration of a spool mechanism 4400. The spool mechanism 4400 can include a spool 4404 and a base 4408. The spool 4404 can be configured to store a wire 4402. The base 4408 can include a motor 4406 with an attachment portion 4410. The spool 4404 can be configured to attach to the attachment portion 4410 of the motor 4406. The motor 4406 can be configured to provide retraction and adjustable drag when the wire 4402 is being pulled from the spool 4404. In some configurations, the base 4408 can be configured to be reusable. In some configurations, the spool 4404 can be configured to be disposable.

[0212] Figures 38A and 38B illustrate a configuration of a spool mechanism 4500. The spool mechanism 4500 can include a spool 4504, a base 4512, a ratchet 4506, and a ratchet wheel 4514. One end of a wire 4502 can be received by a wire stop 4508 of the spool 4504 and wrapped around the spool 4504. The ratchet 4506 and the ratchet wheel 4514 can be positioned radially inward of the wire 4502. The spool mechanism 4500 can be configured to allow the wire 4502 to be pulled in one direction. The base 4512 can include a release button 4510 configured to disengage the ratchet 4506 from the ratchet wheel 4514 such that the wire 4502 can be wrapped around the spool 4504. In some configurations, the spool mechanism 4500 can include a spring configured to provide a force on the spool 4504 such that the wire 4502 retracts (i.e., wraps around the spool 4504) once the release button 4510 is actuated.

Configurations of Failsafe Mechanisms

[0213] Figures 39-41 illustrate configurations of failsafe mechanisms configured to attach to a valve (e.g., a hemostatic valve) and allow the user to manually manipulate the guide extension catheter wire in the event the actuation mechanism fails. The failsafe mechanism can be used with an actuation mechanism and catheter control center described herein. For example, the failsafe mechanisms can be configured to release the actuation mechanism if the user needs to manually manipulate the wire of the guide extension catheter. Moreover, the failsafe mechanisms can be configured to allow a user to remove a guide extension catheter from the guide catheter if the guide extension catheter is stuck, if more room is needed within the guide catheter, or for other reasons. Figure 39 illustrates a configuration of a failsafe mechanism 4600 used with a clamshell type actuation mechanism. The actuation mechanism 4600 can include a first portion 4602 and a second portion 4604. The first portion 4602 can be coupled to the second portion 4604 via a hinge 4606 at a first end of the actuation mechanism 4600. The first portion 4602 and the second portion 4604 can be removably coupled via coupling mechanism 4608. If the user needs to manually manipulate the wire 4610, the user can disengage the coupling mechanism 4608 such that the first and second portions 4602, 4604 can be separated. As illustrated in Figure 39, the coupling mechanism 4608 can be a button that can be twisted or unscrewed to uncouple the first portion 4602 and the second portion 4604. In some configurations, the coupling mechanism 4608 can be configured to move

the guide extension catheter in a proximal direction and a distal direction within the guide catheter.

[0214] Figure 40 illustrates a configuration of a failsafe mechanism 4700. The failsafe mechanism 4700 can include a first portion 4702 and a second portion 4704 configured to be separable from the first portion 4702. The first portion 4702 and the second portion 4704 can be removably coupled via coupling mechanism 4708 (e.g., a screw). If the user needs to manually manipulate the wire 4710, the user can disengage the coupling mechanism 4708 (e.g., unscrewing a screw) such that the first and second portions 4702, 4704 can be separated. The failsafe mechanism 4700 can include an actuation mechanism 4712 configured to move the guide extension catheter in a proximal direction and a distal direction within the guide catheter.

[0215] Figure 41 illustrates a configuration of a failsafe mechanism 4800. The failsafe mechanism 4800 can include an actuation mechanism with a first portion 4802 and a second portion 4804 configured to be separable from the first portion 4802. For example, the second portion 4804 can comprise a cap 4804 and the first portion 4802 can include a threaded portion configured to engage with the cap 4804. If the user needs to manually manipulate the wire (not shown), the user can disengage and remove the cap of the second portion 4804 from the first portion 4802.

Different Wire Control Mechanisms

[0216] Wire control mechanisms as described herein can be used to allow a user to control and manipulate two or more wires used with the systems described herein. As described herein, it can be beneficial to have a wire control mechanism that can separate and/or combine two or more wires at the beginning, middle, or end of a procedure to allow the user to easily identify and manipulate the wires. For example, the wire control mechanism can keep a guide wire separate from a device wire.

[0217] Figures 23A-26C, as described previously, illustrate example wire control mechanisms that can be integral with or attached to a proximal end of a dynamic catheter system. The wire control mechanisms described in Figures 42A-52H can also be integral with or attached to a proximal end of a dynamic catheter system. Any of the wire control mechanisms described herein can be integral with or attached to a valve (e.g. hemostatic valve). For example, a wire control mechanism and a valve can be part of a unibody (e.g., single

structure) device such that the wire control mechanism and the valve are not removable from each other. A unibody wire control mechanism and valve can be integral with or attached to any of the dynamic catheter systems described herein or can be used with any other catheter system, device, or procedure that utilizes one or more wires. Any features of the wire control mechanisms, including, but not limited to, doors (*e.g.*, 4916a, 4916b, 5016), discs (*e.g.*, 5116), liners (*e.g.*, 5216), insert (*e.g.*, 5316), sleeves (*e.g.*, 5416, 5516), caps (*e.g.*, 5616), and/or the sliding components (*e.g.*, 5716a-d) can be integral or attached to a valve. The valve described herein can include a tuohy force valve, a tuohy valve system, a hemostasis valve, a y-connector valve, or any other valve system used with or without a catheter system.

[0218] The wire control mechanisms can couple to or be integral with a valve at the proximal end of the dynamic catheter system, such as one of the dynamic catheter systems 1700, 1800, 2100 described above. Further, the dynamic catheter system can include a guide catheter, guide extension catheter, and a hemostatic valve incorporating the wire control mechanism. In some cases, a catheter control system is not required. Although the wire control mechanisms are described as being used with a dynamic catheter system, the wire control mechanisms can be used with any catheter system, device, or procedure that utilizes one or more wires. For example, all hemostatic valves or valves in use today could benefit from the incorporation of a wire control mechanism as described herein.

[0219] The wire control mechanism shown in Figures 42A-43C can be similar to the wire control mechanism 2300 shown in Figures 23A-24B. The wire control mechanism shown in Figures 42A-43C can include an angle between the second portion and the first portion greater than the angle between the second portion 2310 and the first portion 2312. For example, the wire control mechanism 2300 can include an angle of about 35 degrees between the second portion 2310 and the first portion 2312, while the wire control mechanism shown in Figures 42A-43C can include an angle of about 45 degrees between the second portion and the first portion.

[0220] Figure 42F-42G and 43B-43C show a first wire W1 passing through a first portion of an opening and a second wire W2 passing through the second portion the opening. The wires W1, W2, can be moved from one portion of the opening to another as described above. The wire control mechanism can receive one wire or more than two wires at the same time.

[0221] Figures 44A-44D illustrate another configuration of an example wire control mechanism 4900. The wire control mechanism 4900 can comprise a distal end 4902, a proximal end 4904, and a channel 4906 extending between the distal end 4902 and the proximal end 4904. The wire control mechanism 4900 can include a first door 4916a and a second door 4916b configured to separate two or more wires. The doors 4916a, 4916b can include a first end and a second end opposite the first end. For example, the first and second doors 4916a, 4916b can be attached or coupled to the proximal end 4904 via a hinge so that one or both of the first door 4916a and the second door 4916b can include a closed configuration when the second end of the doors 4916a, 4916b is attached is coupled to an edge 4905 of the proximal end 4904, and an open configuration when the second end of doors 4916a, 4916b is removed from the edge 4905 of the proximal end 4904. In some cases, the doors 4916a, 4916b comprise a substantially rectangular shape. The doors 4916a, 4916b, however, can comprise other shapes including a square shape, a circular shape, or any other suitable shape. The first door 4916a and the second door 4916b can comprise the same or substantially the same shape, size, and/or volume, or different shapes, sizes, and/or volume.

[0222] As shown in Figures 44C and 44D, the distal end 4902 can be integral with or configured to be removably coupled to the proximal end 4912 of a dynamic catheter system. For example, Figures 44C and 44D illustrates a valve 4910 of a dynamic catheter system. The dynamic catheter system can include the valve 4910, such as a hemostatic valve, at the proximal end 4912 configured to couple to the distal end 4902 of the wire control mechanism 4900. In some configurations, the valve 4910 can include and be integral with the wire control mechanism 4900. The valve 4910 can be the same or similar to any of the valve 1710, 1712, 1810, 2110 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 4910 can include any valve, such as a hemostatic valve. For example, the valve 4910 can comprise a rotatable component configured to open or close a seal of the valve 4910. In some configurations, the valve 4910 can comprise a button configured to be pressed to open or close the seal of the valve 4910. In some aspects, the valve 4910 can comprise a rotatable component and a button configured to open or close the seal of the valve 4910.

[0223] The distal end 4902 of the wire control mechanism 4900 can be configured to receive or be received by the proximal end 4912 of the valve 4910. During a procedure, the

user may couple the wire control mechanism 4900 to the valve 4910 or remove the wire control mechanism 4900 from the valve 4910. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 4900 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control mechanism 4900 to the valve 4910 prior to a procedure. In some configurations, the distal end 4902 can be integral with the valve 4910. For example, distal end 4902 and valve 4910 can be part of a unibody (e.g., single structure) device such that the distal end 4902 and the valve 4910 are not removable from each other. A unibody wire control mechanism and valve can be attached to the dynamic catheter system described herein or to any other catheter system, device, or procedure that utilizes one or more wires. The illustrated configuration shows the proximal end 4912 of the valve 4910 comprising a greater diameter than the distal end 4902 such that distal end 4902 of the wire control mechanism 4900 can be received by the proximal end 4912 of the valve 4910. The distal end 4902 of the wire control mechanism 4900 can couple to the valve 4910 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0224] As shown in Figures 44A-44D, the proximal end 4904 can comprise an opening 4908. The opening 4908 can align with the channel 4906 such that the opening 4908 can be in communication with an inner channel of the valve 4910 and/or the dynamic catheter system. In some configurations, the proximal end 4904 can include a plurality of openings (e.g., two, three, four, five). The opening 4908 can include a first portion 4912a, a second portion 4912b, and a third portion 4912c. In some cases, the opening 4908 can include a single portion, two portions, or more than three portions (e.g., four, five, six). The second portion 4912b can align with the channel 4906, and the first portion 4912a and third portion 4912c can be angled from the channel 4906. The angle between the first portion 4912a or third portion 4912c, and the second portion 4912b can be between about 5 degrees and about 60 degrees, about 5 degrees and about 80 degrees, about 10 degrees and about 50 degrees, about 20 degrees and about 40 degrees, or about 15 degrees. This angle can control the distance between two or more wires extending through the wire control mechanism 4900, as further described below. The first portion 4912a and third portion 4912c can extend from the second portion 4912b such that an exchange channel 4914a extends between the first and second portions 4912a, 4912b,

and such that an exchange channel 4914b extends between the second and third portions 4912b, 4912c. A width of the exchange channels 4914a, 4914b and first and third portions 4912a, 4912c can be less than a width of the first portion 4912a. In some cases, the first and third portions 4912a, 4912c can extend radially at an angle to channel 4906. The exchange channels 4914a and 4914b can extend from the opening 4908 to the channel 4906 such that the exchange channels 4914a and 4914b can be in communication with the channel 4906. The exchange channels 4914a and 4914b can be configured to allow the two or more wires to move between the first, second, and third portions 4912a, 4912b, 4912c, as further described below. In some configurations, the wire control mechanism 4900 can include a plurality of channels (e.g., two, three, four, five). In some aspects, each of the plurality of channels can be independently closed and opened.

[0225] The wire control mechanism 4900 can include the first door 4916a and second door 4916b configured to engage with the proximal end 4904 of the wire control mechanism 4900. The first door 4916a and second door 4916b may be attached to the proximal end 4904 (e.g., via a hinge) or the first door 4916a and second door 4916b may be completely removable from the proximal end 4904.

[0226] Figures 44E illustrates the wire control mechanism 4900 with both the first door 4916a and second door 4916b in an open configuration, and Figure 44F illustrates the wire control mechanism 4900 with both the first door 4916a and second door 4916b in a closed configuration. In the open configuration, the first door 4916a and second door 4916b may be disengaged from the proximal end 4904 such that the wire control mechanism 4900 includes a single channel and a user may freely move one or more wires between the first, second, and third portions 4912a, 4912b, 4912c of the opening 4908 via the exchange channel 4914a or the exchange channel 4914b. For example, three wires can extend through the wire control mechanism 4900 while the first door 4916a and the second door 4916b are in the open configuration. The user may move one or more of the wires between the first, second, and third portions 4912a, 4912b, 4912c of the opening 4908 via the exchange channel 4914a or the exchange channel 4914b. The user may also insert more wires into the opening 4908 when the first door 4916a or second door 4916b are in the open configuration.

[0227] In the closed configuration, the first door 4916a or second door 4916b may be coupled to the proximal end 4904 of the wire control mechanism 4900 such that at least a

portion of the exchange channel 4914a or the exchange channel 4914b can be covered and the first door 4916a and second door 4916b can separate the three portions 4912a, 4912b, 4912c of the opening 4908. For example, the first door 4916a and second door 4916b can removably couple with the proximal end 4904 of the wire control mechanism 4900 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable coupling that allows a user to easily open and close the first door 4916a or second door 4916b as needed. For example, a first wire may extend through the first portion 4912a of the opening 4908, a second wire may extend through the second portion 4912b of the opening 4908, and a third wire may extend through the third portion 4912c of the opening 4908. The user can open the first door 4916a or second door 4916b and move the first, second, and/or third wires via the first exchange channel 4914a and the second exchange channel 4914b so that when the user closes the first door 4916a and second door 4916b the first wire can extend through the second portion 4912b of the opening 4908, the second wire can extend through the third portion 4912c of the opening 4908, and the third wire can extend through the first portion 4912a of the opening 4908. Advantageously, the wires and the wire control mechanism 4900 do not need to be removed from the catheter system in order for the user to move each wire to a different portion 4912a, 4912b, 4912c of the opening 4908. The first door 4916a and second door 4916b can separate two or more wires while in the closed configurations. For example, a first wire may extend through the first portion 4912a of the opening 4908, a second wire may extend through the second portion 4912b of the opening 4908, and a third wire may extend through the third portion 4912c of the opening 4908. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire).

[0228] Figure 44E shows a first wire W1 passing through first portion 4912a, a second wire W2 passing through the second portion 4912b, and a third W3 passing through the third portion 4912c, when the first and second doors 4916a, 4916b are in the open configuration. The wires W1, W2, W3 can be moved from one portion to another as described above. The wire control mechanism 4900 can receive one wire, two wires, or more than three wires at the same time. Figure 44F shows a first wire W1 passing through first portion 4912a, a second wire W2 passing through the second portion 4912b, and a third W3 passing through

the third portion 4912c, when the first and second doors 4916a, 4916b are in the closed configuration.

[0229] In other embodiments, no cap or door is required. The exchange channel(s) that separate the portions can be open and closed using a rotational mechanism, a push-button mechanism, or any other well-known design technique. For example, the wire control mechanism could be configured to rotate the proximal portion of the wire control mechanism 4900 to block and unblock the exchange channels. An additional push-button could be added to the wire control mechanism 4900 to block or unblock the exchange channels 4914a and/or 4914b.

[0230] In further embodiments, the wire control mechanism 4900 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the cap or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation.

[0231] Figures 45A-45C illustrate another configuration of an example wire control mechanism 5000. The wire control mechanism 5000 can comprise a distal end 5002, a proximal end 5004, and a channel 5006 extending between the distal end 5002 and the proximal end 5004. The wire control mechanism 5000 can include a door 5016 configured to separate two or more wires. The door 5016 can include a first end and a second end opposite the first end. For example, the first end of door 5016 can be attached or coupled to the proximal end 5004 via hinge so that the door 5016 can include a closed configuration when the second end of the door 5016 is coupled to an edge 5005 of the proximal end 5004 and an open configuration when the second end of door 5016 is removed from the edge 5005 of the proximal end 5004. In some cases, the door 5016 comprises a substantially rectangular shape. The door 5016, however, can comprise other shapes including a square shape, a circular shape, or any other suitable shape. When the door 5016 is in the closed configuration, the door 5016 can separate the two or more wires without removing the two or more wires from the wire control mechanism 5000 and without removing the wire control mechanism 5000 from the

catheter system, as further described below. In other configurations, the door 5016 can include a rotatable mechanism, a pivotable mechanism, or any other mechanism that can separate the two or more wires without removing the wire control mechanism 5000 from the dynamic catheter system.

[0232] The distal end 5002 can be integral with or configured to be removably coupled to the proximal end 5012 of a dynamic catheter system. For example, Figure 45 illustrates a valve 5010 of a dynamic catheter system. The dynamic catheter system can include the valve 5010, such as a hemostatic valve, at the proximal end 5012 configured to couple to the distal end 5002 of the wire control mechanism 5000. In some configurations, the valve 5010 can include and be integral with the wire control mechanism 5000. The valve 5010 can be the same or similar to any of the valve 1710, 1712, 1810, 2110 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 5010 can include any valve, such as a hemostatic valve. For example, the valve 5010 can comprise a rotatable component configured to open or close a seal of the valve 5010. In some configurations, the valve 5010 can comprise a button configured to be pressed to open or close the seal of the valve 5010. In some aspects, the valve 5010 can comprise a rotatable component and a button configured to open or close the seal of the valve 5010.

[0233] The distal end 5002 of the wire control mechanism 5000 can be configured to receive or be received by the proximal end 5012 of the valve 5010. During a procedure, the user may couple the wire control mechanism 5000 to the valve 5010 or remove the wire control mechanism 5000 from the valve 5010. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 5000 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control mechanism 5000 to the valve 5010 prior to a procedure. In some configurations, the distal end 5002 can be integral with the valve 5010. For example, distal end 5002 and valve 5010 can be part of a unibody (e.g., single structure) device such that the distal end 5002 and the valve 5010 are not removable from each other. The illustrated configuration shows the distal end 5002 comprising a greater diameter than the proximal end 5012 of the valve 5010 such that the proximal end 5012 of the valve 5010 can be received by the distal end 5002 of the wire control mechanism 5000. The distal end 5002 of the wire control mechanism 5000 can couple to the

valve 5010 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0234] The proximal end 5004 can comprise an opening 5008. The opening 5008 can align with the channel 5006 such that the opening 5008 can be in communication with an inner channel of the valve 5010 and/or the dynamic catheter system. In some configurations, the proximal end 5004 can include a plurality of openings (e.g., two, three, four, five). The opening 5008 can include a first portion 5012a and a second portion 5012b. In some aspects, the opening 5008 can include a single portion, two portions, three portions, or more than three portions (e.g., four, five, six). The first portion 5012a can align with the channel 5006, and the second portion 5012b can be angled from the channel 5006. The angle between the first portion 5012a and the second portion 5012b can be between about 5 degrees and about 60 degrees, about 10 degrees and about 50 degrees, about 20 degrees and about 40 degrees, or about 15 degrees. This angle can control the distance between two or more wires extending through the wire control mechanism 5000, as further described below. The second portion 5012b can extend from the first portion 5012a such that an exchange channel 5014 extends between the first and second portions 5012a, 5012b. A width of the exchange channel 5014 and second portion 5012b can be less than a width of the first portion 5012a. In some cases, the second portion 5012b can extend radially at an angle to channel 5006. The exchange channel 5014 can extend from the opening 5008 to the channel 5006 such that the exchange channel 5014 can be in communication with the channel 5006. The exchange channel 5014 can be configured to allow the two or more wires to move between the first and second portions 5012a, 5012b, as further described below. In some configurations, the wire control mechanism 5000 can include a plurality of channels (e.g., two, three, four, five). In some aspects, each of the plurality of channels can be independently closed and opened.

[0235] The wire control mechanism 5000 can include the door 5016 configured to engage with the proximal end 5004 of the wire control mechanism 5000. The door 5016 may be attached to the proximal end 5004 (e.g., via a hinge) or the door 5016 may be completely removable from the proximal end 5004.

[0236] In the open configuration, the door 5016 may be disengaged from the proximal end 5004 such that the wire control mechanism 5000 includes a single channel and a user may freely move one or more wires between the first and second portions 5012a, 5012b,

of the opening 5008 via the exchange channel 5014. The user may move one or more of the wires between the first and second portions 5012a, 5012b, of the opening 5008 via the exchange channel 5014. The user may also insert more wires into the opening 5008 while the door 5016 is in the open configuration.

[0237] In the closed configuration, the door 5016 may be coupled to the proximal end 5004 of the wire control mechanism 5000 such that at least a portion of the exchange channel 5014 can be covered and the door 5016 can separate the portions 5012a, 5012b of opening 5008. For example, the door 5016 can removably couple with the proximal end 5004 of the wire control mechanism 5000 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable coupling that allows a user to easily open and close the door 5016 as needed. For example, a first wire may extend through the first portion 5012a of the opening 5008 and a second wire may extend through the second portion 5012b of the opening 5008. The user can open the door 5016 and move the first and second wires via the exchange channel 5014 so that when the user closes the door 5016 the first wire can extend through the second portion 5012b of the opening 5008 and the second wire can extend through the first portion 5012a of the opening 5008. Advantageously, the wires and the wire control mechanism 5000 do not need to be removed from the catheter system in order for the user to move each wire to a different portion 5012a, 5012b, of the opening 5008. The door 5016 can separate two or more wires while in the closed configuration. A first wire may extend through the first portion 5012a of the opening 5008 and a second wire may extend through the second portion 5012b of the opening 5008. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire).

[0238] When the door 5016 is in the closed configuration, the door 5016 can cover only a portion of the second portion 5012b and/or exchange channel 5014. In some cases, the uncovered space along portions 5012a, 5012b and the exchange channel 5014 when the door 5016 is in the closed configuration is greater than the uncovered space along portions 2310, 2312 (of the wire control mechanism 2300) when the cap 2316 is attached. Beneficially, the additional uncovered spaced along portions 5012a, 5012b, and exchange channel 5014 gives more space to a user to manipulate one or more wires along portions 5012a, 5012b, and exchange channel 5014.

[0239] Figure 45B shows a first wire W1 passing through first portion 5012a and a second wire W2 passing through the second portion 5012b when the door 5016 is in the closed configuration. The wires W1, W2 can be moved from one portion to another as described above. The wire control mechanism 4900 can receive one wire or more than two wires at the same time. Figure 45C shows a first wire W1 passing through first portion 5012a and a second wire W2 passing through the second portion 5012b when the door 5016 is in the open configuration.

[0240] In other embodiments, no cap or door is required. The exchange channel(s) that separate the portions can be opened and closed using a rotational mechanism, a push-button mechanism, or any other well-known design technique. For example, the wire control mechanism could be configured to rotate the proximal portion of the wire control mechanism 5000 to block and unblock the exchange channels. An additional push-button could be added to the wire control mechanism 5000 to block or unblock the exchange channel 5014.

[0241] In further embodiments, the wire control mechanism 5000 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the cap or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation.

[0242] Figures 46A-46F illustrate another configuration of an example wire control mechanism 5100 and a valve 5110. The wire control mechanism 5100 can be the same as or similar to the wire control mechanisms 2300, 4900, or 5000 and the valve 5610 can be the same as or similar to the valves 2410, 4910, or 5010 described above in relation to Figures 23A-24B, except as described below. Reference numerals of the same or substantially the same features may share the same last two digits.

[0243] The proximal end 5104 of the wire control mechanism 5100 may include an opening 5108 that can be at least partially covered by a disc portion 5116. The disc portion 5116 can be any shape including a circle, an oval, a square, a rectangle, or any suitable shape. The illustrated disc portion 5116 shown in Figures 46-46E has a circular shape. The disc

portion 5116 can include a cutout 5118 defining a continuous opening including a first region 5118a, a second region 5118b, and a third region 5118c. The first region 5118a and third region 5118c can comprise an arc shape. In some cases, however, the first region 5118a and third region 5118c can include any shape including a circle, an oval, a square, a rectangle, or any suitable shape. The second region 5118b can include a substantially circular shape with two slits 5118d, 5118d extending outwardly from opposing points of the circle as shown in Figure 46A-46E. In some cases, however, any number of slits or formations at any position can be used to provide flexibility for the components of the cap. In some cases, the second region 5118b can include any shape including an oval, a square, a rectangle, or any suitable shape. The first region 5118a, second region 5118b, and third region 5118c can include the same or different shapes. In some configurations, the disc portion 5116 can be integrated with the proximal end 5104 of the wire control mechanism 5100. In some configurations, the disc portion 5116 can be removable from the proximal end 5104 of the wire control mechanism 5100.

[0244] In some configurations, the first, second, and third regions 5118a, 5118b, 5118c can be separated by a seal. For example, a first bridge portion 5150a separating the first region 5118a and the second region 5118b can include a silicone gel having a slit or opening that can partially seal the first region 5118a from the second region 5118b (and vice versa) while still allowing a user to move one or more wires or other equipment between regions by pushing the one or more wires or other equipment through the slit or opening of the silicone gel. Similarly, a second bridge portion 5150b separating the second region 5118b and the third region 5118c can include a silicone gel having a slit or opening that can partially seal the second region 5118b from the third region 5118c (and vice versa) while still allowing a user to move one or more wires or other equipment between regions by pushing the one or more wires or other equipment through the slit or opening of the silicone gel. In some cases, the bridge does not include a silicone gel. For example, the length of the first bridge portion 5150a and the second bridge portion 5150b allow the free end of the first bridge portion 5150a and the second bridge portion 5150b to contact or nearly contact each other and may require users to exercise a minimum threshold force when moving a wire from one region to another. Beneficially, this can prevent accidental or unintentional switching of a wire from one region to another. While silicone gel or close contact is described as being used to prevent accidental

or unintentional switching of a wire from one region to another, any other mechanism can be used to separate or substantially separate the channels but still allow for an opening to provide selective communication between the channels.

[0245] When the disc portion 5116 is attached to the proximal end 5104 of the of the wire control mechanism 5100, the disc portion 5116 can separate the two or more wires without removing the two or more wires from the wire control mechanism 5100 and without removing the wire control mechanism 5100 from the catheter system. In other configurations, the disc portion 5116 can include a rotatable mechanism, a pivotable mechanism, or any other mechanism that can separate the two or more wires without removing the wire control mechanism 5100 from the dynamic catheter system.

[0246] A distal end 5102 of the wire control mechanism 5100 can be integral with or configured to be removably coupled to a proximal end 5112 of a dynamic catheter system. For example, Figure 46E illustrates a valve 5110 of a dynamic catheter system. The dynamic catheter system can include the valve 5110, such as a hemostatic valve, at the proximal end 5112 configured to couple to the distal end 5102 of the wire control mechanism 5100. In some configurations, the valve 5110 can include and be integral with the wire control mechanism 5100. The valve 5110 can be the same or similar to any of the valve 1710, 1712, 1810, 2110, 4910, 5010 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 5110 can include any valve, such as a hemostatic valve. For example, the valve 5110 can comprise a rotatable component configured to open or close a seal of the valve 5110. In some configurations, the valve 5110 can comprise a button configured to be pressed to open or close the seal of the valve 5110. In some cases, the valve 5110 can comprise a rotatable component and a button configured to open or close the seal of the valve 5110.

[0247] The distal end 5102 of the wire control mechanism 5100 can be configured to receive or be received by the proximal end 5112 of the valve 5100. During a procedure, the user may couple the wire control mechanism 5100 to the valve 5110 or remove the wire control mechanism 5100 from the valve 5110. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 5100 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control

mechanism 5100 to the valve 5110 prior to a procedure. In some configurations, the distal end 5102 can be integral with the valve 5110. For example, distal end 5102 and valve 5110 can be part of a unibody (e.g., single structure) device such that the distal end 5102 and the valve 5110 are not removable from each other. The illustrated configuration shows the distal end 5102 comprising a greater diameter than the proximal end 5112 of the valve 5110 such that the proximal end 5112 of the valve 5110 can be received by the distal end 5102 of the wire control mechanism 5100. The distal end 5102 of the wire control mechanism 5100 can couple to the valve 5110 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0248] The wire control mechanism 5100 can include the disc portion 5116 configured to engage with the proximal end 5104 of the wire control mechanism 5100. The disc portion 5116 may be attached to the proximal end 5104 or the disc portion 5116 may be completely removable from the proximal end 5104.

[0249] When the disc portion 5116 is not attached to the proximal end 5104 of the wire control mechanism 5100, the wire control mechanism 5100 includes a single channel where a user may freely move one or more wires. For example, three wires can extend through the wire control mechanism 5100 while the disc portion 5116 is not attached to the proximal end 5104 of the wire control mechanism 5100. The user may move one or more of the wires along the single channel. The user may also insert more wires into the single channel while the disc portion 5116 is not attached to the proximal end 5104 of the wire control mechanism 5100.

[0250] When the disc portion 5116 is attached to the proximal end 5104 of the wire control mechanism 5100, at least a portion of the channel is covered. The disc portion 5116 can removably couple with the proximal end 5104 of the wire control mechanism 5100 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable coupling that allows a user to easily attach and detach the disc portion 5116 as needed. When the disc portion 5116 is attached, a first wire may extend through the first region 5118a, a second wire may extend through the second region 5118b, and a third wire may extend through the third region 5118c. The user can move one or more of the first, second, and third wires to a different region by pushing the first, second, and/or third wires through the first bridge portion 5150a or the second bridge portion 5150b. For example, to move the first wire from the first region 5118a to the second region 5118b, the user can push the first wire from the first

region 5118a through the first bridge portion 5150a into the second region 5118b. Similarly, to move the third wire from the third region 5118c to the second region 5118b, the user can push the third wire from the third region 5118c through the second bridge portion 5150b into the second region 5118b. The wires and the wire control mechanism 5100 do not need to be removed from the catheter system in order for the user to move each wire to a different region 5118a, 5118b, 5118c. The disc portion 5116 can separate two or more wires while the disc portion 5116 is attached to the proximal end 5104 of the wire control mechanism 5100. A first wire may extend through the first region 5118a, a second wire may extend through the second region 5118b, and a third wire may extend through the third region 5118c. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire).

[0251] Figure 46F shows a first wire W1 passing through the first region 5118a, a second wire W2 passing through the second region 5118b, and a third wire W3 passing through the third region 5118c. The wires W1, W2, can be moved from one region to another as described above. The wire control mechanism 5100 can receive one wire, two wires, or more than three wires at the same time.

[0252] In further embodiments, the wire control mechanism 5100 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the cap or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation.

[0253] The wire control mechanism 5200 shown in Figures 47A-47C can be similar to any of the wire control mechanisms described herein and include one or more, or all of features of those wire control mechanisms. In some cases, the wire control mechanism 5200 can include a liner 5216 configured to separate two or more or wires. The liner 5216 can include a bridge portion 5250 separating a first channel 5212a and a second channel 5212b. The bridge portion 5250 can be a slit extending along at least a portion of the liner 5216. The width of the bridge portion 5250 can allow users to move one or more wires from the first

channel 5212a to the second channel 5212b. The width of the bridge portion 5250 can be substantially the same or less than a width of one or more wires and may require a user to exercise a minimum threshold force to move a wire from one portion to another portion. This can prevent users from accidentally or unintentionally moving one wire from one portion to another portion. The width of the bridge portion 5250 may increase while a user passes a wire through the opening of the bridge portion, thereby allowing a width of a wire to pass through the opening or slit of the bridge portion 5250. The liner 5216 can separate the two or more wires without removing the two or more wires from the wire control mechanism 5200 and without removing the wire control mechanism 5200 from the catheter system. The liner 5216 can be attached to a proximal face 5215b of the wire control mechanism 5200. In some cases, the liner 5216 can be positioned within at least a portion of the second channel 5112b. The liner 5216 can also be embedded within a portion of the proximal face 5215b. In some cases, the liner 5216 can be made of a silicone material. The liner 5216, however, can be made of any material or any flexible material that allows the opening of the bridge portion to expand when a user is passing a wire through the bridge portion 5250. The features of the wire control mechanism 5200 should not be limited to the specific shape and proportions depicted in Figures 47A-47C. In some embodiments, the size, shape, and position of the first channel 5212a, the second channel 5212b, the bridge portion 5250, and/or the liner 5216 can vary. For example, the bridge portion 5250 can be narrower (like a smooth slit coated by the liner 5216) that then opens up into a larger second channel 5212b. In those embodiments, the two channels are clearly larger than the bridge portion 5250, to accommodate wire movement when sitting in each channel while maintaining the desired separation between channels via the bridge portion 5250.

[0254] Figure 47B shows a first wire W1 passing through the first channel 5212a and a second wire W2 passing through the second channel 5212b. The wires W1, W2, can be moved from one channel to another as described above. The wire control mechanism can receive one wire or more than two wires at the same time.

[0255] Figures 48A-48C illustrate another configuration of an example wire control mechanism 5300. The wire control mechanism 5300 can comprise a distal end 5302, a proximal end 5304, and a channel 5306 extending between the distal end 5302 and the proximal end 5304. The wire control mechanism 5300 can include an insert 5316 configured

to separate two or more wires. The insert 5316 can be any shape including a circle, an oval, a square, a rectangle, or any suitable shape. The illustrated insert 5316 shown in Figures 48A-48C has a circular shape.

[0256] As shown in Figures 48A-48C, the distal end 5302 can be integral with or configured to be removably coupled to the proximal end 5312 of a dynamic catheter system. For example, Figures 48A-48C illustrate a valve 5310 of a dynamic catheter system. The dynamic catheter system can include the valve 5310, such as a hemostatic valve, at the proximal end 5312 configured to couple to the distal end 5302 of the wire control mechanism 5300. In some configurations, the valve 5310 can include and be integral with the wire control mechanism 5300. The valve 5310 can be the same or similar to any of the valve 1710, 1712, 1810, 2110, 4910, 5010, 5110, 5210 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 5310 can include any valve, such as a hemostatic valve. For example, the valve 5310 can comprise a rotatable component configured to open or close a seal of the valve 5310. In some configurations, the valve 5310 can comprise a button configured to be pressed to open or close the seal of the valve 5310. In some aspects, the valve 5310 can comprise a rotatable component and a button configured to open or close the seal of the valve 4910.

[0257] The distal end 5302 of the wire control mechanism 5300 can be configured to receive or be received by the proximal end 5312 of the valve 5310. During a procedure, the user may couple the wire control mechanism 5300 to the valve 5310 or remove the wire control mechanism 5300 from the valve 5310. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 5300 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control mechanism 5300 to the valve 5310 prior to a procedure. In some configurations, the distal end 5302 can be integral with the valve 5310. For example, distal end 5302 and valve 5310 can be part of a unibody (e.g., single structure) device such that the distal end 5302 and the valve 5310 are not removable from each other. The illustrated configuration shows the proximal end 5312 of the valve 5310 comprising a greater diameter than the distal end 5302 such that the distal end 5302 of the wire control mechanism 5300 can be received by the proximal end 5312 of the valve 5310. The distal end 5302 of the wire control mechanism 5300 can couple to the valve

5310 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0258] The proximal end 5304 can comprise an opening 5308. The opening 5308 can align with the channel 5306 such that the opening 5308 can be in communication with an inner channel of the valve 5310 and/or the dynamic catheter system. In some configurations, the proximal end 5304 can include a plurality of openings (e.g., two, three, four, five). The opening 5308 can include a first portion 5312a and a second portion 5312b. In some cases, the opening 5308 can include a single portion or more than two portions. The first portion 5312a can align with the channel 5306, and the second portion 5312b can be angled from the channel 5306. The angle between the first portion 5312a and the second portion 5312b can be between about 5 degrees and about 60 degrees, about 10 degrees and about 50 degrees, about 20 degrees and about 40 degrees, or about 15 degrees. This angle can control the distance between two or more wires extending through the wire control mechanism 5300, as further described below. The second portion 5312b can extend from the first portion 5312a such that an exchange channel 5314 extends between the first and second portions 5312a, 5312b. The exchange channel 5314 can extend from the opening 5308 to the channel 5306 such that the exchange channel 5314 can be in communication with the channel 5306. The exchange channel 5314 can be configured to allow the two or more wires to move between the first and second portions 5312a, 5312b, as further described below. In some configurations, the wire control mechanism 5300 can include a plurality of channels (e.g., two, three, four, five). In some cases, each of the plurality of channels can be independently closed and opened.

[0259] The wire control mechanism 5300 can include the insert 5316 configured to be embedded within an inner pocket of proximal end 5304 of the wire control mechanism 5300. In some configurations, the insert 5316 may be attached to the proximal end 5304 or the insert 5316 may be completely removable from the proximal end 5304.

[0260] When the insert 5316 is not embedded within the inner pocket of the proximal end 5304 of the wire control mechanism 5300, or attached to the proximal end 5304, the wire control mechanism 5300 includes a single channel and a user may freely move one or more wires between the first and second portions 5312a, 5312b, of the opening 5308 via the exchange channel 5314. For example, two wires can extend through the wire control mechanism 5300 while the insert 5316 is not embedded within the inner pocket of the proximal

end 5304 of the wire control mechanism 5300, or attached to the proximal end 5304. The user may move one or more of the wires between the first and second portions 5312a, 5312b, of the opening 5308 via the exchange channel 5314. The user may also insert more wires into the opening 5308 while the insert 5316 is not embedded within the inner pocket of the proximal end 5304 of the wire control mechanism 5300, or not attached to the proximal end 5304.

[0261] When the insert 5316 is embedded within the inner pocket of the proximal end 5304 of the wire control mechanism 5300, or attached to the proximal end 5304, the insert 5316 can separate the two or more wires without removing the two or more wires from the wire control mechanism 5300 and without removing the wire control mechanism 5300 from the catheter system. In other configurations, the insert 5316 can include a rotatable mechanism, a pivotable mechanism, or any other mechanism that can separate the two or more wires without removing the wire control mechanism 5300 from the dynamic catheter system.

[0262] In some configurations, the first and second portions 5312a, 5312b can be separated by a seal. The insert 5316 can include a bridge portion 5350 configured to separate the first portion 5312a from the second portion 5312b (and vice versa). The bridge portion 5350 can be a slit or opening extending along at least a portion of the insert 5316. The width of the bridge portion 5350 can allow users to move one or more wires from the first portion 5312a and 5312b. The width of the bridge portion 5350 can be substantially the same or less than a width of one or more wires and may require a user to exercise a minimum threshold force to move a wire from one portion to another portion. Beneficially, this can prevent users from accidentally or unintentionally moving one wire from one portion to another portion. The width of the bridge portion 5350 may increase while a user passes a wire through the opening of the bridge portion, thereby allowing a width of a wire to pass through the opening or slit of the bridge portion 5350. The liner 5316 can be attached to a proximal face 5315b of the wire control mechanism 5300. The liner 5316 can also be embedded within a portion of the proximal face 5315b. In some cases, the liner 5316 can be made of a silicone material. The liner 5316, however, can be made of any material that allows the opening of the bridge portion to expand when a user is passing a wire through the bridge portion 5350. The features of the wire control mechanism 5300 should not be limited to the specific shape and proportions depicted in Figures 48A-48C. In some embodiments, the size, shape, and position of the first channel 5312a, the second channel 5312b, the bridge portion 5350, and/or the insert 5316 can

vary. For example, the bridge portion 5350 can be narrower (like a smooth slit coated by the liner 5316) that then opens up into a larger second channel 5312b. In those embodiments, the two channels are larger than the bridge portion 5350, to accommodate wire movement when sitting in each channel while maintaining the desired separation between channels via the bridge portion 5350.

[0263] While silicone gel or close contact is described as being used to prevent accidental or unintentional switching of a wire from one region to another, any other mechanism can be used to separate or substantially separate the channels but still allow for an opening to provide selective communication between regions.

[0264] When the insert 5316 is embedded within the inner pocket of the proximal end 5304 of the wire control mechanism 5300, or attached to the proximal end 5304, a first wire may extend through the first portion 5312a and a second wire may extend through the second portion 5312b. The user can move one or more of the first and second wires to a different region by pushing the first and/or second wires through the bridge portion 5350. For example, to move the first wire from the first portion 5312a to the second portion 5312b, the user can push the first wire from the first portion 5312a through the bridge portion 5350 into the second portion 5312b via the exchange channel 5314. Similarly, to move the second wire from the second portion 5312b to the first portion 5312a, the user can push the second wire vis the exchange channel 5314 from the second portion 5312b through the bridge portion 5350 into the first region 5312a. Advantageously, the wires and the wire control mechanism 5300 do not need to be removed from the catheter system in order for the user to move each wire to a different region 5312a, 5312b. The insert 5316 can separate two or more wires while the insert 5316 is embedded within the inner pocket of the proximal end 5304 of the wire control mechanism 5300, or attached to the proximal end 5304. For example, a first wire may extend through the first portion 5312a and a second wire may extend through the second portion 5318b. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire).

[0265] In further embodiments, the wire control mechanism 5300 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the

insert or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation.

[0266] Figures 49A-49F illustrate an implementation of a wire control mechanism 5400. The wire control mechanism 5400 can comprise a distal end 5402, a proximal end 5404, and a channel 5406 extending between the distal end 5402 and the proximal end 5404. The wire control mechanism 5400 can include a main body 5415 and a sleeve 5416 configured to separate two or more wires. The main body 5415 of the wire control mechanism can include a distal end 5415a and a proximal end 5415b. The sleeve 5416 can include a distal end 5416a and a proximal end 5416b. The sleeve 5416 can be removably connected to the main body 5415. For example, the distal end 5415a of the main body 5415 can be configured to receive or be received by the proximal end 5416b of the sleeve 5416. When the sleeve 5416 is connected to the main body 5415, the sleeve 5416 can separate two or more wires without removing the two or more wires from the wire control mechanism 5400 and without removing the wire control mechanism 5400 from the catheter system, as further described below. In other configurations, the sleeve 5416 can include a rotatable mechanism, a pivotable mechanism, or any other mechanism that can separate the two or more wires without removing the wire control mechanism 5400 from the dynamic catheter system.

[0267] As shown in Figures 49D and 49E, the distal end 5402 of the wire control mechanism 5400 can be integral with or configured to be removably coupled to the proximal end 5412 of a dynamic catheter system. For example, Figure 49D illustrates a valve 5410 of a dynamic catheter system. The dynamic catheter system can include the valve 5410, such as a hemostatic valve, at the proximal end 5412 configured to couple to the distal end 5402 of the wire control mechanism 5400. In some configurations, the valve 5410 can include and be integral with the wire control mechanism 5400. The valve 5420 can be the same or similar to any of the valve 1710, 1712, 1810, 2110, 4900, 5000, 5100, 5200, 5300 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 5410 can include any valve, such as a hemostatic valve. For example, the valve 5410 can comprise a rotatable component configured to open or close a seal of the valve

5410. In some configurations, the valve 5410 can comprise a button configured to be pressed to open or close the seal of the valve 5410. In some aspects, the valve 5410 can comprise a rotatable component and a button configured to open or close the seal of the valve 5410.

[0268] The distal end 5402 of the wire control mechanism 5400 can be configured to receive or be received by the proximal end 5412 of the valve 5410. During a procedure, the user may couple the wire control mechanism 5400 to the valve 5410 or remove the wire control mechanism 5400 from the valve 5410. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 5400 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control mechanism 5400 to the valve 5410 prior to a procedure. In some configurations, the distal end 5402 can be integral with the valve 5410. For example, distal end 5402 and valve 5410 can be part of a unibody (e.g., single structure) device such that the distal end 5402 and the valve 5410 are not removable from each other. The illustrated configuration shows the proximal end 5412 of the valve 5410 comprising a greater diameter than the distal end 5402 such that distal end 5402 of the wire control mechanism 5400 can be received by the proximal end 2412 of the valve 2410. The distal end 5402 of the wire control mechanism 5400 can couple to the valve 5410 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0269] The proximal end 5415b of the main body 5415 can comprise an opening 5408. The opening 5408 can align with the channel 5406 such that the opening 5408 can be in communication with an inner channel of the valve 5410 and/or the dynamic catheter system. In some configurations, the main body 5415 can include a plurality of cutouts (e.g., two, three, four, five) in the sidewalls of the main body 5415. For example, the main body 5415 can include a first cutout 5417a and a second cutout 5417b. Each cutout 5417a, 5417b can include a bridge portion 5417c, 5417d and an end portion 5417e, 5417f. The cutouts 5417a, 5417b can extend from the proximal end 5415b of the main body 5415 along the sidewalls of the main body 5415 to end portions 5417e, 5417f. The bridge portions 5417c, 5417d can be located between the end portions 5417e, 5417f and the portion where the cutouts 5417a, 5417b extend from the proximal end 5415b. The cutouts 5417a, 5417b can comprise a u-shape or a c-shape. In some cases, however, the cutouts 5417a, 5417b can comprise other shapes. Each of the

cutouts 5417a, 5417b, can include the same shape, or a different shape from each other. In some cases, the opening 5408 can include a single portion or more than two portions (e.g., three, four, five, six). The shape, length, and size, of the first and second cutouts 5417a, 5417b can be the substantially the same or different. The opening 5408 can be configured to allow the two or more wires to move between the first and second cutouts 5417a, 5417b, as further described below.

[0270] The wire control mechanism 5400 can include the sleeve 5416 configured to engage with the distal end 5415a of the main body 5415. The sleeve 5416 may be attached to the main body 5415 by, for example, inserting the distal end 5415a of the main body 5415 through an opening 5419 on the sleeve 5416. The sleeve 5416 may be completely removable from the main body 5415. In some cases, the sleeve 5416 can be coupled to the main body 5415 and can be movable along the length of the main body but not removable from the main body 5415. The length of the main body 5415 can run along the axis as the channel 5406. The main body 5415 can comprise a first cutout 5417a and a second cutout 5417b. In some cases, the main body 5415 can include a single channel or more than channels (e.g., three, four, five, six). In some configurations, the first cutout 5417a may be larger than the second cutout 5417b. In other configurations, the first cutout 5417a may be smaller than or the same size as the second cutout 5417b. In some configurations, the first cutout 5417a and/or the second cutout 5417b can include a seal. For example, the first cutout 5417a and/or the second cutout 5417b can include a silicone gel having a slit or opening that can partially seal the cutouts 5417a, 5417b so that one or more wires or other equipment can be pushed through the slit or opening of the silicone gel. The first cutout 5417a and/or the second cutout 5417b can include any material, including a flexible material, other than silicone gel that allows or more wires or other equipment to be pushed through the material. Beneficially, this can prevent a user from accidentally or unintentionally moving one wire from one channel to another channel. In some cases, however, the cutouts 5417a, 5417b do not include a silicone gel and can include a different seal, or no seal at all.

[0271] Figures 49C and 49E illustrate the sleeve 5416 attached to the main body 5415. When the sleeve 5416 is attached to the main body 5415, the sleeve 5416 can move between at least a first position and a second position. The sleeve 5416 can move between the first and second positions by axially sliding the sleeve 5416 along the main body 5415 in a

direction going from the distal end 5415a to the proximal end 5415b, or vice versa, as shown by arrow 5421. In some cases, the sleeve 5416 can rotate along an axis of rotation that runs along the channel 5406. In some cases, the first position can include any position in which the sleeve 5416 fully blocks bridge portions 5417c and 5417d. In some cases, the second position of the sleeve 5416 can include any position in which at least a portion of bridges 5417c and 5417d is not blocked by sleeve 5416. When the sleeve 5416 is in the first position, the wire control mechanism includes a single channel formed by opening 5408, the first cutout 5417a, and the second cutout 5417b and a user may freely move one more wires between the opening 5408, the first cutout 5417a, and the second cutout 5417b. For example, two wires can extend through the wire control mechanism 5400 while the sleeve 5416 is in the first position. The user may move one or both of the wires between the first and second cutouts 5417a, 5417b via the opening 5408. The user may also insert more wires into the opening 5408, the first cutout 5417a, or the second cutout 5417b while the sleeve 5416 is in the first position.

[0272] When the sleeve 5416 is in the second position, as shown in Figures 49C and 49E, the wire control mechanism includes three channels formed by opening 5408, end 5417e of the first cutout 5417a, and end 5417f of the second cutout 5417b. When the sleeve 5416 is in the second position, a first wire may extend through end 5417e of the first cutout 5417a and a second wire may extend through end 5417f of the second cutout 5417b. Since the sleeve 5416 blocks bridge portions 5417c, 5417d when the sleeve 5416 is in the second position, the first and second wires cannot move beyond bridge portions 5417c and 5417d. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire). In some cases, when the sleeve 5416 is in the second position, a first wire may extend through end 5417e of the first cutout 5417a or end 5417f of the second cutout 5417b, and a second wire may extend through opening 5408. In cases where three wires are used, when the sleeve 5416 is in the second position, a first wire may extend through end 5417e of the first cutout 5417a, a second wire may extend through end 5417f of the second cutout 5417b, and a third wire may extend through opening 5408. The user can transition the sleeve 5416 from the first position to the second position and move the first and second wires to a different cutout via the area of opening 5408. For example, while the sleeve is in the first position, a user may move the first wire from the first cutout 5417a to the second cutout 5417b by moving the first wire from end

5417e via bridge portion 5417c and opening 5408 to end 5417f. Similarly, while the sleeve is in the first position, a user may move the second wire from the second cutout 5417b to the first cutout 5417a by moving the second wire from end 5417f via bridge portion 5417d and opening 5408 to end 5417e. After moving the first and second wires, the user can transition the sleeve 5416 to the second position so that the first wire can extend through end 5417f of the second cutout 5417b and the second wire can extend through end 5417e of the first cutout 5417a. Advantageously, the wires and the wire control mechanism 5400 do not need to be removed from the catheter system in order for the user to move each wire to a different cutout 5417a, 5417b.

[0273] Figure 49F shows a first wire W1 passing through the end portion 5417e of the first cutout 5417a and a second wire W2 passing through the end portion 5417f of the second cutout 5417b. The wires W1, W2, can be moved from one end portion to another as described above. The wire control mechanism 5400 can receive one wire or more than two wires at the same time.

[0274] In further embodiments, the wire control mechanism 5400 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the cap or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation.

[0275] Figures 50A-50G illustrate an implementation of a wire control mechanism 5500. The wire control mechanism 5500 can comprise a distal end 5502, a proximal end 5504, and a channel 5506 extending between the distal end 5502 and the proximal end 5504. The wire control mechanism 5500 can include a main body 5515 and a sleeve 5516 configured to separate two or more wires. The main body 5515 of the wire control mechanism can include a distal end 5515a and a proximal end 5515b. The sleeve 5516 can include a distal end 5516a and a proximal end 5516b. The sleeve 5516 can be removably connected to the main body 5515. For example, the distal end 5515a of the main body 5515 can be configured to receive or be received by the proximal end 5516b of the sleeve 5516. When the sleeve 5516 is

connected to the main body 5515, the sleeve 5516 can separate two or more wires without removing the two or more wires from the wire control mechanism 5500 and without removing the wire control mechanism 5500 from the catheter system, as further described below. In other configurations, the sleeve 5516 can include a rotatable mechanism, a pivotable mechanism, or any other mechanism that can separate the two or more wires without removing the wire control mechanism 5500 from the dynamic catheter system.

[0276] As shown in Figure 50F, the distal end 5502 of the wire control mechanism 5500 can be integral with or configured to be removably coupled to the proximal end 5512 of a dynamic catheter system. For example, Figure 50D, like Figure 49D, illustrates a valve 5510 of a dynamic catheter system. The dynamic catheter system can include the valve 5510, such as a hemostatic valve, at the proximal end 5512 configured to couple to the distal end 5502 of the wire control mechanism 5500. In some configurations, the valve 5510 can include and be integral with the wire control mechanism 5500. The valve 5520 can be the same or similar to any of the valve 1710, 1712, 1810, 2110, 4900, 5000, 5100, 5200, 5300, 5400 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 5510 can include any valve, such as a hemostatic valve. For example, the valve 5510 can comprise a rotatable component configured to open or close a seal of the valve 5510. In some configurations, the valve 5510 can comprise a button configured to be pressed to open or close the seal of the valve 5510. In some cases, the valve 5510 can comprise a rotatable component and a button configured to open or close the seal of the valve 5510.

[0277] The distal end 5502 of the wire control mechanism 5500 can be configured to receive or be received by the proximal end 5512 of the valve 5510. During a procedure, the user may couple the wire control mechanism 5500 to the valve 5510 or remove the wire control mechanism 5500 from the valve 5510. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 5500 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control mechanism 5500 to the valve 5510 prior to a procedure. In some configurations, the distal end 5502 can be integral with the valve 5510. For example, distal end 5502 and valve 5510 can be part of a unibody (e.g., single structure) device such that the distal end 5502 and the valve 5510

are not removable from each other. The illustrated configuration shows the proximal end 5512 of the valve 5510 comprising a greater diameter than the distal end 5510 such that the distal end 5402 of the wire control mechanism 5400 can be received by the proximal end 5512 of the valve 5510. The distal end 5502 of the wire control mechanism 5500 can couple to the valve 5510 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0278] As shown in Figure 50C, the proximal end 5515b of the main body 5515 can comprise an opening 5508. The opening 5508 can align with the channel 5506 such that the opening 5508 can be in communication with an inner channel of the valve 5510 and/or the dynamic catheter system. In some configurations, the main body 5515 can include a plurality of cutouts (e.g., two, three, four, five) extending in the sidewalls of the main body 5515. For example, the main body 5515 can include a first cutout 5517a and a second cutout 5517b. Each cutout 5517a, 5517b can include an end portion 5517e, 5517f. The cutouts 5517a, 5517b can extend from the proximal end 5515b of the main body 5515 along the sidewalls of the main body 5515 to end portions 5517e, 5517f. The bridge portions 5517c, 5517d can be located at an open end of the cutouts 5517a, 5517b (e.g., at a portion where the cutouts 5517a, 5517b first extend from the proximal end 5515b). The cutouts 5517a, 551b can comprise an L-shape. In some cases, however the cutouts 5517a, 5517b can comprise other shapes. Each of the cutouts 5517a, 5517b can include the same shape, or a different shape from each other. In some cases, the opening 5508 can include more than one portion (e.g., two, three, four, five, six). The shape, length, and size, of the first and second cutouts 5517a, 5517b can be the substantially the same or different. The opening 5508 can be configured to allow the two or more wires to move between the first and second cutouts 5517a, 5517b, as further described below.

[0279] The wire control mechanism 5500 can include the sleeve 5516 configured to engage with the distal end 5515a of the main body 5515. The sleeve 5516 may be attached to the main body 5515 by, for example, inserting the distal end 5515a of the main body 5515 through an opening 5519 on the sleeve 5516. The sleeve 5516 may be completely removable from the main body 5515. The main body 5515 can comprise a first cutout 5517a and a second cutout 5517b. In some cases, the main body 5515 can include a single channel or more than two channels (e.g., three, four, five, six). In some configurations, the first cutout 5517a may be

larger than the second cutout 5517b. In other configurations, the first cutout 5517a may be smaller than or the same size as the second cutout 5517b. In some configurations, the first cutout 5517a and/or the second cutout 5517b can include a seal. For example, the first cutout 5517a and/or the second cutout 5517b can include a silicone gel having a slit or opening that can partially seal the cutout 5517a, 5517b so that one or more wires or other equipment can be pushed through the slit or the opening of the silicone gel. The first cutout 5517a and/or the second cutout 5517b can include a material, including a flexible material, other than silicone gel that allows one or more wires or other equipment to be pushed through the material. Beneficially, this can prevent a user from accidentally or unintentionally moving one wire from one channel to another channel. In some cases, however, the cutouts 5517a, 5517b do not include a silicone gel and can include a different seal, or no seal at all.

[0280] Figures 50C, 50D, and 50F illustrate the sleeve 5516 attached to the main body 5515. When the sleeve 5516 is attached to the main body 5515, the sleeve 5516 can move between at least a first position and a second position. The sleeve 5416 can move between the first and second positions by rotating the sleeve 5516 clockwise or counterclockwise, as shown by arrow 5521, along an axis of rotation that runs along the channel 5506. In some cases, the sleeve 5516 can slide axially along the main body 5515 in a direction going from the distal end 5515a to the proximal end 5515b. In some cases, a coil 5580 can be disposed between the sleeve 5516 and the main body 5515. As shown in Figure 50B, the coil 5580 can be wrapped around the main body 5515. In some cases, the coil 5580 can be configured to maintain the sleeve 5516 in the first or second position when a user is not actively rotating the sleeve 5516. In some cases, the first position can include any position in which an access port 5590a, 5590b of sleeve 5516 aligns with at least one bridge portion 5517c, 5517d of the main body. In some cases, the second position of the sleeve 5516 can include any position in which bridges 5517c and 5517d do not align with access ports 5590a, 5590b. When the sleeve 5516 is in the first position, the wire control mechanism includes a single channel formed by opening 5508, the first bridge portion 5517c of the first cutout 5517a, and the second bridge portion 5517d of the second cutout 5517b and a user may freely move one or more wires between these portions. In the first position, the access ports 5590a, 5590b can align with the bridge portions 5517c, 5517d. For example two wires can extend through the wire control mechanism 5500 while the sleeve 5516 is in the first position. The user may move one or both of the wires between a

portion of the the first and second cutouts 5517a, 5517b via the opening 5508. The user may also insert more wires into the opening 5508, and a portion of the first cutout 5517a or the second cutout 5517b while the sleeve 5516 is in the first position.

[0281] When the sleeve 5516 is in the second position, as shown in Figures 50C, 50D, and 50F, the wire control mechanism includes three channels formed by opening 5508, end 5517e of the first cutout 5517a, and end 5517f of the second cutout 5517b. In the second position, the access ports 5590a, 5590b can align with end portions 5517e, 5517f. Transitioning the sleeve 5516 from the first position to the second position can cause the wires located at or near the first and second bridge portions 5516c, 5516d to move to the end portions 5517e, 5517f. When the sleeve 5516 is in the second position, a first wire may extend through end 5517e of the first cutout 5517a and a second wire may extend through end 5517f of the second cutout 5517b. Since the sleeve 5516 blocks bridge portions 5517c, 5517d when the sleeve 5516 is in the second position, the first and second wires will not move beyond bridge portions 5517c and 5517d. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire). The user can transition the sleeve 5516 from the first position to the second position and move the first and second wires to a different channel via the area of opening 5508, For example, while the sleeve is in the first position, a user may move the first wire from the first cutout 5517a to the second cutout 5517b by moving the first wire from end 5517e via opening 5508 to end 5517f. Similarly, while the sleeve is in the first position, a user may move the second wire from the second cutout 5517b to the first cutout 5517a by moving the second wire from end 5517f via opening 5508 to end 5517e. After moving the first and second wires, the user can transition the sleeve 5516 to the second position so that the first wire can extend through end 5517f of the second cutout 5517b and the second wire can extend through end 5517e of the first cutout 5517a. Advantageously, the wires and the wire control mechanism 5500 do not need to be removed from the catheter system in order for the user to move each wire to a different cutout 5517a, 5517b. In cases where three wires are used, when the sleeve 5516 is in the second position, a first wire may extend through end 5517e of the first cutout 5517a, a second wire may extend through end 5517f of the second cutout 5517b, and a third wire may extend through opening 5508.

[0282] Figure 50G shows a first wire W1 passing through the end portion 5517e of the first cutout 5517a and access port 5590a, and a second wire W2 passing through the second portion 5517f of the second cutout 5517b and access port 5590b when the sleeve is in the second position. The wires W1, W2, can be moved from one end portion to another as described above. The wire control mechanism 5500 can receive one wire or more than two wires at the same time.

[0283] In further embodiments, the wire control mechanism 5500 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the cap or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation.

[0284] Figures 51A-51F illustrate an implementation of a wire control mechanism 5600. The wire control mechanism 5600 can comprise a distal end 5602, a proximal end 5604, and a channel 5606 extending between the distal end 5602 and the proximal end 5604. The wire control mechanism 5600 can include a main body 5615 and a cap 5616 configured to separate two or more wires. The main body 5615 of the wire control mechanism 5600 can include a distal end 5615a and a proximal end 5615b. The cap 5616 can include one or more arms 5650. Each of the one or more arms 5650 can include an cutout 5652. The cap 5616 can be removably connected to the main body 5615. For example, the distal end 5415a of the main body 5415 can be configured to receive or be received by the sleeve 5416. The arms 5650 of the cap 5616 can be configured to attach to the main body 5615, as shown in Figures 51C and 51E. When the cap 5616 is connected to the main body 5615, the cap 5616 can separate two or more wires without removing the two or more wires from the wire control mechanism 5600 and without removing the wire control mechanism 5600 from the catheter system, as further described below. In other configurations, the cap 5616 can include a rotatable mechanism, a pivotable mechanism, or any other mechanism that can separate the two or more wires without removing the wire control mechanism 5600 from the dynamic catheter system.

[0285] As shown in Figures 51D and 51E, the distal end 5602 of the wire control mechanism 5600 can be integral with or configured to be removably coupled to the proximal end 5612 of a dynamic catheter system. For example, Figure 51D illustrates a valve 5610 of a dynamic catheter system. The dynamic catheter system can include the valve 5610, such as a hemostatic valve, at the proximal end 5612 configured to couple to the distal end 5602 of the wire control mechanism 5600. In some configurations, the valve 5610 can include and be integral with the wire control mechanism 5600. The valve 5620 can be the same or similar to any of the valve 1710, 1712, 1810, 2110, 4900, 5000, 5100, 5200, 5300, 5400, 5500 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 5610 can include any valve, such as a hemostatic valve. For example, the valve 5610 can comprise a rotatable component configured to open or close a seal of the valve 5610. In some configurations, the valve 5610 can comprise a button configured to be pressed to open or close the seal of the valve 5610. In some cases, the valve 5610 can comprise a rotatable component and a button configured to open or close the seal of the valve 5610.

[0286] The distal end 5602 of the wire control mechanism 5600 can be configured to receive or be received by the proximal end 5612 of the valve 5610. During a procedure, the user may couple the wire control mechanism 5600 to the valve 5610 or remove the wire control mechanism 5600 from the valve 5610. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 5600 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control mechanism 5600 to the valve 5620 prior to a procedure. In some configurations, the distal end 5602 can be integral with the valve 5610. For example, distal end 5602 and valve 5610 can be part of a unibody (e.g., single structure) device such that the distal end 5602 and the valve 5610 are not removable from each other. The illustrated configuration shows the proximal end 5612 of the valve 5610 comprising a greater diameter than the distal end 5602 such that the distal end 5602 of the wire control mechanism 5600 can be received by the proximal end 5612 of the valve 5610. The distal end 5602 of the wire control mechanism 5600 can couple to the valve 5610 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0287] As shown in Figure 51A, the proximal end 5615b of the main body 5615 can comprise an opening 5608. The opening 5608 can align with the channel 5606 such that the opening 5608 can be in communication with an inner channel of the valve 5610 and/or the dynamic catheter system. In some configurations, the main body 5615 can include a plurality of cutouts (e.g., two, three, four, five) in the sidewalls of the main body 5615. For example, the main body 5615 can include a first cutout 5617a and a second cutout 5617b. The cutouts 5617a, 5617b can extend from at the proximal end 5615b of the main body 5615 along the sidewalls of the main body 5615 to end portions 5617e, 5617f. The bridge portions 5617c, 5617d can be located at an open end of the cutouts 5617a, 5617b (e.g., at a portion where the cutouts 5617a, 5617b first extend from the proximal end 5615b). The cutouts 5617a, 5617b can comprise an L-shape. In some cases, however the cutouts 5617a, 5617b can comprise other shapes. Each of the cutouts 5617a, 5617b can include the same shape, or a different shape from each other. Each channel 5627a, 5627b can include an end portion 5617e, 5617f. In some cases, the opening 5608 can include one channel or more than two channels (e.g., three, four, five, six). The shape, length, and size, of the first and second cutouts 5617a, 5617b can be substantially the same or different. The opening 5608 can be configured to allow the two or more wires to move between the first and second cutouts 5617a, 5617b, as further described below.

[0288] The wire control mechanism 5600 can include the cap 5616 configured to engage with the proximal end 5615b of the main body 5615. The cap 5616 may be attached to the main body 5615 by, for example, aligning the arms 5650 of the cap 5616, as shown in Figures 51C and 51E, with the main body 5615 and pushing the cap 5616 axially towards the main body 5615. The cap 5616 may be completely removable from the main body 5615. The main body 5615 can comprise a first cutout 5617a and a second cutout 5617b. In some cases, the main body 5615 can include a single channel or more than two channels (e.g., three, four, five, six). In some configurations, the first cutout 5617a may be larger than the second cutout 5617b. In other configurations, the first cutout 5617a may be smaller than or the same size as the second cutout 5617b. In some configurations, the first cutout 5617a and/or the second cutout 5617b can include a seal. For example, the first cutout 5617a and/or the second cutout 5617b can include a silicone gel having a slit or an opening that can partially seal the cutouts 5617a, 5617b so that one or more wires or other equipment can be pushed through the slit or

the opening of the silicone gel. The first cutout 5617a and/or the second cutout 5617b can include a material, including a flexible material, other than silicone gel that allows or more wires or other equipment to be pushed through the material. Beneficially, this can prevent a user from accidentally or unintentionally moving one wire from one channel to another channel.

[0289] Figures 51C and 51E illustrate the cap 5616 attached to the main body 5615. When the cap 5616 is attached to the main body 5615, the cap 5616 can move between at least a first position and a second position. The cap 5616 can move between the first and second positions by rotating the cap 5616 clockwise or counterclockwise, as shown by arrow 5621, along an axis of rotation that runs along the channel 5606. In some cases, the first position can include any position in which the arms 5650 of the cap 5616 fully block bridge portions 5617c and 5617d. In some cases, the second position of the cap 5616 can include any position in which at least a portion of bridges 5617c and 5617d is not blocked by arms 5650. When the cap 5616 is in the first position, the wire control mechanism includes a single channel formed by opening 5408, the first bridge portion 5617c, and the second bridge portion 5617d and a user may freely move one more wires between the opening 5608, the first bridge portion 5617c, and the second bridge portion 5617c. In the first position, the cutouts 5562 can align with the bridge portions 5617c, 5617d. For example, two wires can extend through the wire control mechanism 5600 while the cap 5616 is in the first position. The user may move one or both of the wires between the first and second cutouts 5617a, 5617b via the opening 5608. The user may also insert more wires into the opening 5608, the first cutout 5617a, or the second cutout 5617b while the cap 5616 is in the first position.

[0290] When the cap 5616 is in the second position, the wire control mechanism 5600 includes three channels formed by opening 5608, end 5617e of the first cutout 5617a, and end 5617f of the second cutout 5617b. In the second position, the cutouts 5652 can align with end portions 5617e, 5617f. Transitioning the cap 5616 from the first position to the second position can cause the wires located at or near the first and second bridge portions 5617c, 5617d to move to the end portions 5617e, 5617f. When the cap 5616 is in the second position, a first wire may extend through end 5617e of the first cutout 5617a and a second wire may extend through end 5617f of the second cutout 5617b. Since the cap 5616 blocks bridge portions 5617c, 5617d when the cap 5616 is in the second position, the first and second wires

will not move beyond bridge portions 5617c and 5617d. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire). The user can transition the cap 5616 from the first position to the second position and move the first and second wires to a different channel via the opening 5608. For example, while the cap is in the first position, a user may move the first wire from the first cutout 5617a to the second cutout 5617b by moving the first wire from end 5617e via opening 5608 to end 5617f. Similarly, while the cap is in the first position, a user may move the second wire from the second cutout 5617b to the first cutout 5617a by moving the second wire from end 5617f via opening 5608 to end 5617e. After moving the first and second wires, the user can transition the cap 5616 to the second position so that the first wire extends through end 5617f of the second cutout 5617b and one cutout 5652, and the second wire extends through end 5617e of the first cutout 5617a and the other cutout 5652. Advantageously, the wires and the wire control mechanism 5600 do not need to be removed from the catheter system in order for the user to move each wire to a different cutout 5617a, 5617b. In cases where three wires are used, when the cap 5616 is in the second position, a first wire may extend through end 5617e of the first cutout 5617a, a second wire may extend through end 5617f of the second cutout 5617b, and a third wire may extend through opening 5608.

[0291] Figure 51F shows a wire W1 passing through cutout 5652 and end portion 5617e when the cap 5616 is in the second position. The wires W1 can be moved from one portion to another as described above. The wire control mechanism can receive more than one wire at the same time.

[0292] In further embodiments, the wire control mechanism 5600 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the cap or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation

[0293] Figures 52A-51H illustrate an implementation of a wire control mechanism 5700. The wire control mechanism 5700 can comprise a distal end 5702, a proximal end 5704, and a channel 5706 extending between the distal end 5702 and the proximal end 5704. The wire control mechanism 5700 can include a main body 5715 and a plurality of sliding components, 5716a, 5716b, 5716c, 5716d configured to separate two or more wires. The plurality of sliding components can each include a channel 5519a, 5519b, 519c, 5519d extending from a proximal portion of the sliding components to a distal portion of the sliding component. The main body 5715 of the wire control mechanism 5700 can include a distal end 5715a and a proximal end 5715b. The plurality of sliding components 5716a, 5716b, 5716c, 5716d can be removably connected to the main body 5715. The plurality of sliding components 5716a, 5716b, 5716c, 5716d can be configured to attach to the main body 5715, as shown in Figures 52C and 52E-52G. When at least one of the plurality of sliding components 5716a, 5716b, 5716c, 5716d is connected to the main body 5715, the plurality of sliding components 5716a, 5716b, 5716c, 5716d can separate two or more wires without removing the two or more wires from the wire control mechanism 5700 and without removing the wire control mechanism 5700 from the catheter system, as further described below.

[0294] As shown in Figures 52D and 52E, the distal end 5702 of the wire control mechanism 5700 can be integral with or configured to be removably coupled to the proximal end 5712 of a dynamic catheter system. For example, Figure 52D illustrates a valve 5710 of a dynamic catheter system. The dynamic catheter system can include the valve 5710, such as a hemostatic valve, at the proximal end 5712 configured to couple to the distal end 5702 of the wire control mechanism 5700. In some configurations, the valve 5710 can include and be integral with the wire control mechanism 5700. The valve 5730 can be the same or similar to any of the valve 1710, 1712, 1810, 2110, 4900, 5000, 5100, 5200, 5300, 5400, 5500, 5600 described herein and can be used with or without the actuation mechanism and/or catheter control center described herein. The valve 5710 can include any valve, such as a hemostatic valve. For example, the valve 5710 can comprise a rotatable component configured to open or close a seal of the valve 5710. In some configurations, the valve 5710 can comprise a button configured to be pressed to open or close the seal of the valve 5710. In some cases, the valve 5710 can comprise a rotatable component and a button configured to open or close the seal of the valve 5710.

[0295] The distal end 5702 of the wire control mechanism 5700 can be configured to receive or be received by the proximal end 5712 of the valve 5710. During a procedure, the user may couple the wire control mechanism 5700 to the valve 5710 or remove the wire control mechanism 5700 from the valve 5710. For example, the user may determine that a guide extension catheter is needed during the procedure. The user can insert the guide extension catheter into the guide catheter and couple the wire control mechanism 5700 to separate the multiple wires during the procedure. Moreover, the user may couple the wire control mechanism 5700 to the valve 5720 prior to a procedure. In some configurations, the distal end 5702 can be integral with the valve 5710. For example, distal end 5702 and valve 5710 can be part of a unibody (e.g., single structure) device such that the distal end 5702 and the valve 5710 are not removable from each other. The illustrated configuration shows the proximal end 5712 of the valve 5710 comprising a greater diameter than the distal end 5702 such that the distal end 5702 of the wire control mechanism 5700 can be received by the proximal end 5712 of the valve 5710. The distal end 5702 of the wire control mechanism 5700 can couple to the valve 5710 via a push-fit engagement, a threaded engagement, a snap-fit engagement, or any suitable releasable couplings.

[0296] As shown in Figure 52A, the proximal end 5715b of the main body 5715 can comprise an opening 5708. The opening 5708 can align with the channel 5706 such that the opening 5708 can be in communication with an inner channel of the valve 5710 and/or the dynamic catheter system. In some configurations, the main body 5715 can include a plurality of cutouts (e.g., two, three, four, five) in the sidewalls of the main body 5715. For example, the main body 5715 can include a first cutout 5717a, a second cutout 5717b, a third cutout 5717c, and a fourth cutout 5717d. The cutouts 5717a, 5717b, 5717c, 5717d can extend from the proximal end 5715b of the main body 5715 along the sidewalls of the main body 5715. The cutouts 5717a, 5717b, 5717c, 5717d can comprise a linear shape. In some cases, however the cutouts 5717a, 5717b, 5717c, 5717d can include other shapes. Each of the cutouts 5717a, 5717b, 5717c, 5717d can include the same shape, or a different shape from each other. Each cutout 5717a, 5717b, 5717c, 5717d can include an end portion. In some cases, the opening 5708 can include a single channel or more than two channels (e.g., three, four, five, six). The shape, length, and size, of the cutouts 5717a, 5717b, 5717c, 5717d can be substantially the

same or different. The opening 5708 can be configured to allow the two or more wires to move between the cutouts 5717a, 5717b, 5717c, 5717d, as further described below.

[0297] The wire control mechanism 5700 can include the plurality of sliding components 5716a, 5716b, 5716c, 5716d configured to engage with the main body 5715. The plurality of sliding components 5716a, 5716b, 5716c, 5716d may be attached to the main body 5715 by, for example, aligning each of the plurality of sliding components 5716a, 5716b, 5716c, 5716d, as shown in Figures 52C and 52E, with the cutouts 5717a, 5717b, 5717c, 5717d and pushing the plurality of sliding components 5716a, 5716b, 5716c, 5716d axially towards the main body 5715. The plurality of sliding components 5716a, 5716b, 5716c, 5716d may be completely removable from the main body 5716. The main body 5716 can comprise a plurality of cutouts 5717a, 5717b, 5717c, 5717d. In some cases, the main body 5715 can include a single channel or more than two channels (e.g., three, four, five, six). The dimensions of each cutout 5717a, 5717b, 5717c, 5717d can be different or the same. For example, in some configurations, the first cutout 5717a may be larger than the second cutout 5717b. In other configurations, the first cutout 5717a may be smaller than or the same size as the second cutout 5717b. In some configurations, the cutout 5717a, 5717b, 5717c, 5717d can include a seal. For example, the cutouts 5717a, 5717b, 5717c, 5717d can include a silicone gel having a slit or opening that can partially seal the cutouts 5717a, 5717b, 5717c, 5717d so that one or more wires or other equipment can be pushed through the slit or opening of the silicone gel. The first cutouts 5717a, 5717b, 5717c, 5717d can include a material, including a flexible material, other than silicone gel that allows or more wires or other equipment to be pushed through the material. Beneficially, this can prevent a user from accidentally or unintentionally moving one wire from one channel to another channel.

[0298] Figures 52C and 52G illustrate all of the plurality of sliding components 5716a, 5716b, 5716c, 5716d attached to the main body 5716. Not all sliding components 5716a, 5716b, 5716c, 5716d have to be used at the same time. For example, as shown in Figures 52E and 52F, a user can attach only two or three sliding components attached. When the plurality of sliding components is attached to the main body 5715, each of the plurality of sliding components can move between at least a first position and a second position. Each of the plurality of sliding components can move between the first and second positions by axially moving each sliding component in a direction going from the distal end 5715a to the proximal

end 5715b, or vice versa, as shown by arrow 5721. In some cases, the first position can include any position in which a sliding component fully blocks a bridge portion 5718a, 5718b, 5718c, 5718d thereby allowing a wire to exit the wire control mechanism 5700 only through channels 5719a-5719d of the sliding doors. In some cases, the second position of the plurality of sliding components can include any position in which at least a portion of bridges 5718a-5718d is not blocked by the plurality of sliding components. When all of the plurality of sliding components is in the first position, the wire control mechanism includes a single channel formed by opening 5408, and cutouts 5717a, 5717b, 5717c, 5717d, and a user may freely move one more wires between the opening 5708, and cutouts 5717a, 5717b, 5717c, 5717d. For example, four wires can extend through the wire control mechanism 5700 while the first sliding component 5716a is in the second position and the second, third, and fourth sliding components 5716b-d are in the first position. A user may move one or more of the wires between the opening 5708 and channels when the sliding component is in the first position. For example, and referring to Figure 52G, a user may move one or more wires between the opening 5708 and cutouts 5717b, 5716c, 5716d. The user may also insert more wires into the opening 5708, and any cutout whose associated sliding component is in the first position.

[0299] The wire control mechanism 5700 includes two separate channels when one sliding component is in the second position, three when two sliding components are in the second position, four when three sliding components are in the second position, and five when all four sliding components are in the second position. For example, when all four sliding components 5716a, 5716b, 5716c, 5716d are in the second position, a first wire may extend through cutout 5717a, a second wire may extend through cutout 5717b, a third wire may extend through cutout 5717c, and a fourth wire may extend through cutout 5717d. Since the plurality of sliding components 5716a-d block bridge portions 5718a-d when the plurality of sliding components 5716a-d is in the second position, the first, second, third, and fourth wires will not move beyond bridge portions 5718a-d. Advantageously, this arrangement can separate two or more wires during a procedure to allow the user to easily identify and manipulate the wires (e.g., a guide wire and a devices wire). The user can transition each of the plurality of sliding components from the first position to the second position and move two or more wires to a different channel via the opening 5708. For example, while sliding components 5716a, 5716b are in the first position, a user may move a first wire from the first cutout 5717a to the second

cutout 5717b by moving the first wire from cutout 5717a via opening 5708 to cutout 5717b. Further, the user may move the second wire from the second cutout 5717b to the first cutout 5717a by moving the second wire from cutout 5717b via opening 5708 to cutout 5717a. After moving the first and second wires, the user can transition sliding components 5716a 5716b to the second position so that the first wire extends through the second channel 5719b and the second wire extends through the first channel 5719a. Advantageously, the wires and the wire control mechanism 5700 do not need to be removed from the catheter system in order for the user to move each wire to a different channel.

[0300] Figure 52H shows a first wire W1 passing through channel 5719a when the first sliding component 5716a is in the second position, a second wire W2 passing through channel 5719b, a third wire W3 passing through channel 5719c, and a fourth wire W4 passing through channel 5719d when sliding components 5716b, 5716c, and 5716d are in the first position. The wires W1, W2, W3, W4 can be moved from one channel to another as described above. The wire control mechanism 5700 can receive one, two, three, or more than four wires at the same time.

[0301] In further embodiments, the wire control mechanism 5700 can include wire anchors. A wire anchor can be used to prevent the wires from moving in any direction, which can be advantageous to the user in many situations. The wire anchors can be placed on the cap or on the main body of the wire control mechanism. For example, the wire anchor can be comprised of a rotating mechanism that tightens around the wire (in any portion or cutout). In other embodiments, the wire anchor can be a push-button, sliding, or pinching mechanism – or any other well-known mechanism. Wire anchors provide additional control functionality to the wire control mechanism beyond wire separation

[0302] All of the features disclosed in this specification (including any accompanying exhibits, claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. The disclosure is not restricted to the details of any foregoing embodiments. The disclosure extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

[0303] Various modifications to the implementations described in this disclosure may be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other implementations without departing from the spirit or scope of this disclosure. Thus, the disclosure is not intended to be limited to the implementations shown herein, but is to be accorded the widest scope consistent with the principles and features disclosed herein. Certain embodiments of the disclosure are encompassed in the claim set listed below or presented in the future.

WHAT IS CLAIMED IS:

1. A dynamic catheter system comprising:

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

2. The dynamic catheter system of Claim 1, wherein a variation of the first wall thickness is inversely related to a variation of the second wall thickness.

3. The dynamic catheter system of Claim 1 or Claim 2, wherein the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness.

4. The dynamic catheter system of Claim 3, wherein the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter.

5. The dynamic catheter system of Claim 3 or Claim 4, wherein the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter.

6. The dynamic catheter system of any one of Claims 3-5, wherein the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region.

7. The dynamic catheter system of any one of Claims 3-6, wherein the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

8. The dynamic catheter system of any one of the preceding claims, wherein the first wall thickness comprises a thickness of between 0.01 mm and 1.0 mm.

9. The dynamic catheter system of any one of the preceding claims, wherein the first wall thickness comprises a thickness of between 0.065 mm and about 0.125 mm.

10. The dynamic catheter system of any one of the preceding claims, wherein the second wall thickness comprises a thickness of between 0.05 mm and 1.0 mm.

11. The dynamic catheter system of any one of the preceding claims wherein the second wall thickness comprises a thickness of between 0.1 mm and about 0.125 mm.

12. The dynamic catheter system of any one of the preceding claims, wherein the guide extension catheter comprises an inner diameter of between 0.50 mm and 2.00 mm.

13. The dynamic catheter system of any one of the preceding claims, wherein the guide extension catheter comprises an inner diameter of between 1.60 mm and 1.67 mm.

14. The dynamic catheter system of any one of Claims 1-12, wherein the guide extension catheter comprises an inner diameter of between 1.17 mm and 1.30 mm.

15. The dynamic catheter system of any one of Claims 1-12, wherein the guide extension catheter comprises an inner diameter of between 1.42 mm and 1.45 mm.

16. The dynamic catheter system of any one of Claims 1-12, wherein the guide extension catheter comprises an inner diameter of between 1.57 mm and 1.60 mm.

17. The dynamic catheter system of any one of Claims 1-12, wherein the guide extension catheter comprises an inner diameter of between 1.80 mm and 1.83 mm.

18. The dynamic catheter system of any one of the preceding claims, further comprising an expanded configuration and an unexpanded configuration.

19. The dynamic catheter system of Claim 18, wherein the distal portion of the guide extension catheter extends beyond the distal end of the guide catheter when the dynamic catheter system is in the expanded configuration.

20. The dynamic catheter system of Claim 18 or Claim 19, wherein the distal end of the guide extension catheter does not extend beyond the distal end of the guide catheter when the dynamic catheter system is in the unexpanded configuration.

21. The dynamic catheter system of any one of Claims 18-20, wherein the second wall thickness of the distal end of the guide extension catheter comprises a maximum wall thickness.

22. The dynamic catheter system of any one of Claims 18-21, wherein the first wall thickness of the distal end of the guide catheter comprises a minimum wall thickness.

23. The dynamic catheter system of any one of the preceding claims, further comprising a valve and a wire control mechanism.

24. The dynamic catheter system of Claim 23, wherein the wire control mechanism is integrated with the valve.

25. The dynamic catheter system of Claim 23, wherein the wire control mechanism is configured to be removably coupled to the valve.

26. A dynamic catheter system comprising one or more of the features of the foregoing description.

27. A method of using the dynamic catheter system comprising one or more features of the foregoing description.

28. A wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion;

one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and

a cap configured to engage with the proximal opening of the channel, the cap comprising a first cutout and a second cutout, wherein the cap is configured to uncover and cover the exchange channel without a user removing the two or more wires from

the wire control mechanism, wherein each of the first and second cutouts are configured to receive at least one wire of the two or more wires.

29. The wire control mechanism of Claim 28, wherein the cap is configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the cap engages with the proximal opening and covers the exchange channel.

30. The wire control mechanism of Claim 28 or Claim 29, wherein the cap is configured to uncover the exchange channel when the cap is disengaged from the proximal opening allowing the user to move the two or more wires between the first portion and the second portion of the proximal opening via the exchange channel.

31. The wire control mechanism of any one of Claims 28-30, wherein the cap comprises an open configuration and a closed configuration, wherein the cap is disengaged with the proximal opening and the exchange channel is uncovered when the cap is in the open configuration, and wherein the cap is engaged with the proximal opening and the exchange channel is covered when the cap is in the closed configuration.

32. The wire control mechanism of any one of Claims 28-31, wherein the first portion of the proximal opening aligns with the first cutout of the cap when the cap is engaged with the proximal opening.

33. The wire control mechanism of any one of Claims 28-32, wherein the second portion of the proximal opening aligns with the second cutout of the cap when the cap is engaged with the proximal opening.

34. The wire control mechanism of any one of Claims 28-33, wherein the distal end is configured to be removably coupled to a hemostatic valve.

35. The wire control mechanism of any one of Claims 28-33, wherein the distal end is configured to be integral with a hemostatic valve.

36. A dynamic catheter system comprising:

a hemostatic valve comprising a valve and a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion;

one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and

a cap configured to engage with the proximal opening of the channel, the cap comprising a first cutout and a second cutout, wherein the cap is configured to uncover and cover the exchange channel without a user removing the two or more wires from the wire control mechanism, wherein each of the first and second cutouts are configured to receive at least one wire of the two or more wires.

37. The dynamic catheter system of Claim 36, wherein the cap is configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the cap engages with the proximal opening and covers the exchange channel.

38. The dynamic catheter system of Claim 36 or Claim 37, wherein the cap is configured to uncover the exchange channel when the cap is disengaged from the proximal opening allowing the user to move the two or more wires between the first portion and the second portion of the proximal opening via the exchange channel.

39. The dynamic catheter system of any one of Claims 36-38, wherein the cap comprises an open configuration and a closed configuration, wherein the cap is disengaged with the proximal opening and the exchange channel is uncovered when the cap is in the open configuration, and wherein the cap is engaged with the proximal opening and the exchange channel is covered when the cap is in the closed configuration.

40. The dynamic catheter system of any one of Claims 36-39, wherein the first portion of the proximal opening aligns with the first cutout of the cap when the cap is engaged with the proximal opening.

41. The dynamic catheter system of any one of Claims 36-40, wherein the second portion of the proximal opening aligns with the second cutout of the cap when the cap is engaged with the proximal opening.

42. The dynamic catheter system of any one of Claims 36-41, wherein the valve comprises a valve channel configured to align with the central channel of the wire control mechanism.

43. The dynamic catheter system of Claim 42, wherein the valve channel is configured to receive the two or more wires.

44. A valve system comprising:

a valve; and

a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion, a second portion, and a third portion;

one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel, a first exchange channel, and a second exchange channel, the first and second exchange channels extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the first exchange channel comprises the second portion of the proximal opening and the third exchange channel comprises the third portion of the proximal opening, wherein the first and second exchange channels are configured to allow the two or more wires to be exchanged between the first portion, the second portion, and the third portion of the proximal opening; and

a first door and a second door configured to engage with the proximal opening of the channel, wherein the first and second doors are further configured to uncover and cover at least a portion of the first and second exchange channels without a user removing the two or more wires from the

wire control mechanism, wherein each of the first, second, and third portions of the proximal opening are configured to receive at least one wire of the two or more wires.

45. The valve system of Claim 44, wherein the valve comprises a hemostasis valve.

46. The valve system of any one of Claims 44-52, wherein the valve and the wire control mechanism form a single continuous structure.

47. The valve system of any one of Claims 44-46, wherein the first door is configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the first door engages with the proximal opening and covers at least a portion of the first exchange channel.

48. The valve system of any one of Claims 44-47, wherein the second door is configured to separate the second portion of the proximal opening from the third portion of the proximal opening and separate the two or more wires when the second door engages with the proximal opening and covers at least a portion of the second exchange channel.

49. The valve system of any one of Claims 44-48, wherein the first door is configured to uncover the first exchange channel when the first door is disengaged from the proximal opening allowing the user to move the two or more wires between the first portion and the second portion of the proximal opening via the first exchange channel.

50. The valve system of any one of Claims 44-49, wherein the second door is configured to uncover the second exchange channel when the second door is disengaged from the proximal opening allowing the user to move the two or more wires between the second portion and the third portion of the proximal opening via the second exchange channel.

51. The valve system of any one of Claims 44-50, wherein the first and second doors comprise an open configuration and a closed configuration, wherein the first and second doors are disengaged with the proximal opening and the first and second exchange channels are uncovered when the first and second doors are in the open configuration, and wherein first and second doors are engaged with the proximal opening and the first and second exchange channels are at least partially covered when the first and second doors are in the closed configuration.

52. The valve system of any one of Claims 44-51, wherein the valve comprises a valve channel configured to align with the central channel of the wire control mechanism.

53. The valve system of any one of Claims 44-52, wherein the valve channel is configured to receive the two or more wires.

54. The valve system of any one of Claims 44-53, wherein the first and second doors comprise a rectangular shape.

55. The valve system of any one of Claims 44-54, wherein the proximal end comprises one or more hinges, and wherein an end of the first and second doors couples to the one or more hinges.

56. A dynamic catheter system comprising:

the valve system of any one of Claims 44-55;

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with the valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

57. The dynamic catheter system of Claim 56, wherein a variation of the first wall thickness is inversely related to a variation of the second wall thickness.

58. The dynamic catheter system of Claim 56 or Claim 57, wherein the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness.

59. The dynamic catheter system of Claim 58, wherein the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter.

60. The dynamic catheter system of Claim 58 or Claim 59, wherein the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter.

61. The dynamic catheter system of any one of Claims 58-60, wherein the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region.

62. The dynamic catheter system of any one of Claims 58-61, wherein the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

63. A valve system comprising:

a valve; and

a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion;

one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and

a door configured to engage with the proximal opening of the channel, wherein the door is further configured to uncover and cover at least a portion of the exchange channel without a user removing the two or more wires from the wire control mechanism, wherein the first portion and the second portion of the

proximal opening are configured to receive at least one wire of the two or more wires.

64. The valve system of Claim 63, wherein the door is configured to separate the first portion of the proximal opening from the second portion of the proximal opening and separate the two or more wires when the door engages with the proximal opening and covers at least a portion of the exchange channel.

65. The valve system of any of Claims 63-64, wherein the door is configured to uncover the exchange channel when the door is disengaged from the proximal opening allowing the user to move the two or more wires between the first portion and the second portion of the proximal opening via the exchange channel.

66. The valve system of any one of Claims 63-65, wherein the door comprises an open configuration and a closed configuration, wherein the door is disengaged with the proximal opening and the exchange channel is uncovered when the door is in the open configuration, and wherein door is engaged with the proximal opening and the exchange channel is at least partially covered when the door is in the closed configuration.

67. The valve system of any one of Claims 63-66, wherein the valve comprises a valve channel configured to align with the central channel of the wire control mechanism.

68. The valve system of any one of Claims 63-67, wherein the valve channel is configured to receive the two or more wires.

69. The valve system of any one of Claims 63-68, wherein the door comprises a rectangular shape.

70. The valve system of any one of Claims 63-69, wherein the proximal end comprises one or more hinges, and wherein an end of the door couples to the one or more hinges.

71. The valve system of any one of Claims 63-70, wherein the valve and the wire control mechanism form a single continuous structure.

72. A dynamic catheter system comprising:

the valve system of any one of Claims 63-71;

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with the

valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

73. A valve system comprising:

a valve; and

a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween;

a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the proximal opening at the proximal end; and

a disc configured to engage with the proximal opening of the channel, the disc comprising a cutout defining a first portion, a second portion, and a third portion, wherein the disc is configured to cover at least a portion of the proximal opening, wherein the disc is configured to allow communication between the first portion, the second portion, and the third portion and allow the two or more wires to move between the first portion, the second portion, and the third portion without a user removing the two or more wires from the wire control mechanism, wherein the first, second, and third portions of the cutout are configured to receive at least one wire of the two or more wires.

74. The valve system of Claim 73, wherein a first bridge portion separates the first and second portions of the cutout, and a second bridge portion separates the second and third portions of the cutout.

75. The valve system of any one of Claims 73-74, wherein the first and second bridge portions comprise a seal.

76. The valve system of any one of Claims 73-75, wherein the second portion of the cutout comprises one or more slits extending from the second portion.

77. The valve system of any one of Claims 73-76 wherein the valve comprises a valve channel configured to align with the central channel of the wire control mechanism.

78. The valve system of any one of Claims 73-77, wherein the valve channel is configured to receive the two or more wires.

79. The valve system of any one of Claims 73-78, wherein the disc comprises a circular shape.

80. The valve system of any one of Claims 73-79, wherein the first and third portions of the cutout comprise an arc shape, and wherein the second portion of the cutout comprises a circular shape.

81. The valve system of any one of Claims 73-80, wherein the valve and the wire control mechanism form a single continuous structure.

82. A dynamic catheter system comprising:

the valve system of any of Claims 73-81;

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

83. The dynamic catheter system of Claim 82, wherein a variation of the first wall thickness is inversely related to a variation of the second wall thickness.

84. The dynamic catheter system of Claim 82 or Claim 83, wherein the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness.

85. The dynamic catheter system of Claim 84, wherein the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter.

86. The dynamic catheter system of Claim 84 or Claim 85, wherein the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter.

87. The dynamic catheter system of any one of Claims 84-86, wherein the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region.

88. The dynamic catheter system of any one of Claims 84-87, wherein the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

89. A valve system comprising:

a valve; and

a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a main portion, a first cutout, and a second cutout, the first and second cutouts extending from the main portion of the proximal opening;

a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and

a sleeve configured to engage with the distal end, wherein the sleeve is configured to uncover and cover at least a portion of the first and second cutouts, wherein the sleeve is configured to allow communication between the main portion, the first cutout, and the second cutout when the sleeve uncovers the portion of the first and second cutout and configured to allow the two or more wires to move between the main portion, the first cutout, and the second cutout without a user removing the two or more wires from the wire control mechanism, wherein the main portion, the first cutout, and the second cutout are configured to receive at least one wire of the two or more wires.

90. The valve system of Claim 89, wherein the sleeve includes a first position in which at least a portion of the first and second cutouts are not covered by the sleeve.

91. The valve system of any one of Claims 89-90, wherein the sleeve includes a second position in which an end portion of the first and second cutouts is secluded from the main portion of the proximal opening by the sleeve.

92. The valve system of any one of Claims 89-91, wherein the sleeve transitions from the first position to the second position by rotating the sleeve along a rotational axis defined by the central channel.

93. The valve system of any one of Claims 89-92, wherein the sleeve transitions from the first position to the second position by moving the sleeve along an axial axis defined the central channel.

94. The valve system of any one of Claims 89-93, wherein the valve and the wire control mechanism form a single continuous structure.

95. A dynamic catheter system comprising:

the valve system of any of Claims 89-94;

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

96. The dynamic catheter system of Claim 95, wherein a variation of the first wall thickness is inversely related to a variation of the second wall thickness.

97. The dynamic catheter system of Claim 95 or Claim 96, wherein the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness.

98. The dynamic catheter system of Claim 97, wherein the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter.

99. The dynamic catheter system of Claim 97 or Claim 98, wherein the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter.

100. The dynamic catheter system of any one of Claims 97-99, wherein the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region.

101. The dynamic catheter system of any one of Claims 97-100, wherein the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

102. A valve system comprising:

a valve; and

a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening

comprises a main portion, a first cutout, and a second cutout, the first and second cutouts extending from the main portion of the proximal opening;

a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and

a cap comprising a first arm and a second arm and configured to engage with the proximal end, wherein the first and second arms of the cap are configured to uncover and cover at least a portion of the first and second cutouts, wherein the first and second arms are configured to allow communication between the main portion, the first cutout, and the second cutout when the first and second arms uncover the portion of the first and second cutout and configured to allow the two or more wires to move between the main portion, the first cutout, and the second cutout without a user removing the two or more wires from the wire control mechanism, wherein the main portion, the first cutout, and the second cutout are configured to receive at least one wire of the two or more wires.

103. The valve system of Claim 102, wherein the valve and the wire control mechanism form a single continuous structure.

104. A dynamic catheter system comprising:

the valve system of any of Claims 102-103;

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide

extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

105. The dynamic catheter system of Claim 104, wherein a variation of the first wall thickness is inversely related to a variation of the second wall thickness.

106. The dynamic catheter system of Claim 104 or Claim 105, wherein the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness.

107. The dynamic catheter system of Claim 106, wherein the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter.

108. The dynamic catheter system of Claim 106 or Claim 107, wherein the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter.

109. The dynamic catheter system of any one of Claims 106-108, wherein the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region.

110. The dynamic catheter system of any one of Claims 106-109, wherein the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

111. A valve system comprising:

a valve; and

a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a main portion and a plurality of cutouts, the plurality of cutouts extending from the main portion of the proximal opening;

a channel configured to receive two or more wires, wherein the channel comprises a central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the main portion of the proximal opening at the proximal end; and

a plurality of sliding components configured to engage with the plurality of cutouts, wherein the plurality of sliding components are configured to uncover and cover at least a portion of the plurality of cutouts, wherein the plurality of sliding components are configured to allow communication between the main portion and the plurality of cutouts when the plurality of sliding components uncover the portion of the plurality of cutouts and configured to allow the two or more wires to move between the main portion and the plurality of cutouts without a user removing the two or more wires from the wire control mechanism, wherein the main portion and the plurality of cutouts are configured to receive at least one wire of the two or more wires.

112. A dynamic catheter system comprising:
the valve system of Claim 111;

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

113. The dynamic catheter system of Claim 112, wherein a variation of the first wall thickness is inversely related to a variation of the second wall thickness.

114. The dynamic catheter system of Claim 112 or Claim 113, wherein the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness.

115. The dynamic catheter system of Claim 114, wherein the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter.

116. The dynamic catheter system of Claim 114 or Claim 115, wherein the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter.

117. The dynamic catheter system of any one of Claims 114-116, wherein the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region.

118. The dynamic catheter system of any one of Claims 114-117, wherein the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

119. A valve system comprising:

a valve; and

a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion;

one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel, the exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening,

wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and

a liner configured to engage with the proximal end, the liner comprising a bridge portion at least partially sealing the second portion from the first portion, wherein each of the first and second portions of the proximal opening are configured to receive at least one wire of the two or more wires.

120. The valve system of Claim 119, wherein the liner is partially embedded within a portion of the second portion of the proximal opening.

121. The valve system of any one of Claims 119-120, wherein the liner partially covers the second portion of the proximal opening.

122. The valve system of any one of Claims 119-121, wherein the bridge portion comprises an opening separating a first segment of the liner and a second segment of the liner.

123. The valve system of any one of Claims 119-122, wherein the liner and the valve comprise a single continuous structure.

124. The valve system of any one of Claims 119-123, wherein the liner comprises a V-shape.

125. The valve system of any one of Claims 119-124, wherein the liner comprises a silicone gel.

126. A dynamic catheter comprising:

the valve system of any of Claims 119-125;

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from

the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

127. The dynamic catheter of Claim 126, wherein a variation of the first wall thickness is inversely related to a variation of the second wall thickness.

128. The dynamic catheter of Claim 126 or Claim 127, wherein the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness.

129. The dynamic catheter of Claim 128, wherein the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter.

130. The dynamic catheter of Claim 128 or Claim 129, wherein the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter.

131. The dynamic catheter of any one of Claims 128-130, wherein the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region.

132. The dynamic catheter of any one of Claims 128-131, wherein the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

133. A valve system comprising:

a valve; and

a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion;

one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel, the exchange channel extending radially outward from the central channel, the

central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and

an insert configured to engage with the proximal end, the insert comprising a bridge portion at least partially sealing the second portion from the first portion, wherein each of the first and second portions of the proximal opening are configured to receive at least one wire of the two or more wires.

134. The valve system of Claim 133, wherein the insert is partially embedded within a portion of the second portion of the proximal opening.

135. The valve system of any one of Claims 133-134, wherein the insert partially covers the first portion of the proximal opening.

136. The valve system of any one of Claims 133-135, wherein the bridge portion comprises an opening separating a first segment of the insert and a second segment of the insert.

137. The valve system of any one of Claims 133-136, wherein the insert and the valve comprise a single continuous structure.

138. The valve system of any one of Claims 133-137, wherein the insert comprises a circular shape.

139. The valve system of Claim 133, wherein the insert comprises a silicone gel.

140. A dynamic catheter comprising:

the valve system of any of Claims 133-139;

a guide catheter comprising a first wall, the first wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the distal portion is configured to be positioned within an artery and the proximal end is configured to interact with a valve, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and

a guide extension catheter comprising a second wall, the second wall comprising a distal portion comprising a distal end, a proximal portion comprising a proximal end, and a middle portion extending therebetween, wherein the guide extension catheter is positioned within the guide catheter and configured to extend from the distal end of the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end.

141. The dynamic catheter of Claim 140, wherein a variation of the first wall thickness is inversely related to a variation of the second wall thickness.

142. The dynamic catheter of Claim 140 or Claim 141, wherein the guide catheter comprises a first transition region comprising a change in the first wall thickness, and wherein the guide extension catheter comprises a second transition region comprising a change in the second wall thickness.

143. The dynamic catheter of Claim 142, wherein the first transition region is positioned in the middle portion of the guide catheter, and wherein the second transition region is positioned in the middle portion of the guide extension catheter.

144. The dynamic catheter of Claim 142 or Claim 143, wherein the first transition region is positioned in a distal section of the middle portion of the guide catheter, and wherein the second transition region is positioned in a distal section of the middle portion of the guide extension catheter.

145. The dynamic catheter of any one of Claims 142-144, wherein the first wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a proximal to distal direction within the first transition region.

146. The dynamic catheter of any one of Claims 142-145, wherein the second wall thickness decreases from a maximum wall thickness to a minimum wall thickness in a distal to proximal direction within the second transition region.

147. A valve system comprising:

a valve;

and a wire control mechanism in communication with the valve, the wire control mechanism comprising:

a distal end comprising a distal opening, a proximal end comprising a proximal opening, and a length therebetween, wherein the proximal opening comprises a first portion and a second portion;

one or more channels configured to receive two or more wires, wherein the one or more channels comprise a central channel and an exchange channel extending radially outward from the central channel, the central channel extending along the length from the distal end to the proximal end, wherein the central channel comprises the distal opening at the distal end and the first portion of the proximal opening at the proximal end, wherein the exchange channel comprises the second portion of the proximal opening, wherein the exchange channel is configured to allow the two or more wires to be exchanged between the first portion and the second portion of the proximal opening; and

a cap configured to engage with the proximal opening of the channel, the cap comprising a first cutout and a second cutout, wherein the cap is configured to uncover and cover the exchange channel without a user removing the two or more wires from the wire control mechanism, wherein each of the first and second cutouts are configured to receive at least one wire of the two or more wires.

148. A dynamic catheter system comprising one or more of the features of the foregoing description.

149. A method of using the dynamic catheter system comprising one or more features of the foregoing description.

150. A wire control mechanism comprising one or more of the features of the foregoing description.

151. A method of using the wire control mechanism comprising one or more features of the foregoing description.

152. A dynamic catheter system comprising one or more of the features of the foregoing description for use in interventional cardiology procedures.

153. A method of using the wire control mechanism comprising one or more features of the foregoing description for use in interventional cardiology procedures.

154. A wire control mechanism comprising one or more of the features of the foregoing description for use in interventional cardiology procedures.

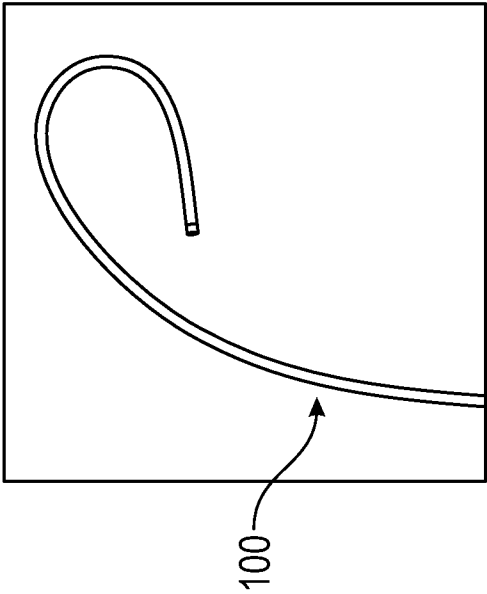


FIG. 1

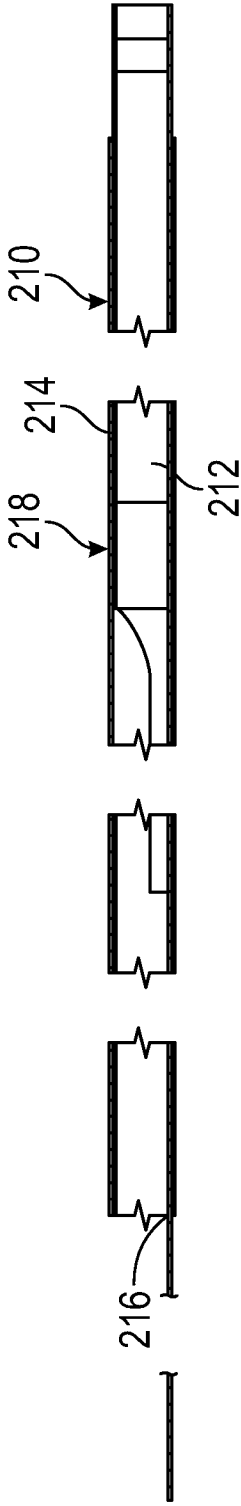


FIG. 2A

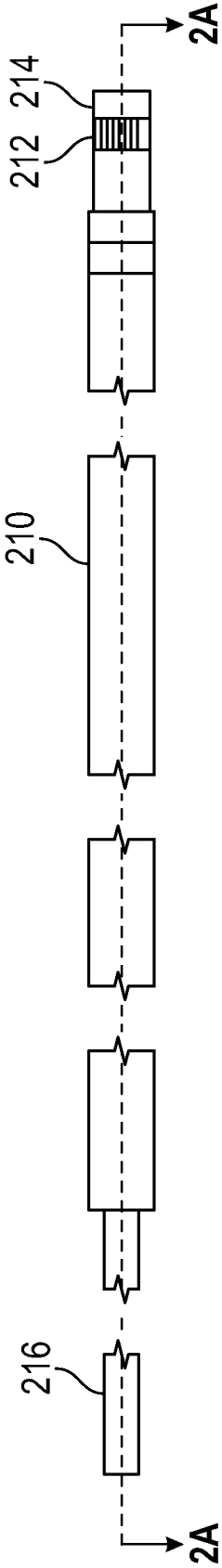


FIG. 2B

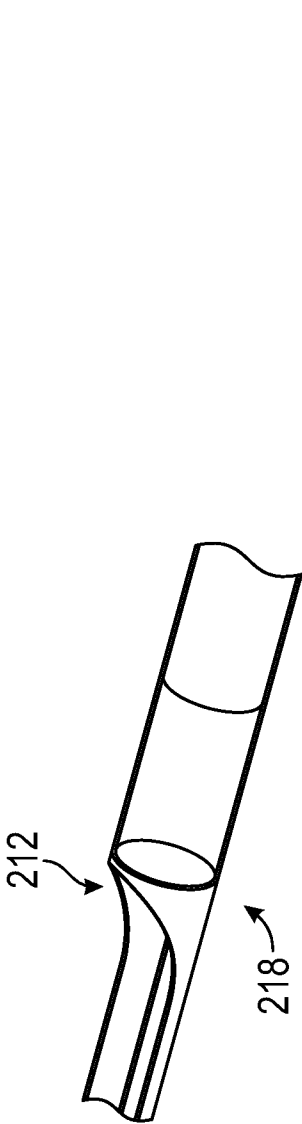


FIG. 3A

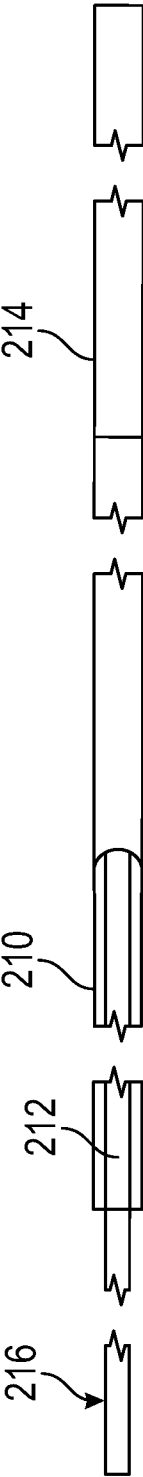


FIG. 3B

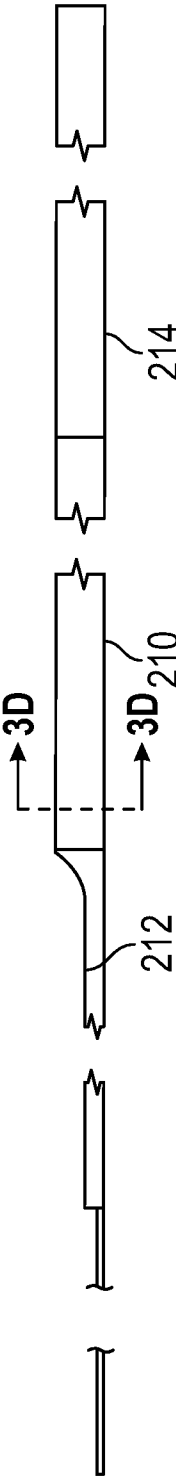


FIG. 3C

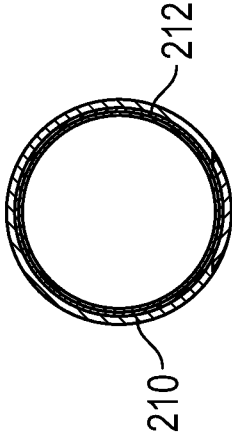


FIG. 3D

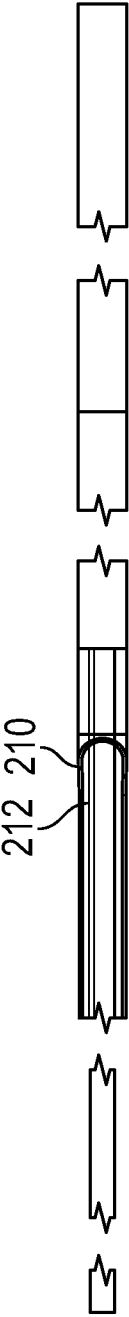


FIG. 4A

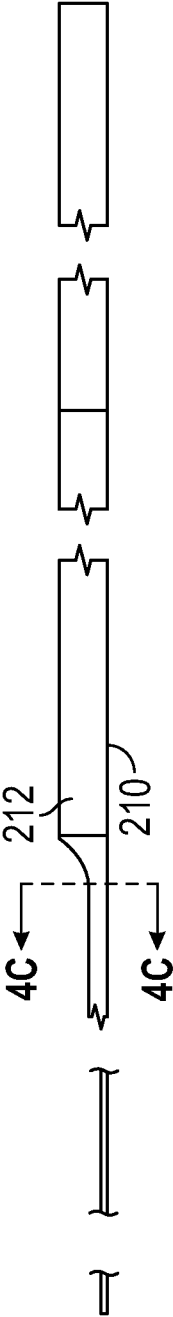


FIG. 4B

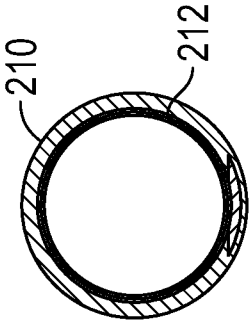


FIG. 4C

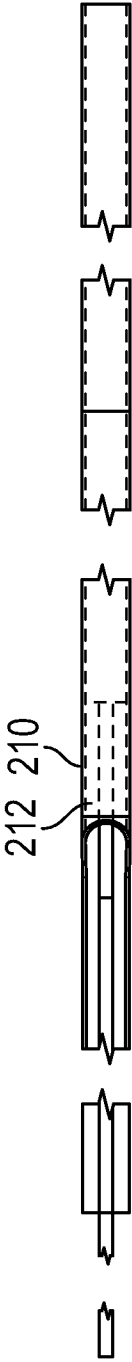


FIG. 5A

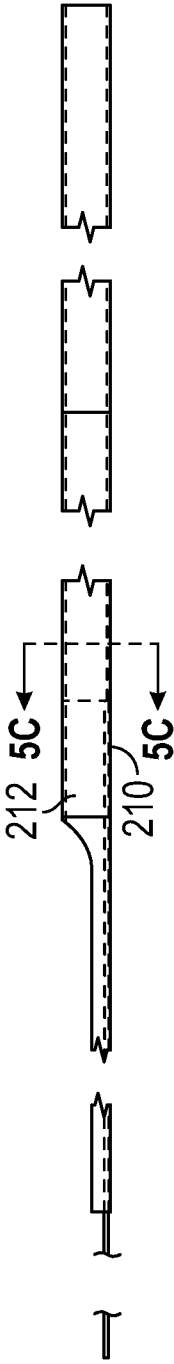


FIG. 5B

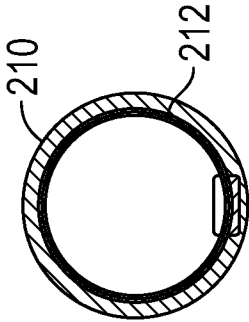


FIG. 5C

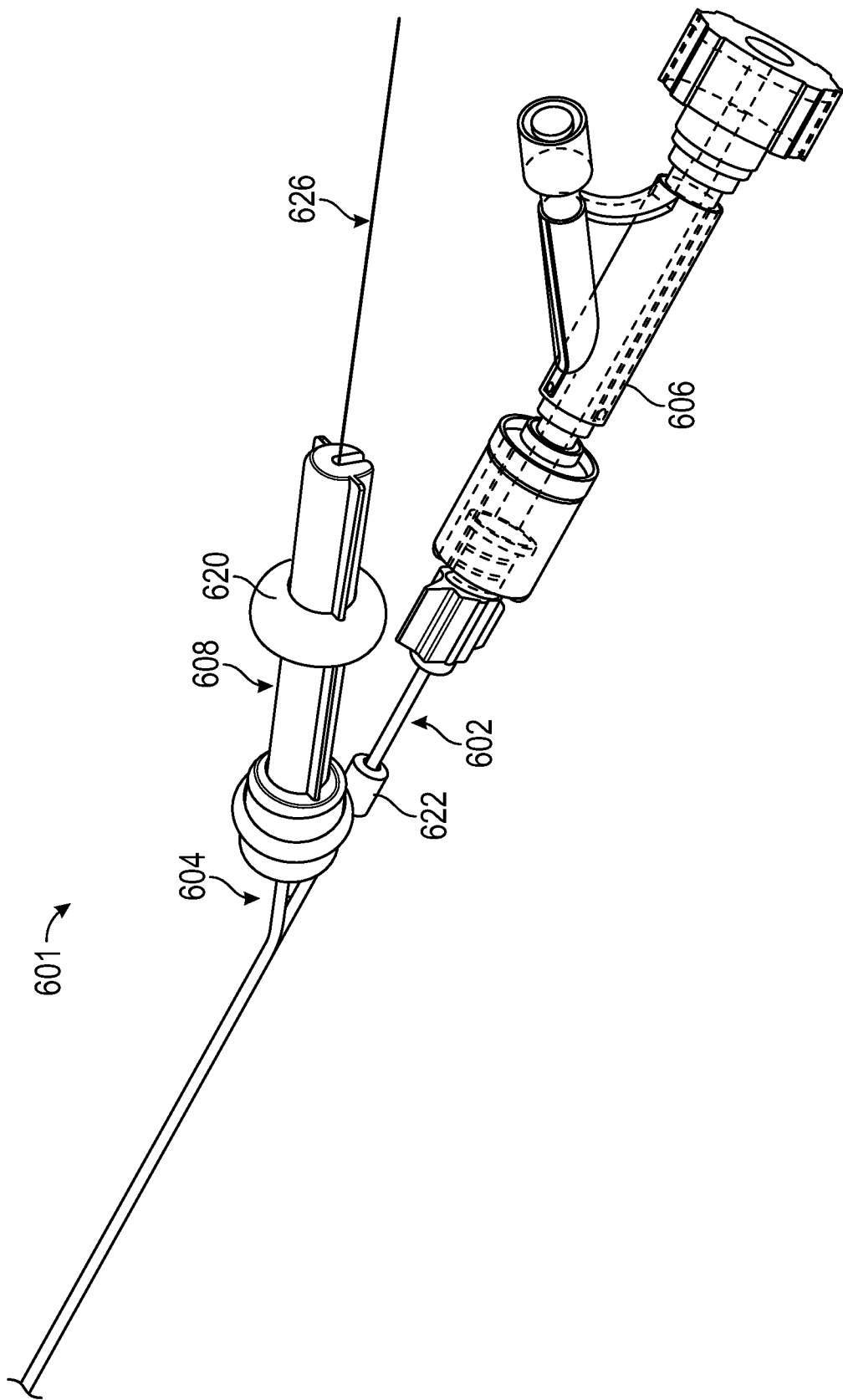


FIG. 6A

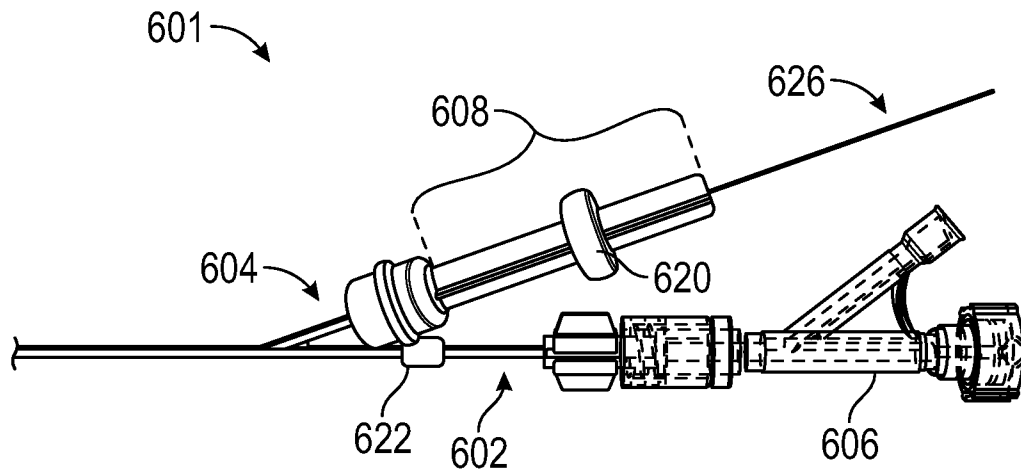


FIG. 6B

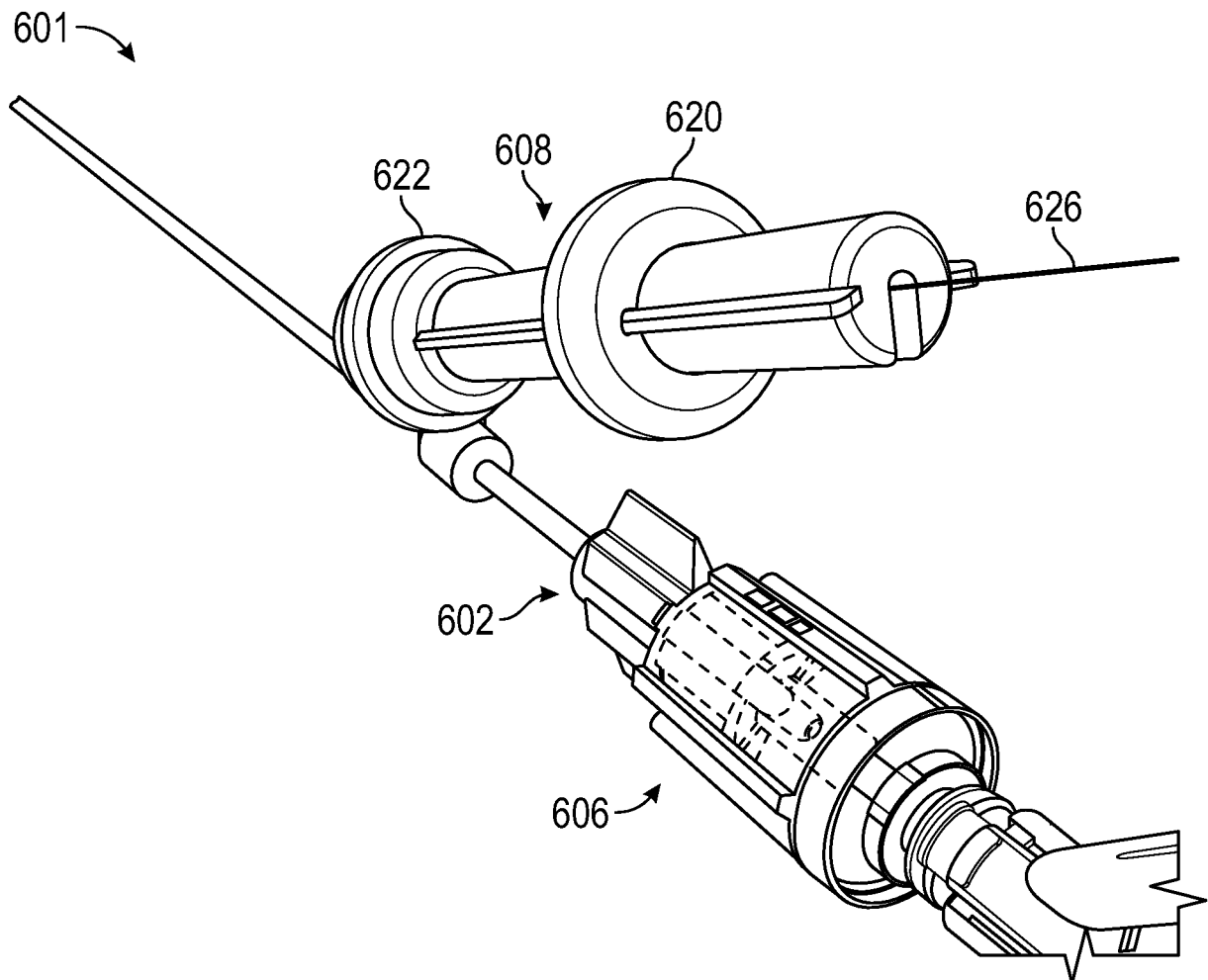


FIG. 6C

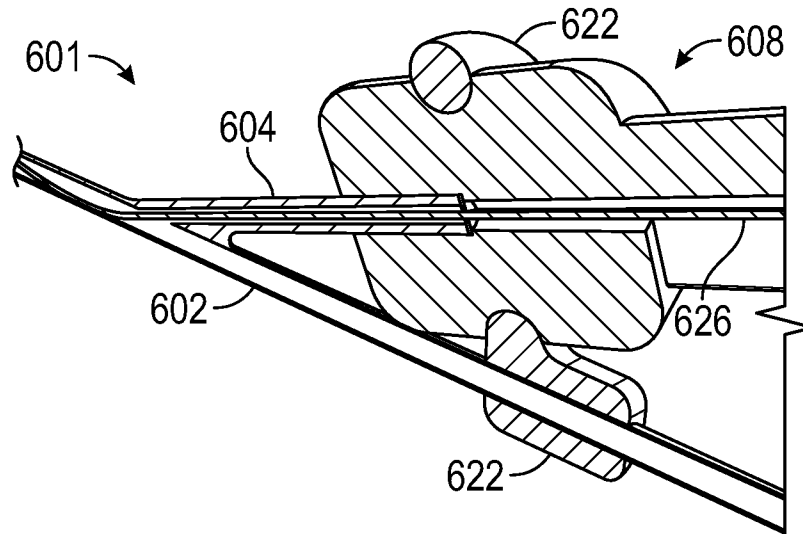


FIG. 6D

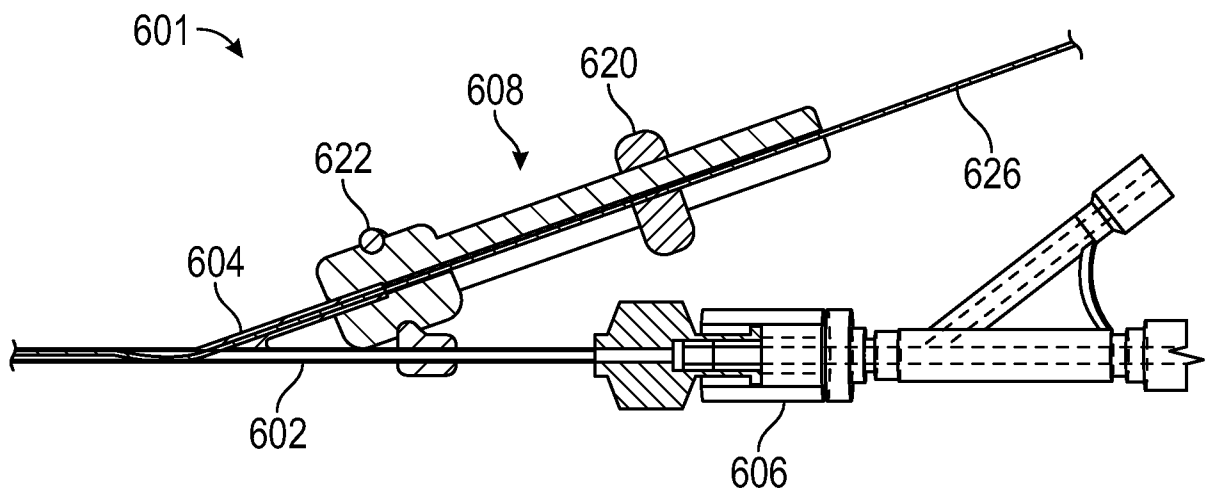


FIG. 6E

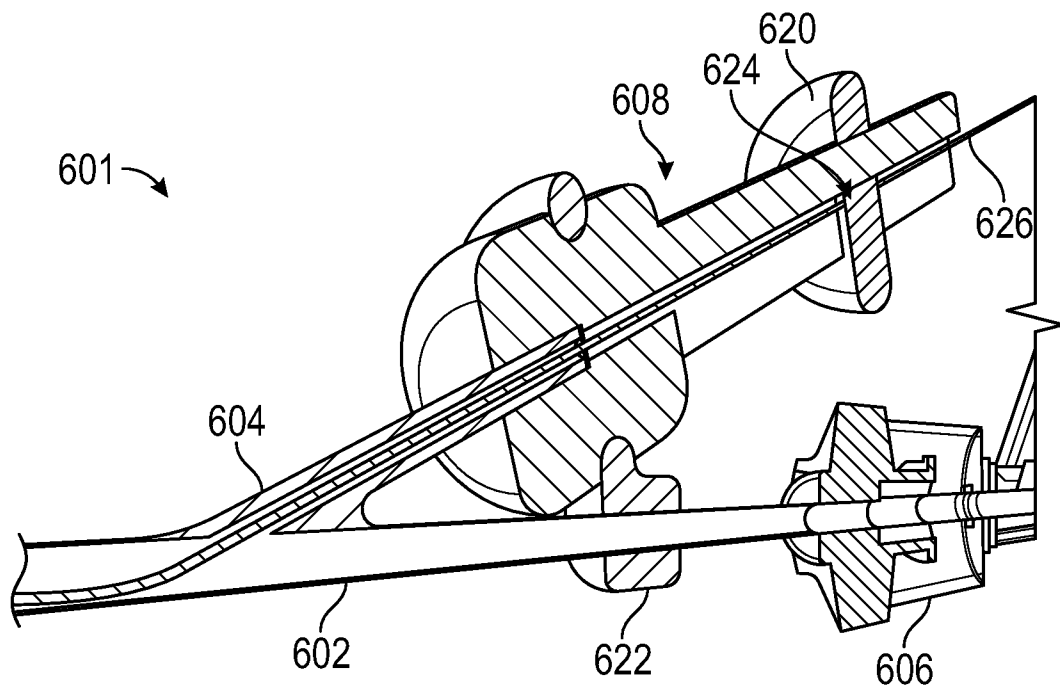


FIG. 6F

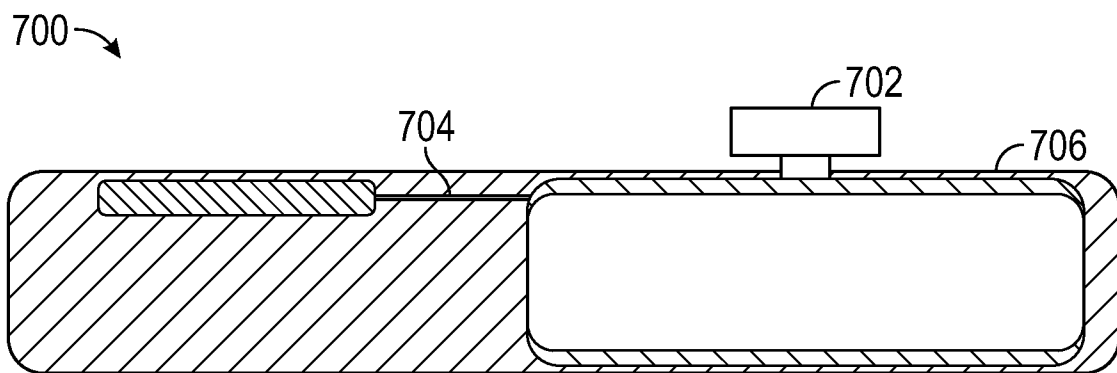


FIG. 7A

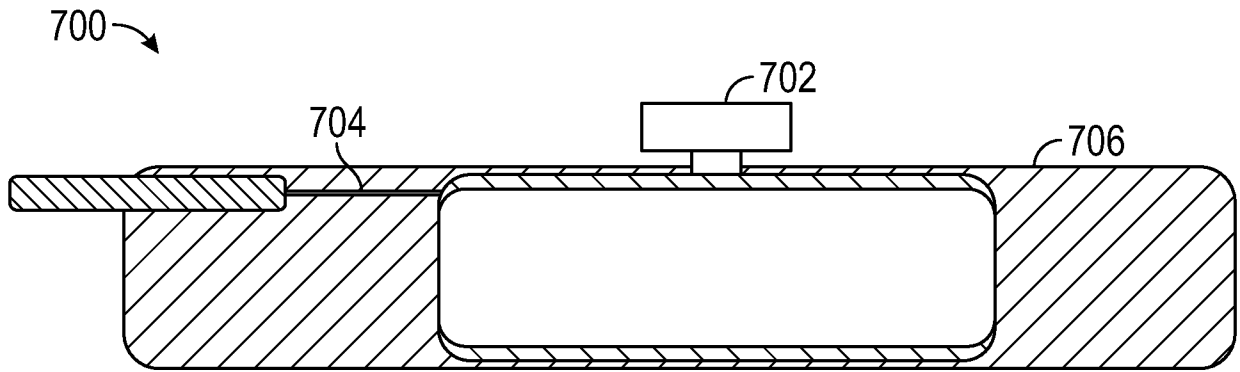


FIG. 7B

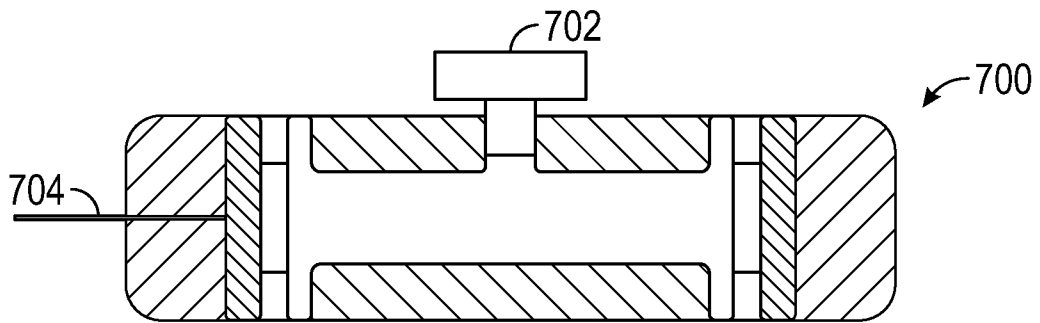


FIG. 7C

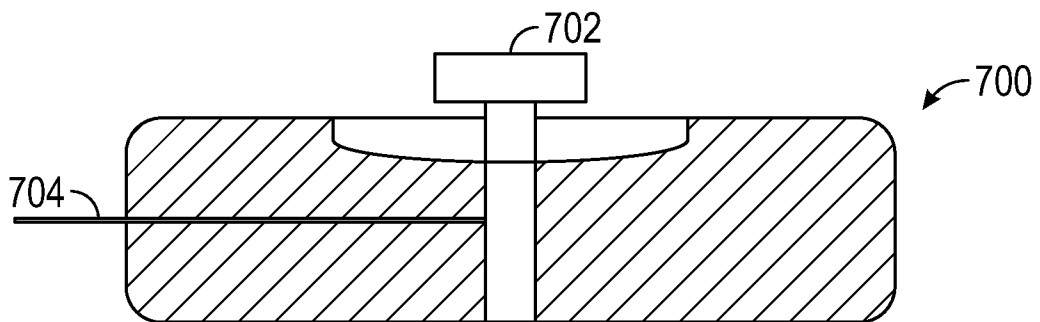


FIG. 7D

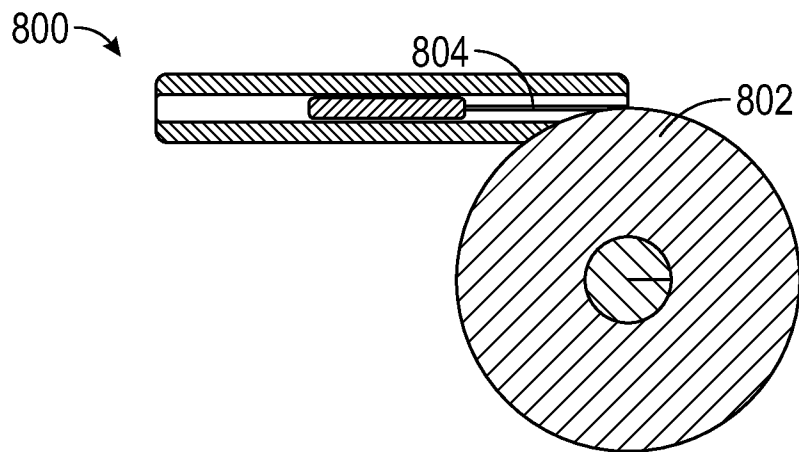


FIG. 8A

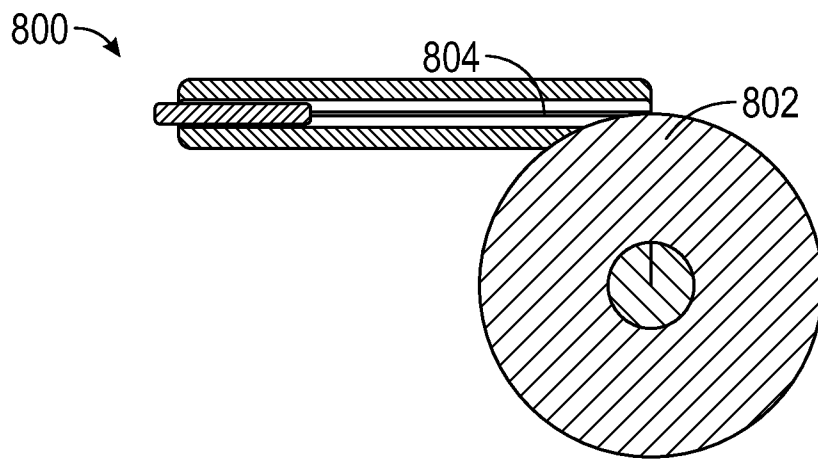


FIG. 8B

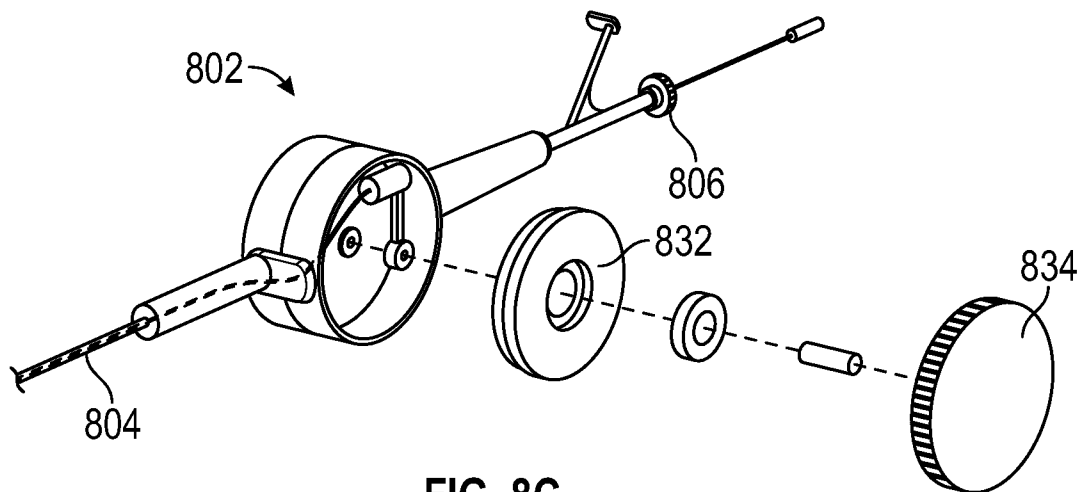


FIG. 8C

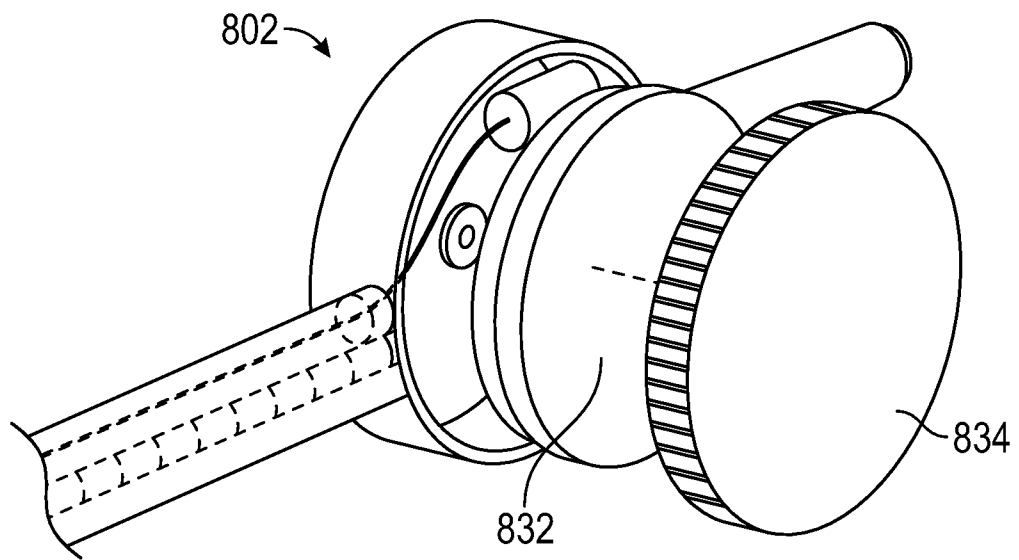


FIG. 8D

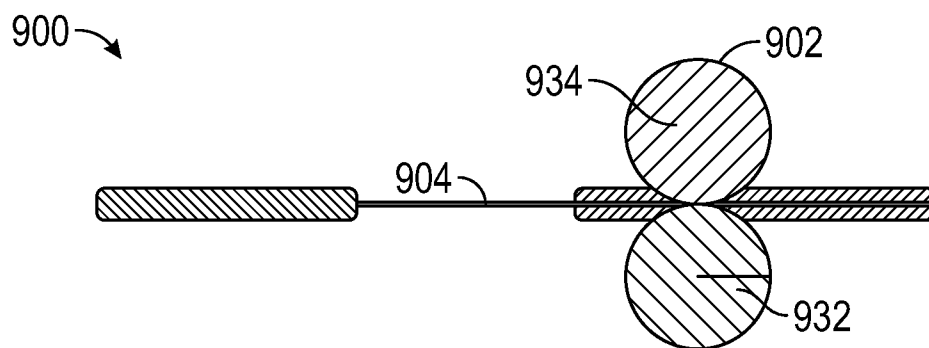


FIG. 9A

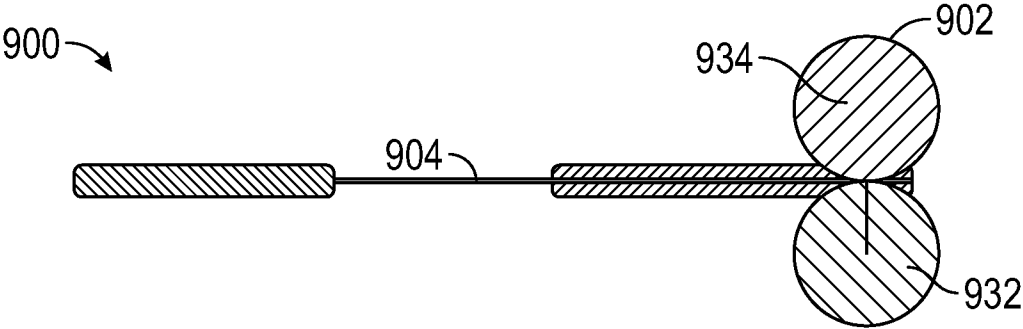


FIG. 9B

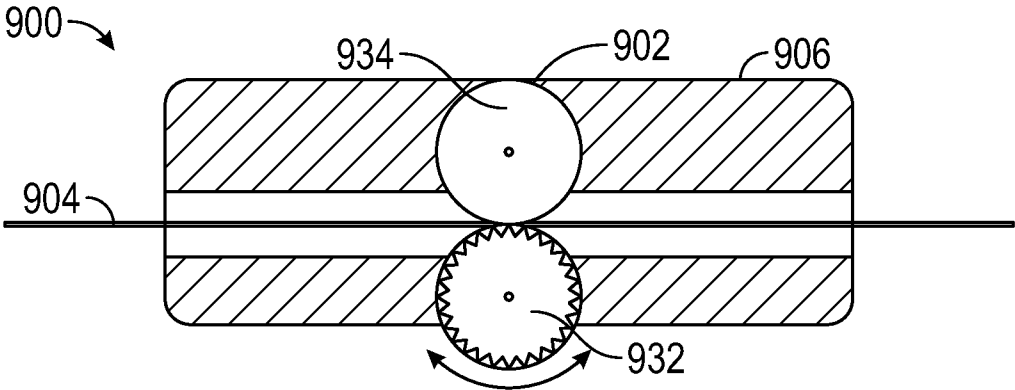


FIG. 9C

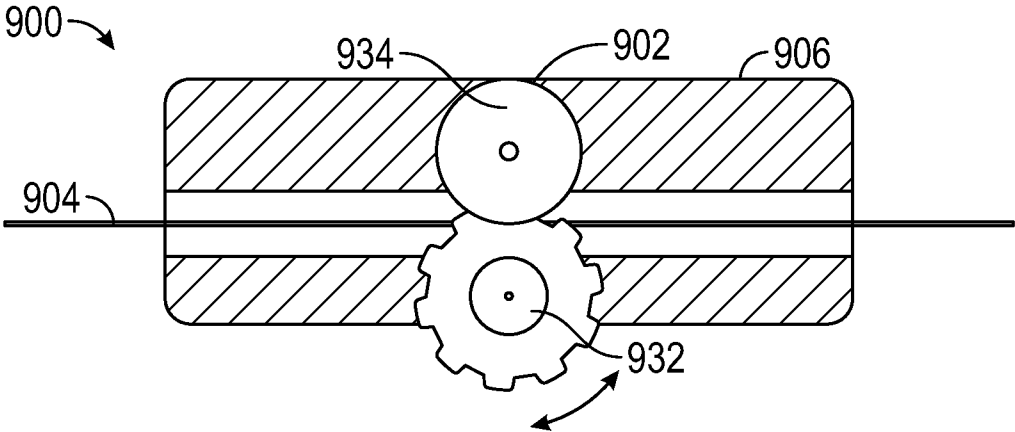


FIG. 9D

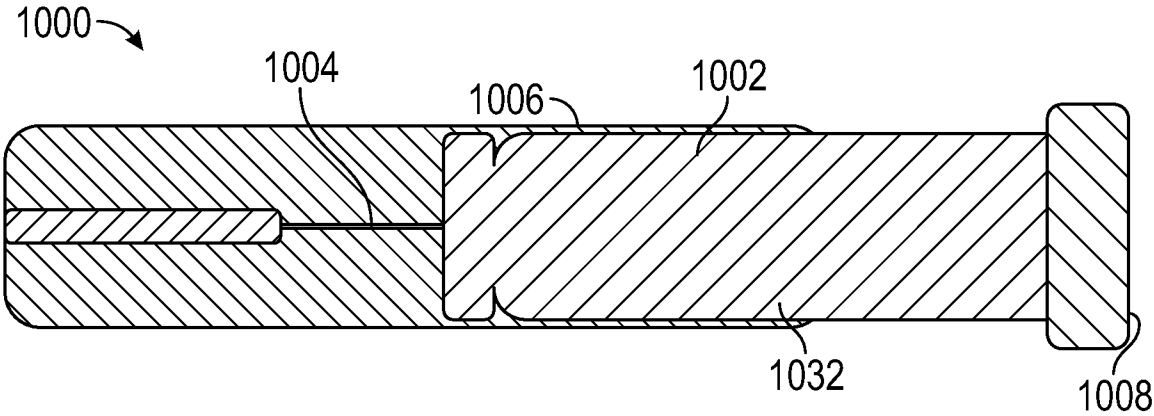


FIG. 10A

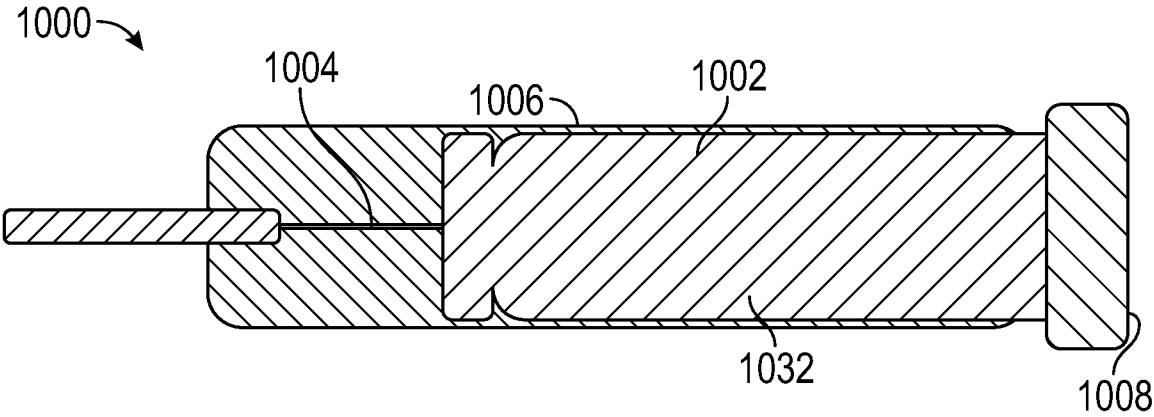


FIG. 10B

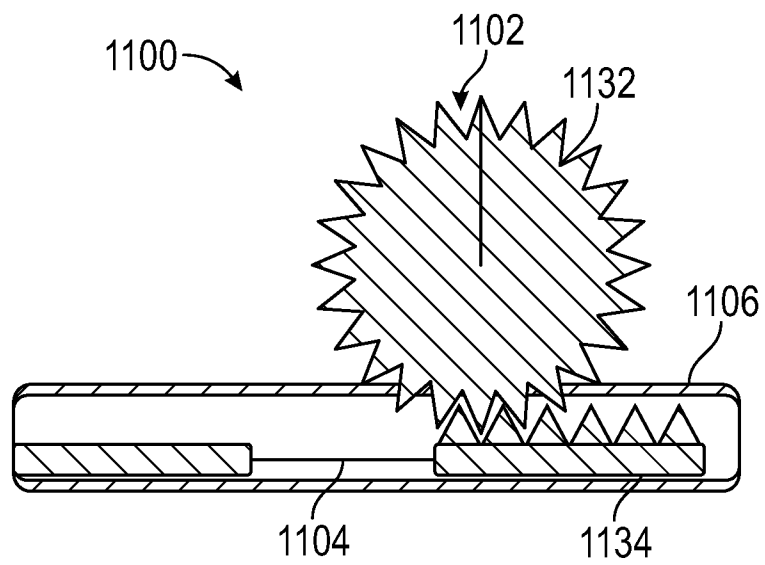


FIG. 11A

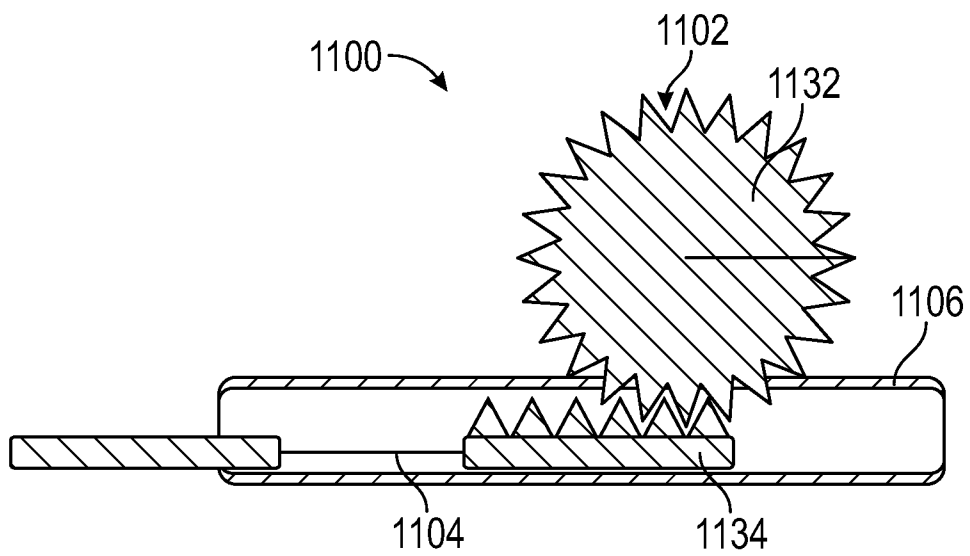


FIG. 11B

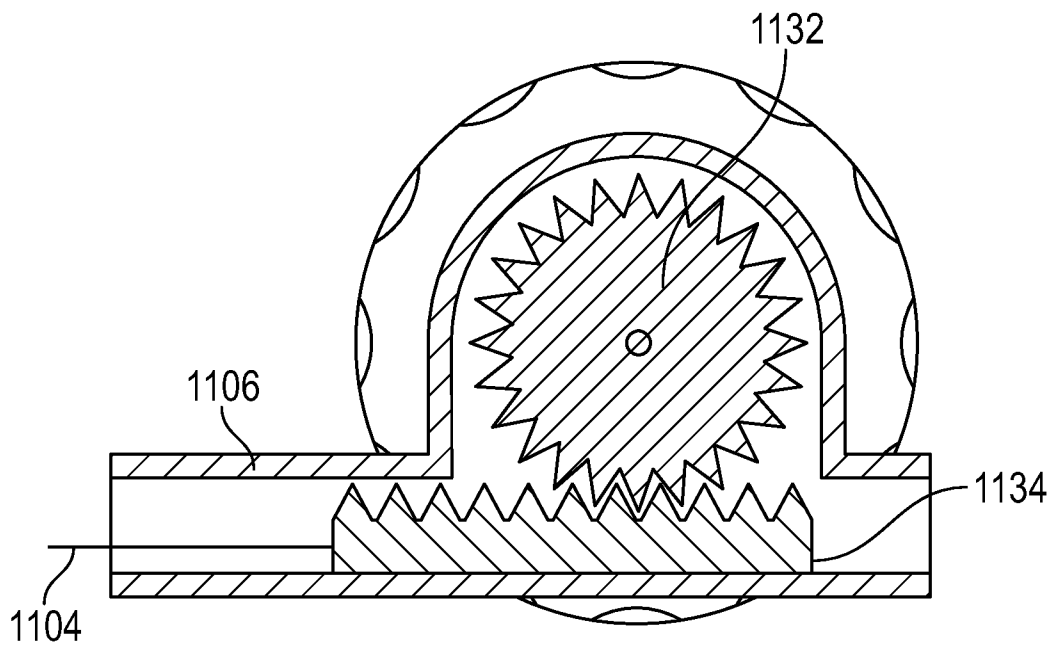


FIG. 11C

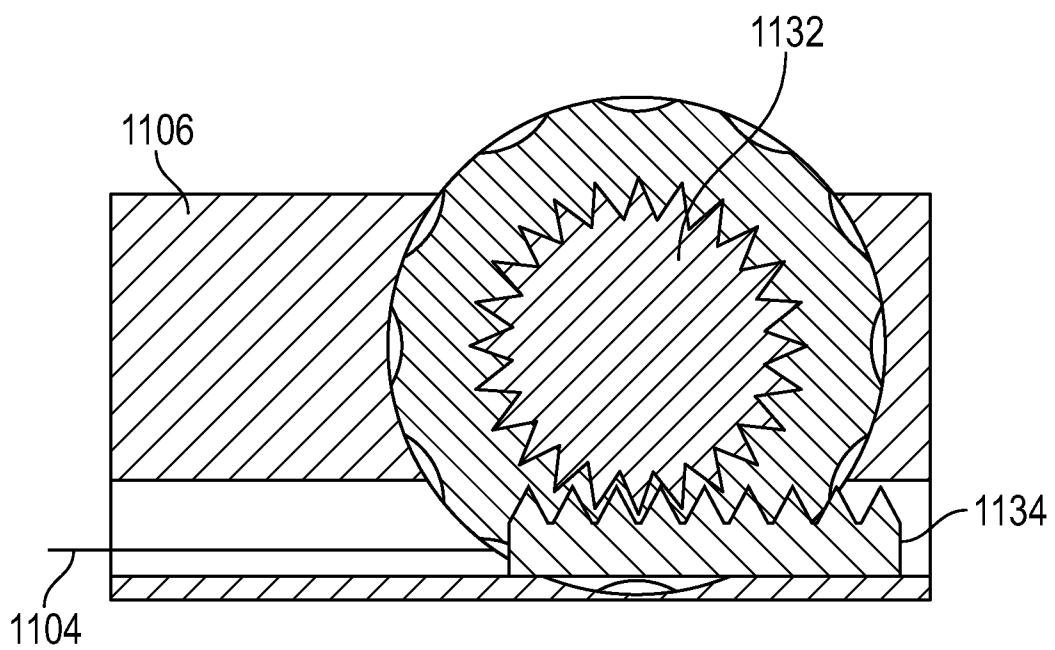


FIG. 11D

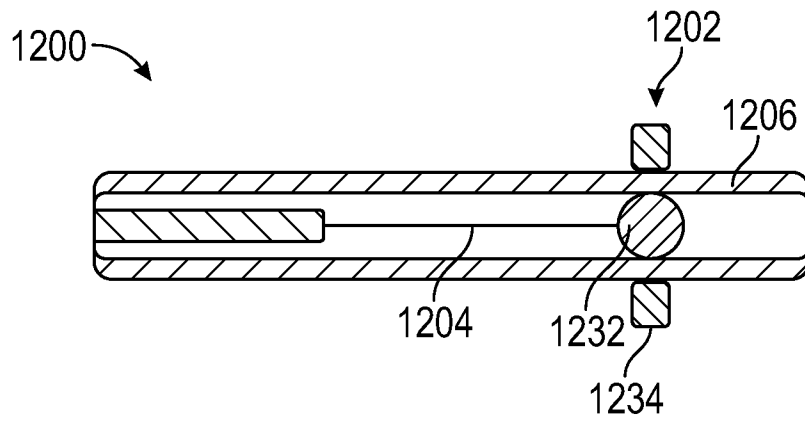


FIG. 12A

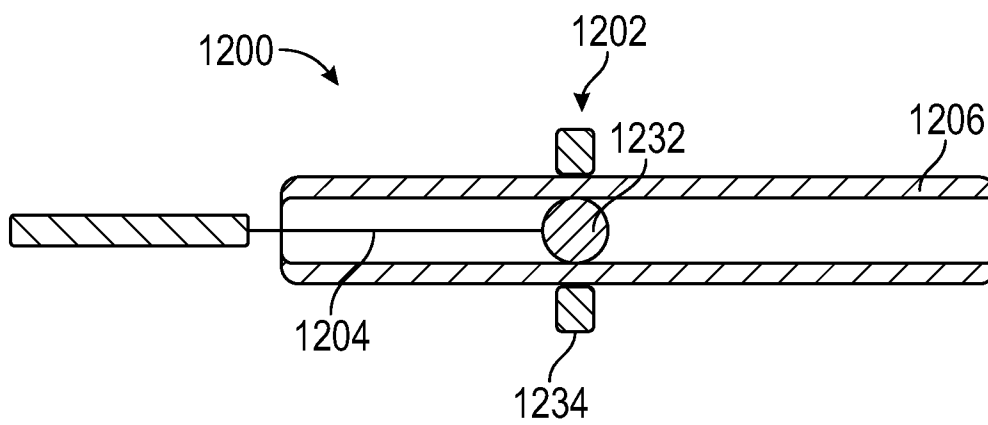


FIG. 12B

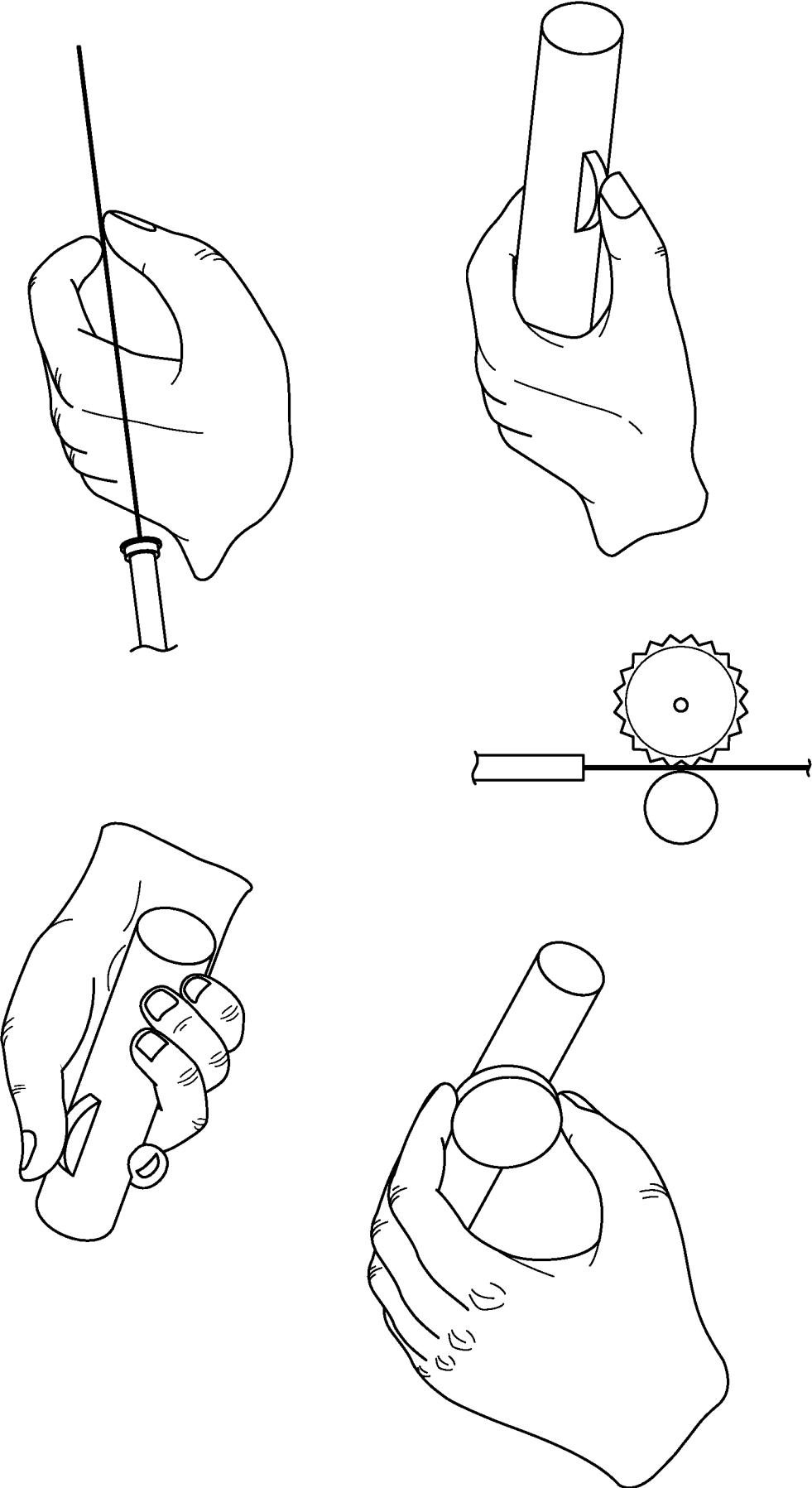


FIG. 13

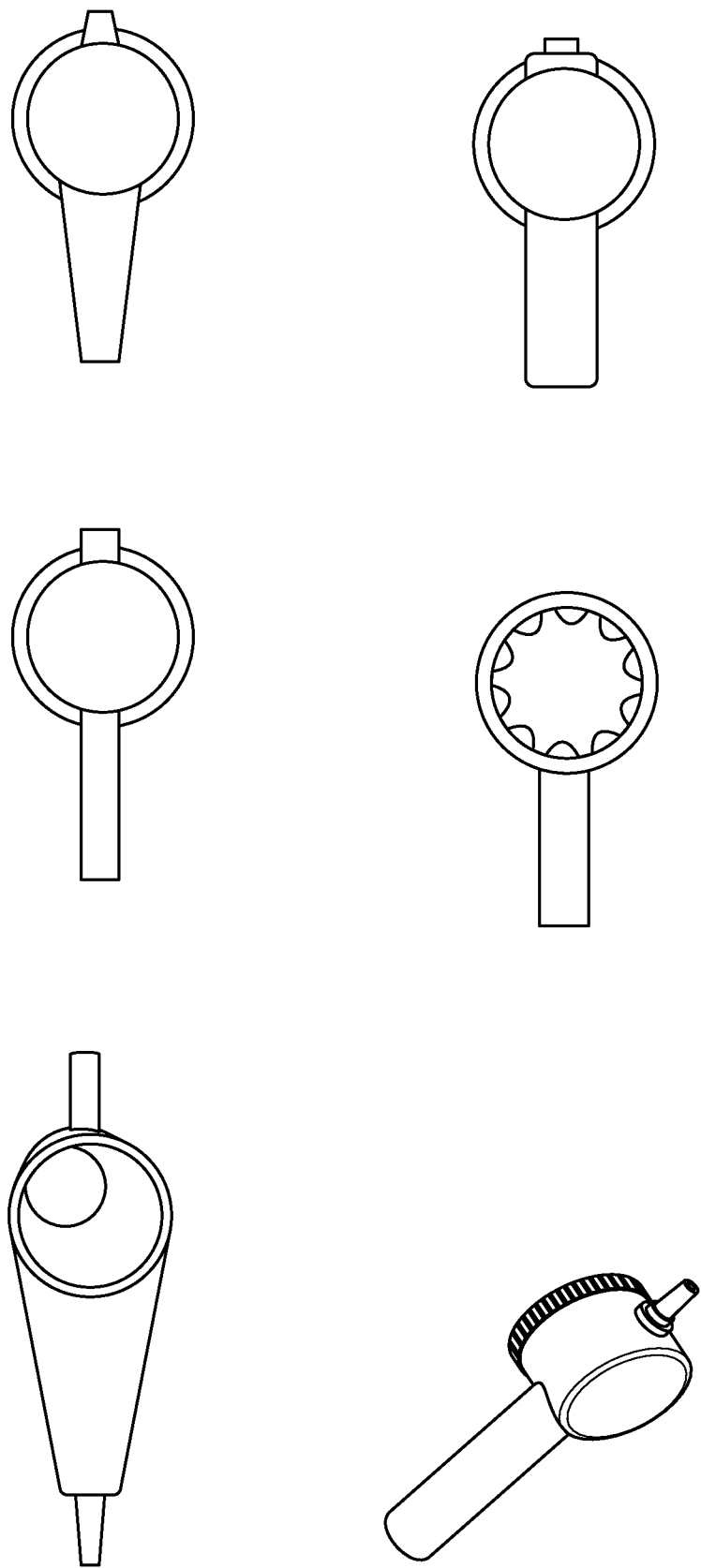


FIG. 14

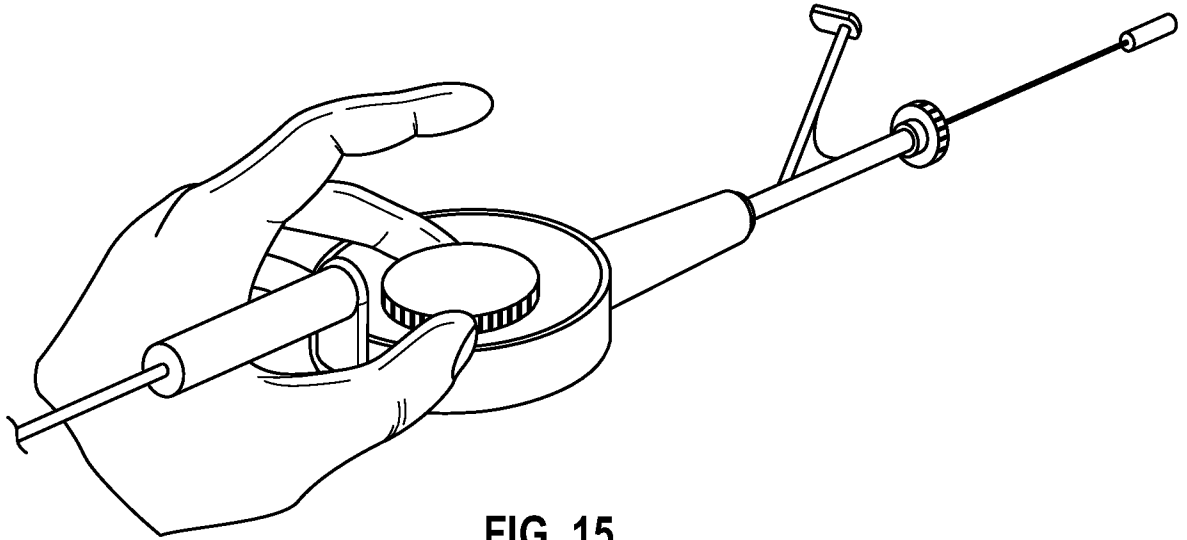


FIG. 15

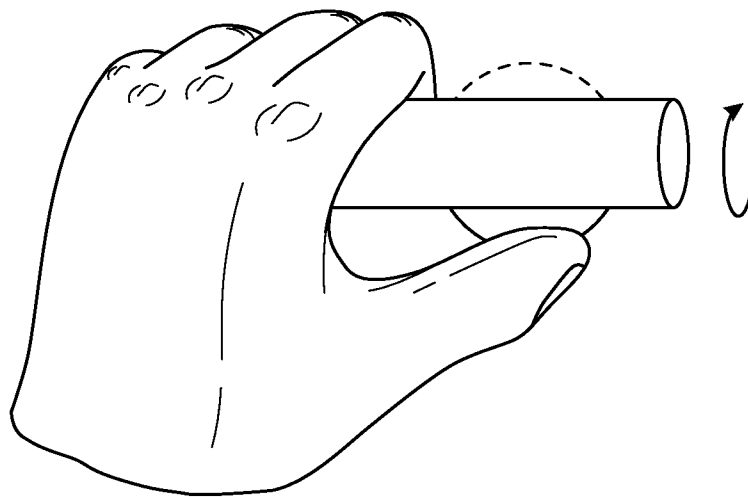


FIG. 16

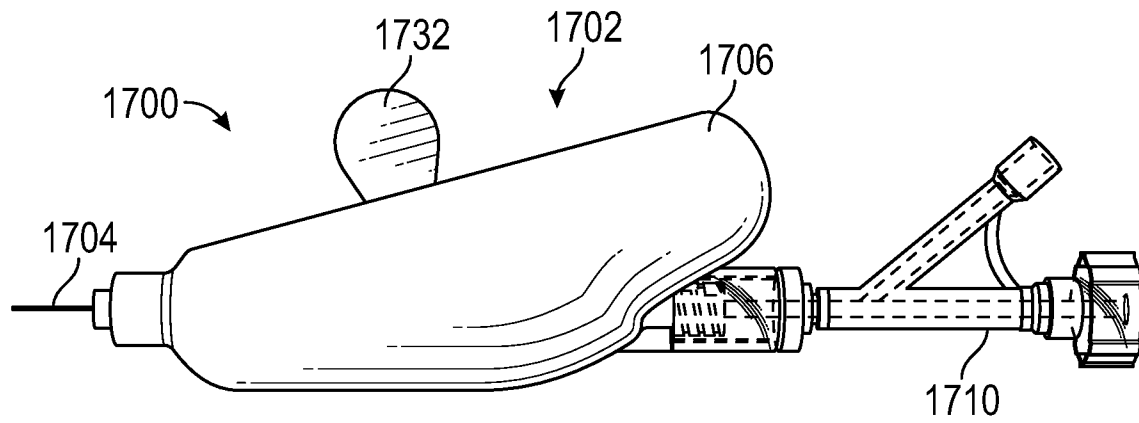


FIG. 17A

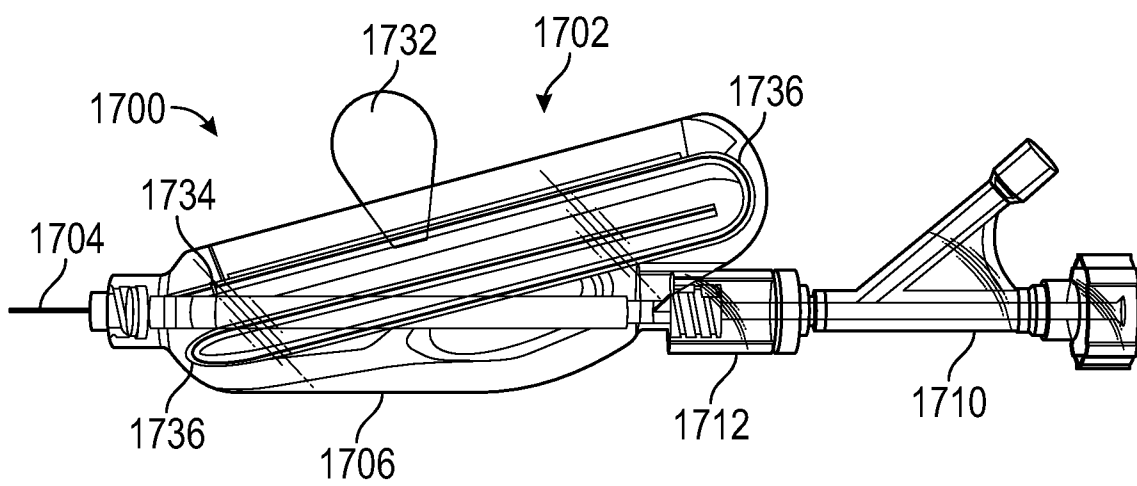


FIG. 17B

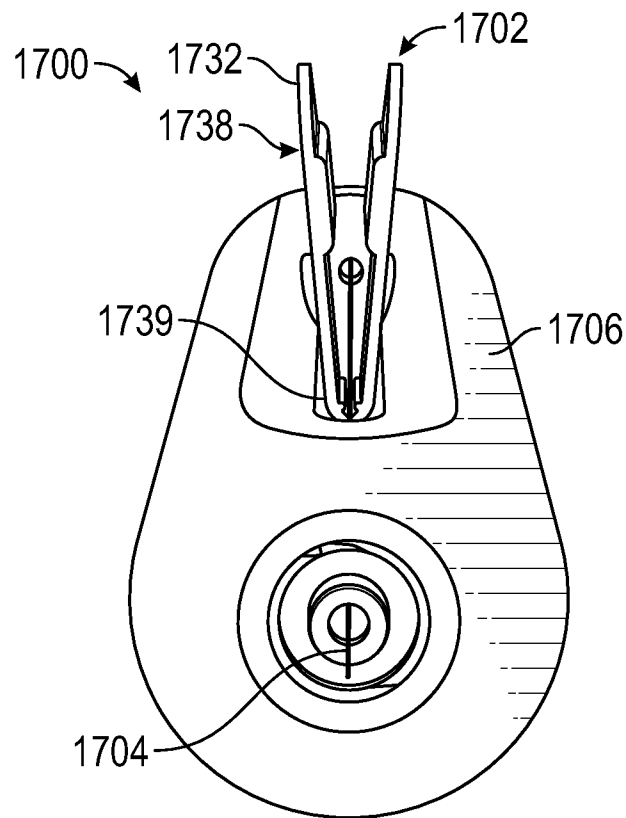


FIG. 17C

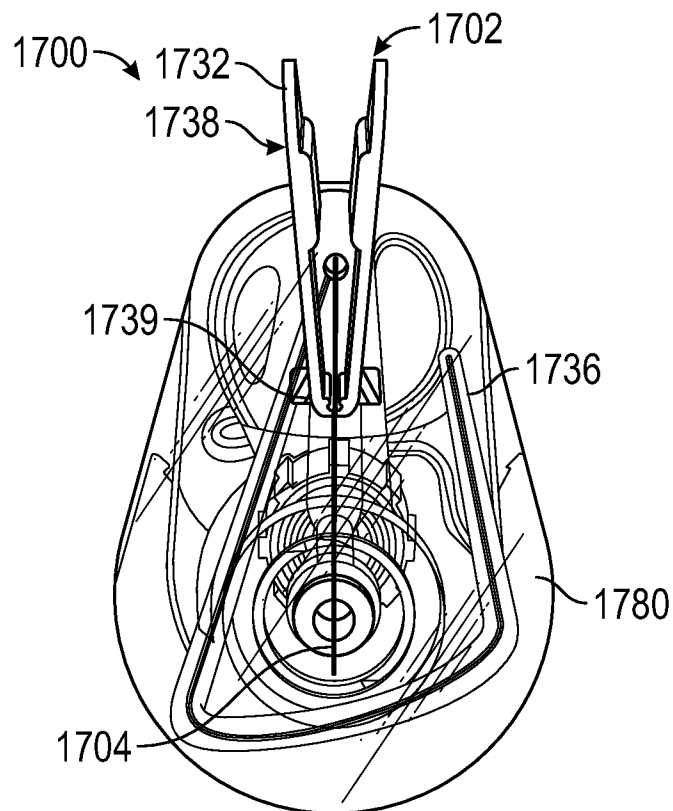


FIG. 17D

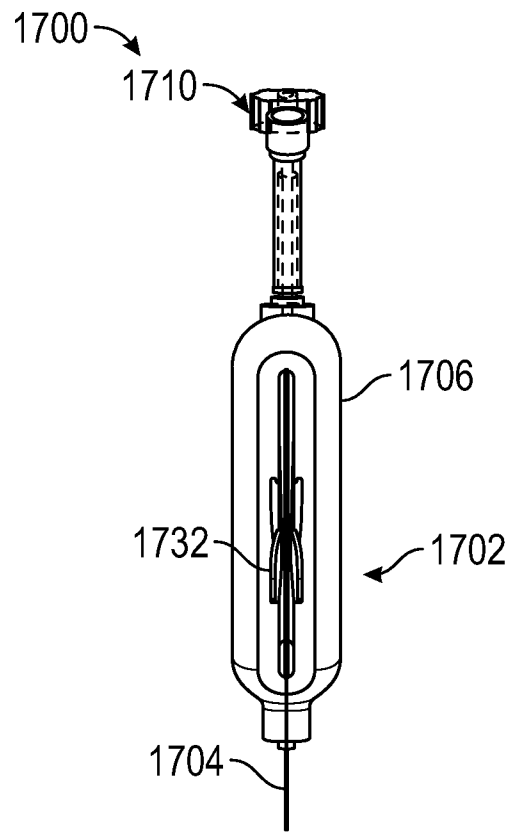


FIG. 17E

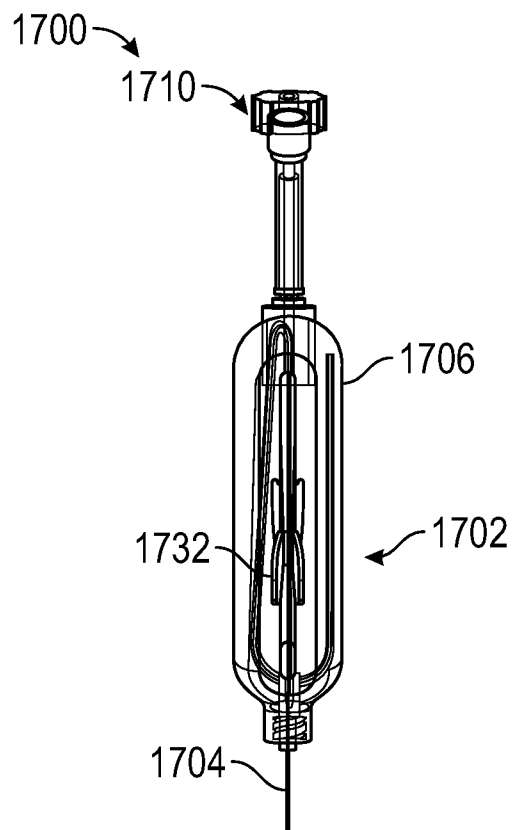


FIG. 17F

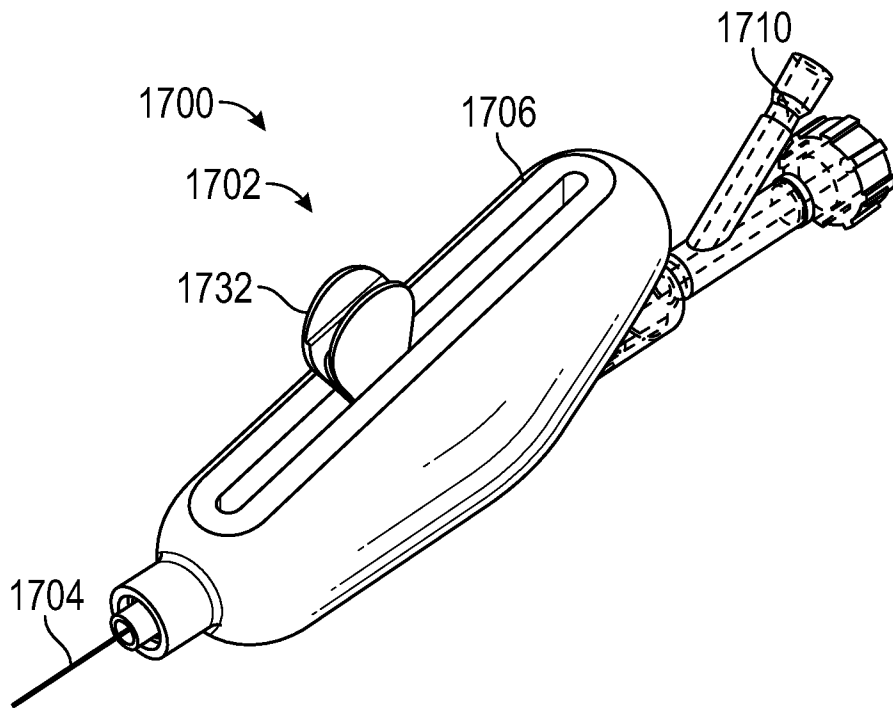


FIG. 17G

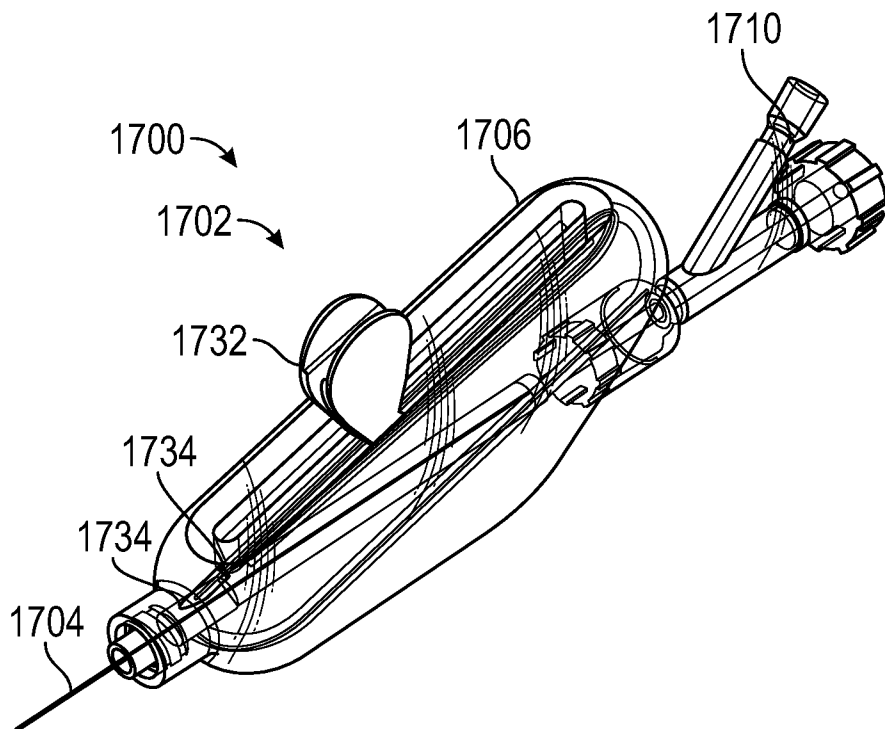


FIG. 17H

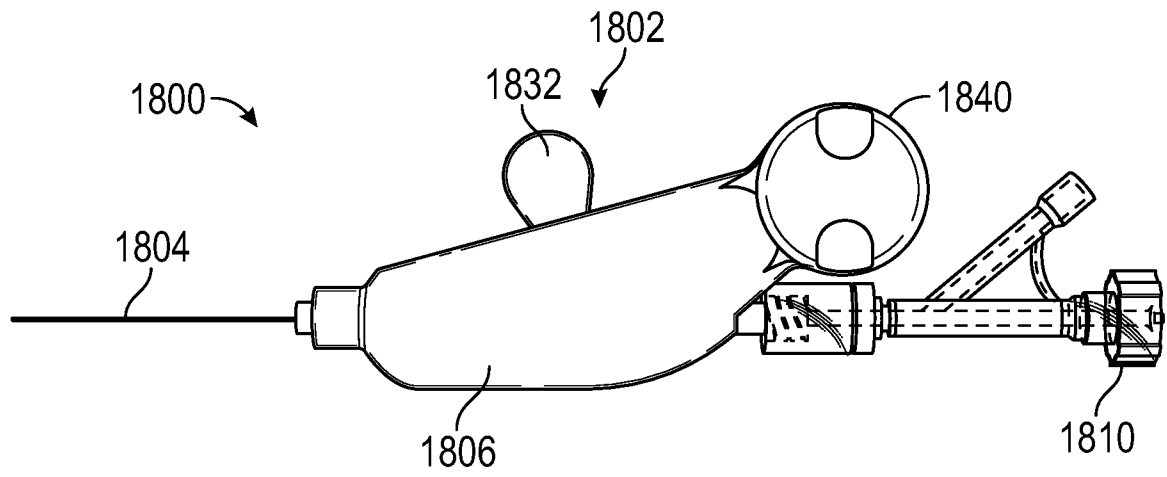


FIG. 18A

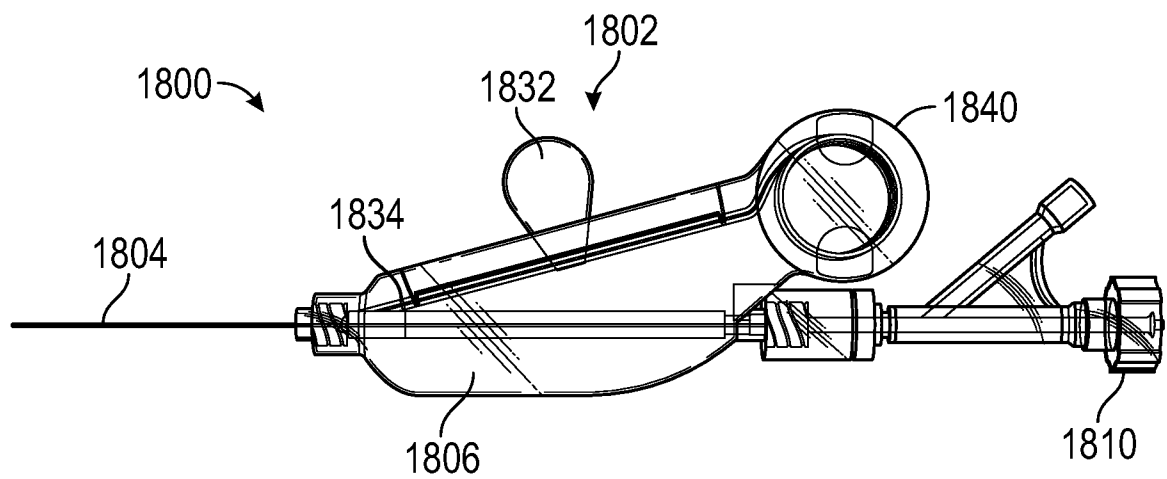


FIG. 18B

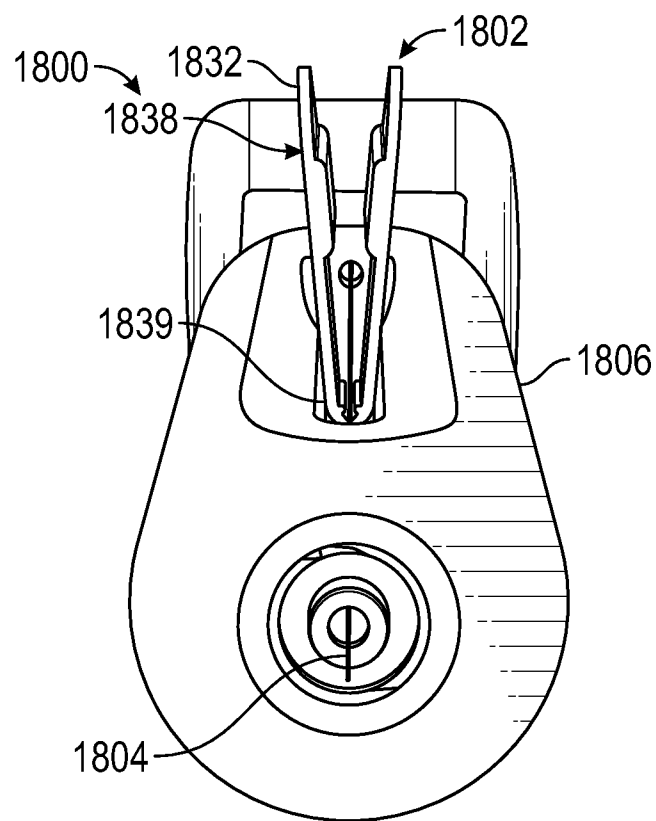


FIG. 18C

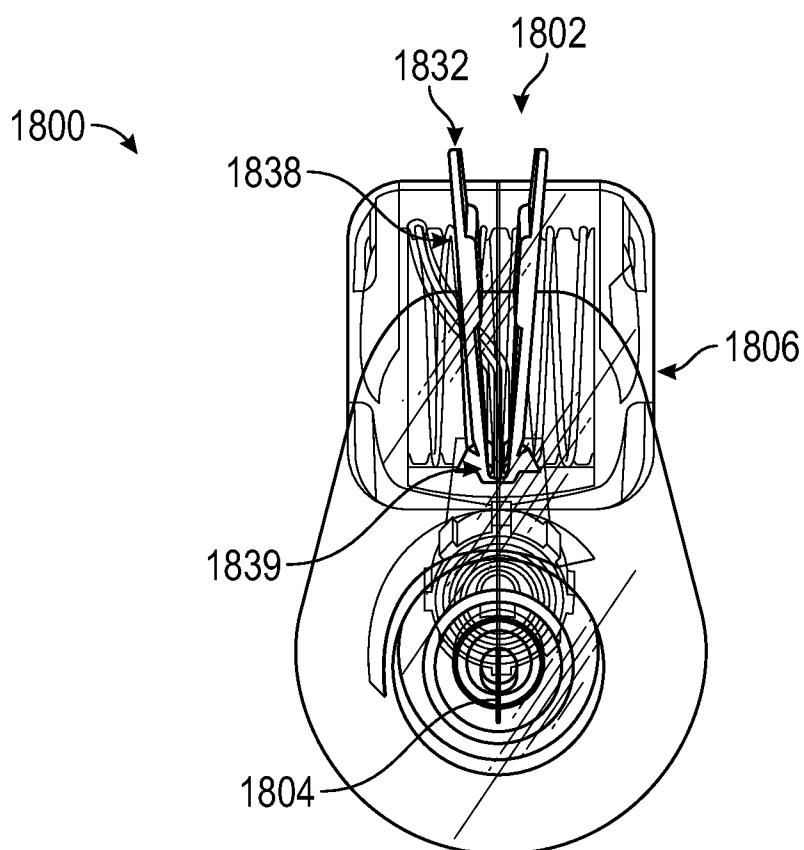


FIG. 18D

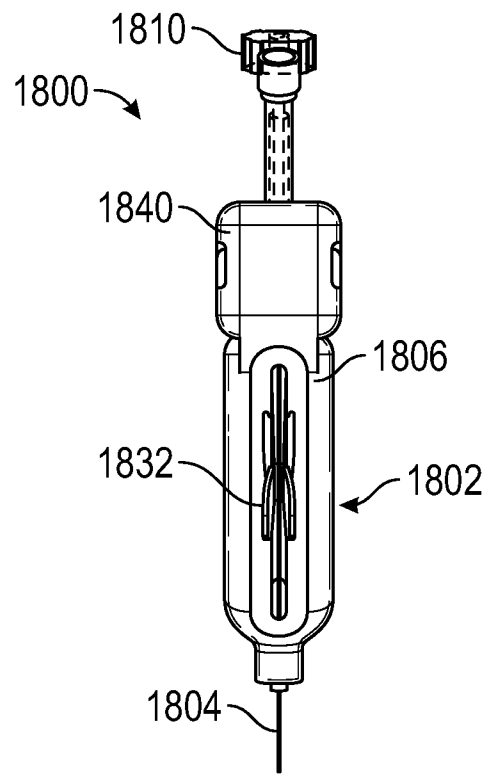


FIG. 18E

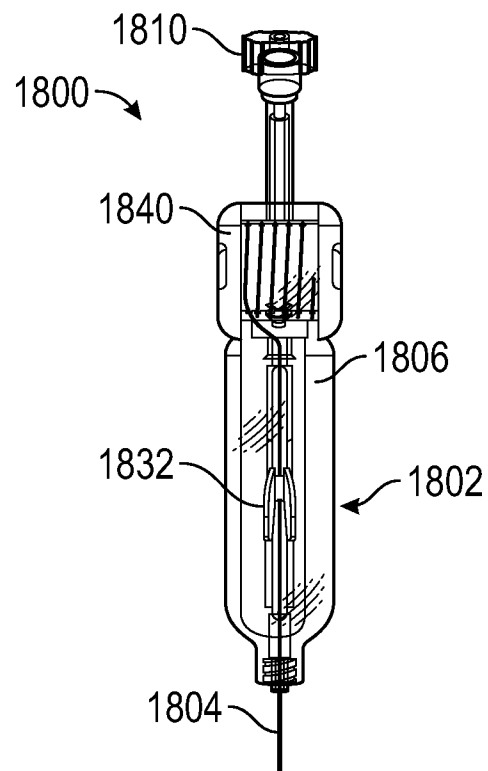


FIG. 18F

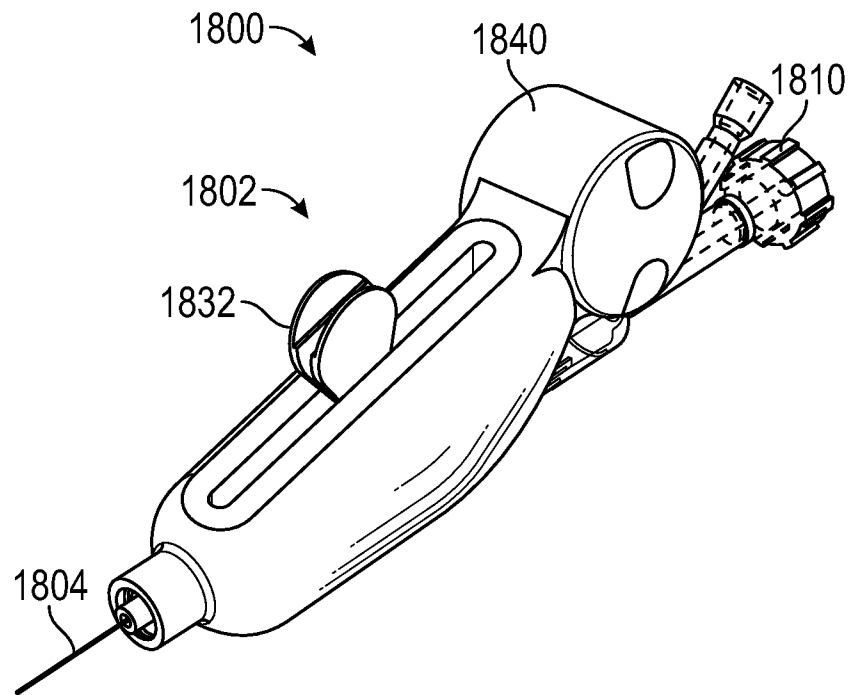


FIG. 18G

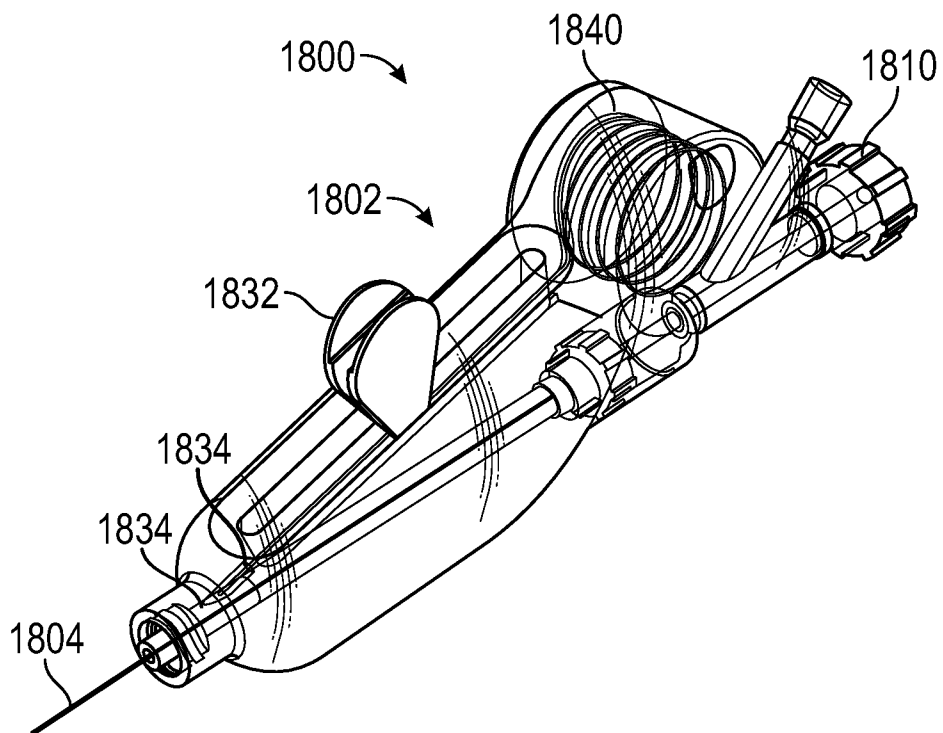


FIG. 18H

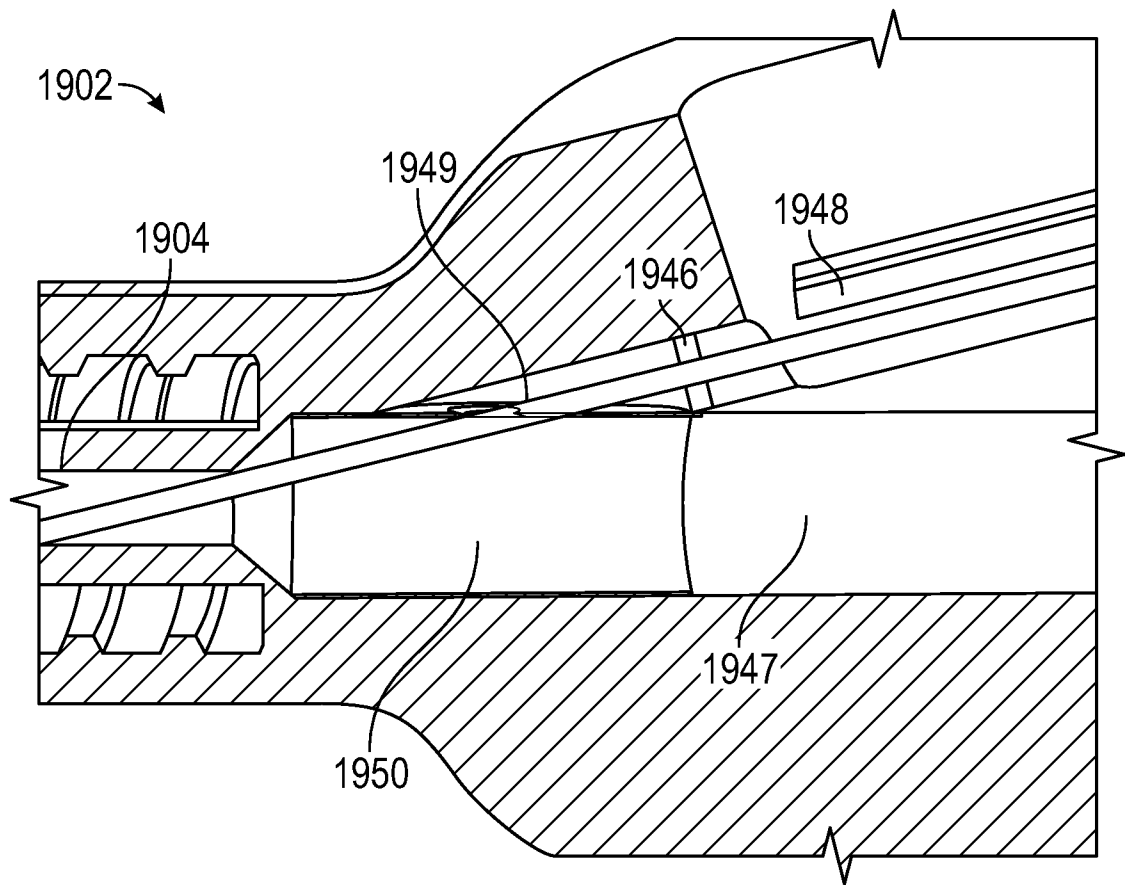


FIG. 19A

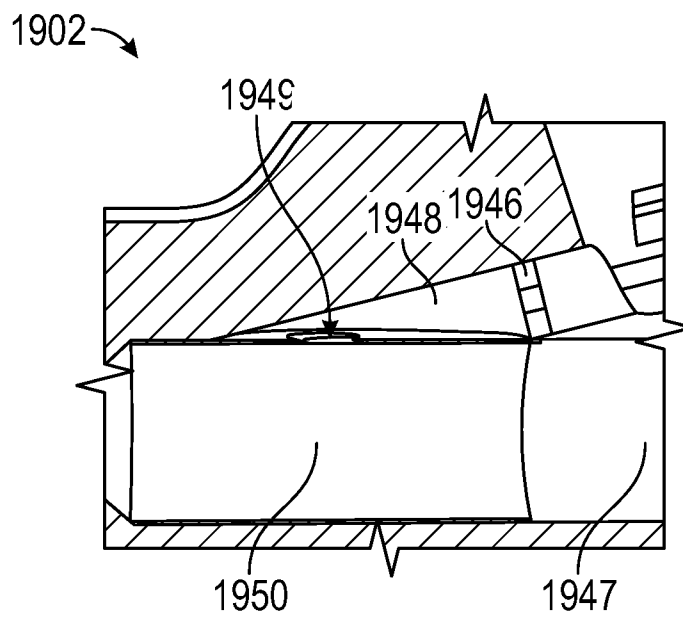


FIG. 19B

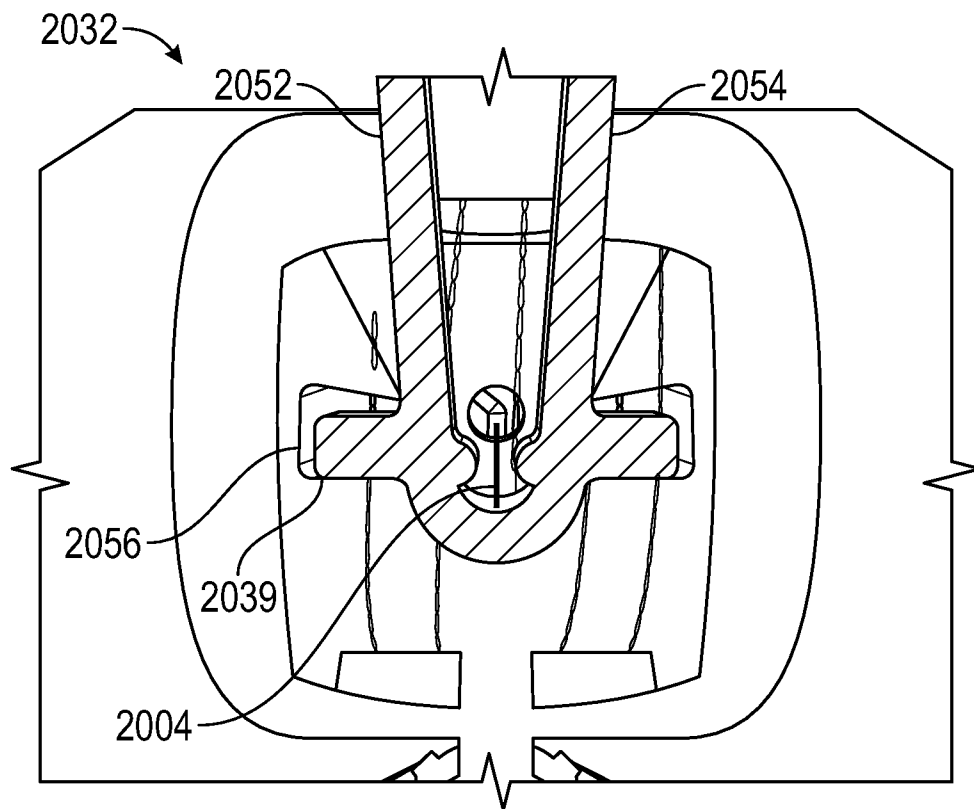


FIG. 20A

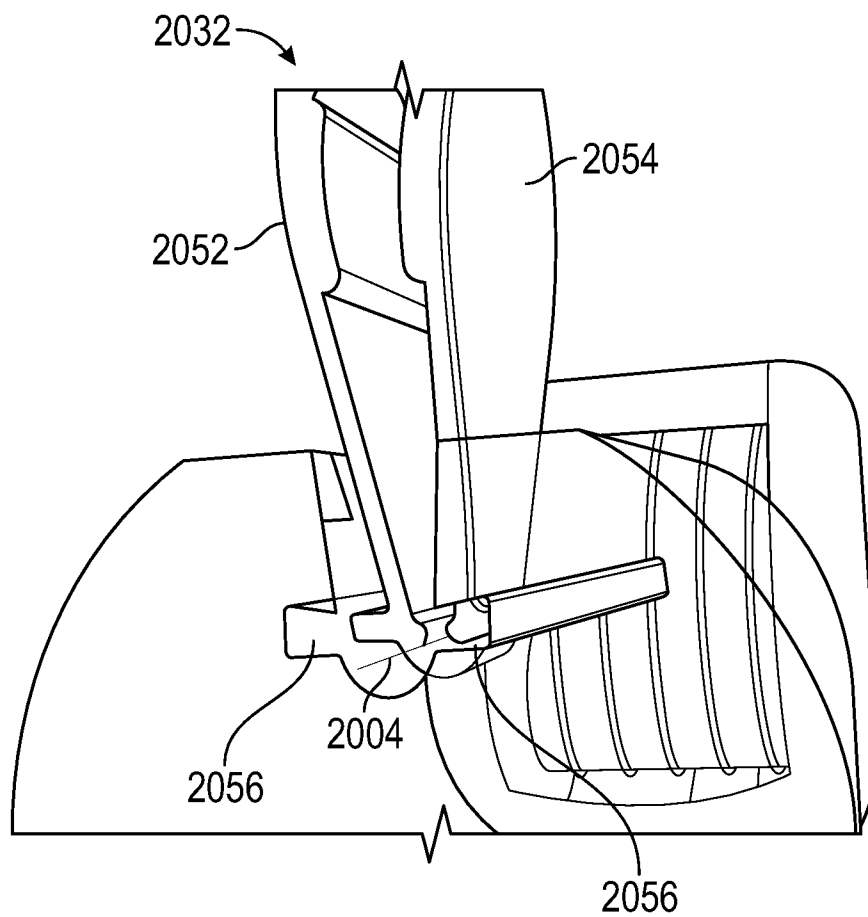


FIG. 20B

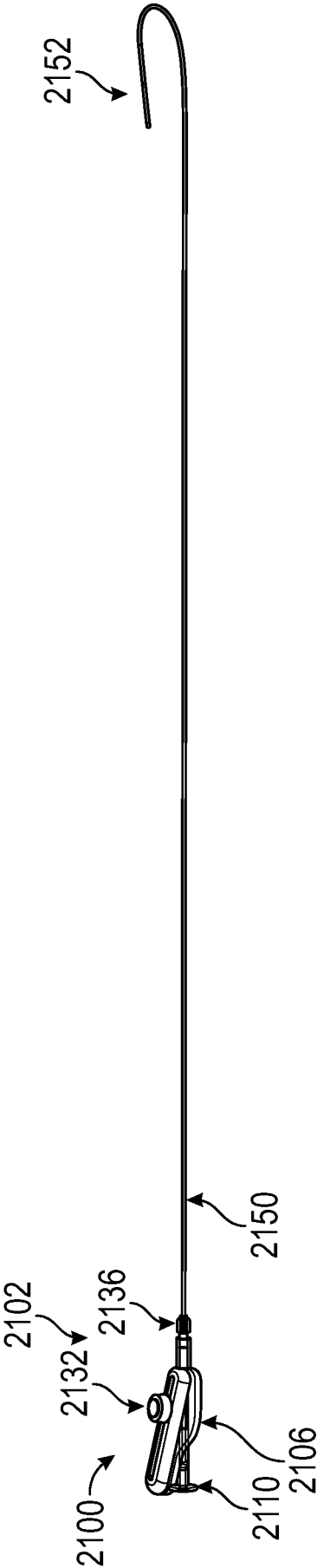


FIG. 21A

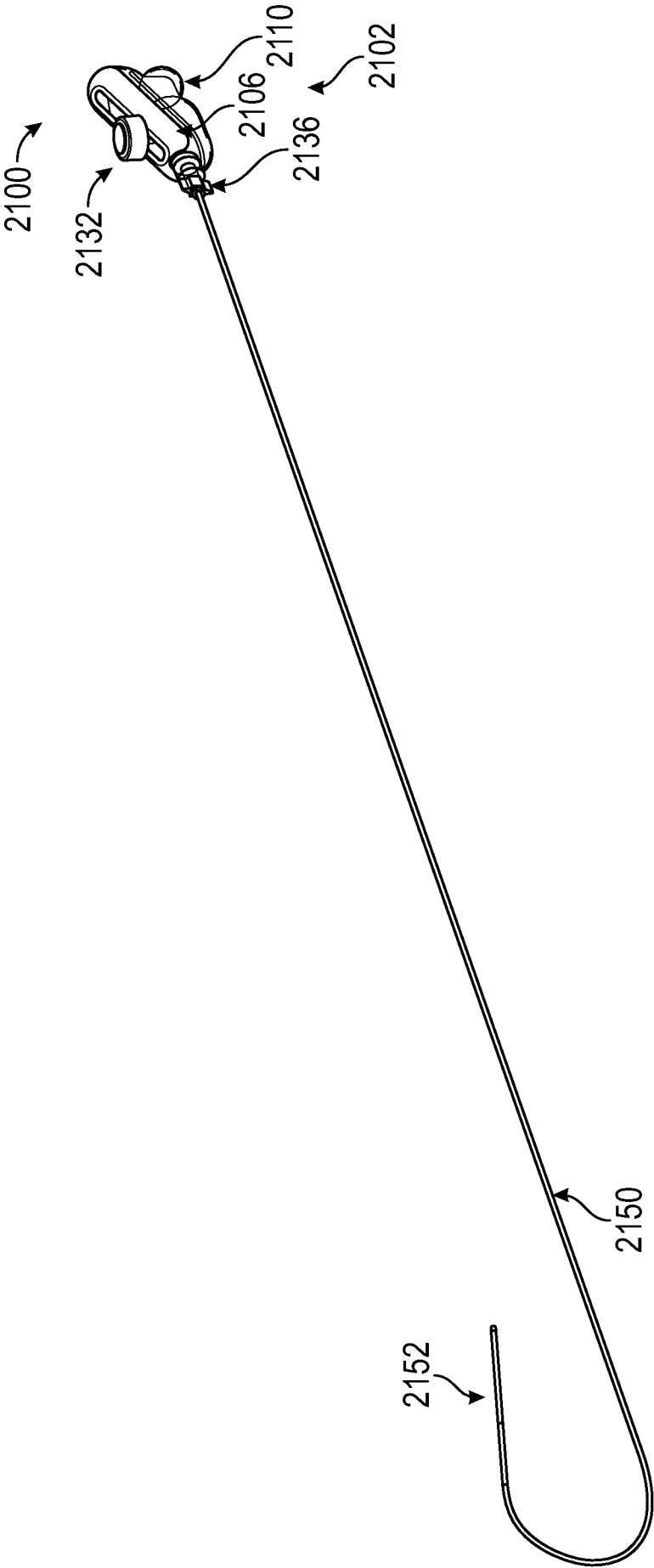


FIG. 21B

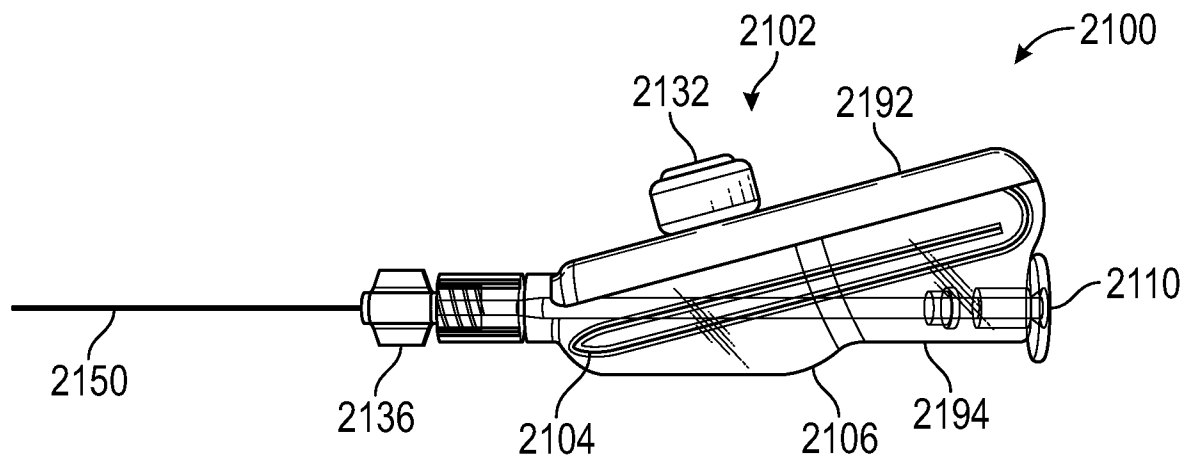


FIG. 21C

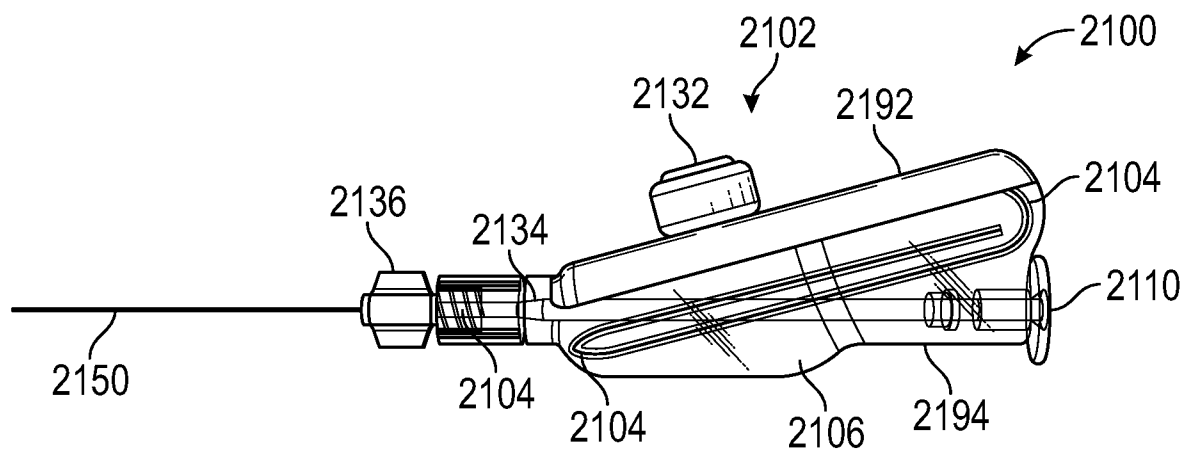


FIG. 21D

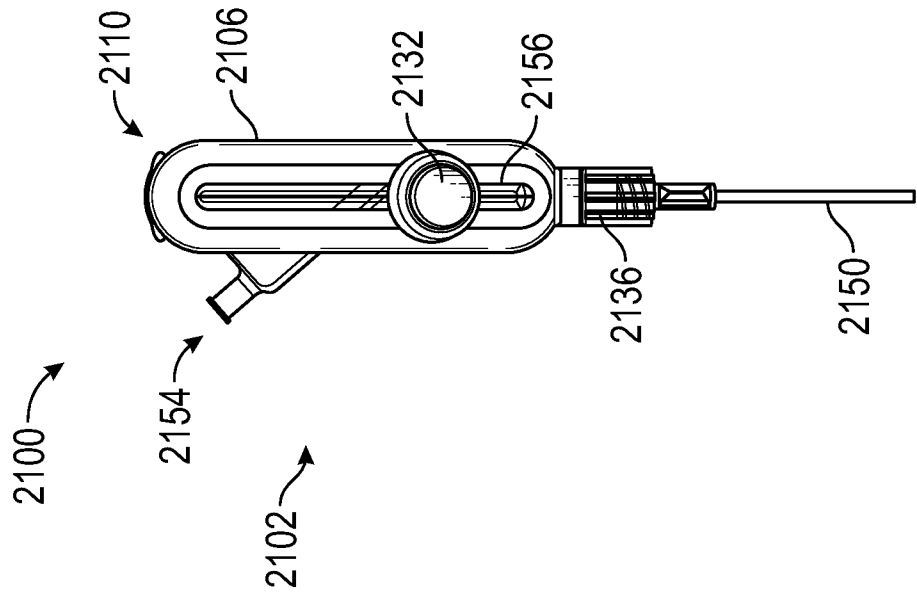


FIG. 21F

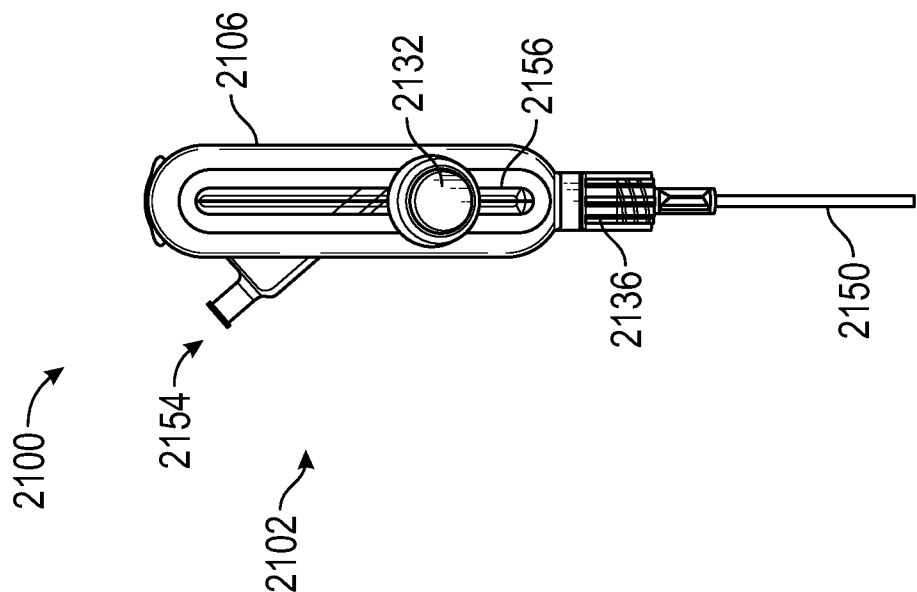


FIG. 21E

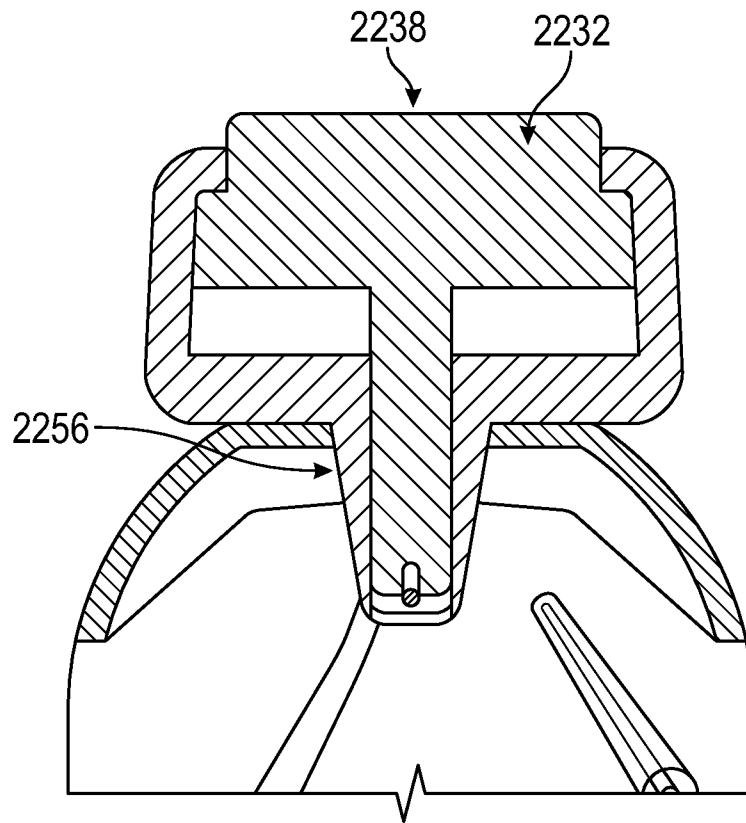


FIG. 22A

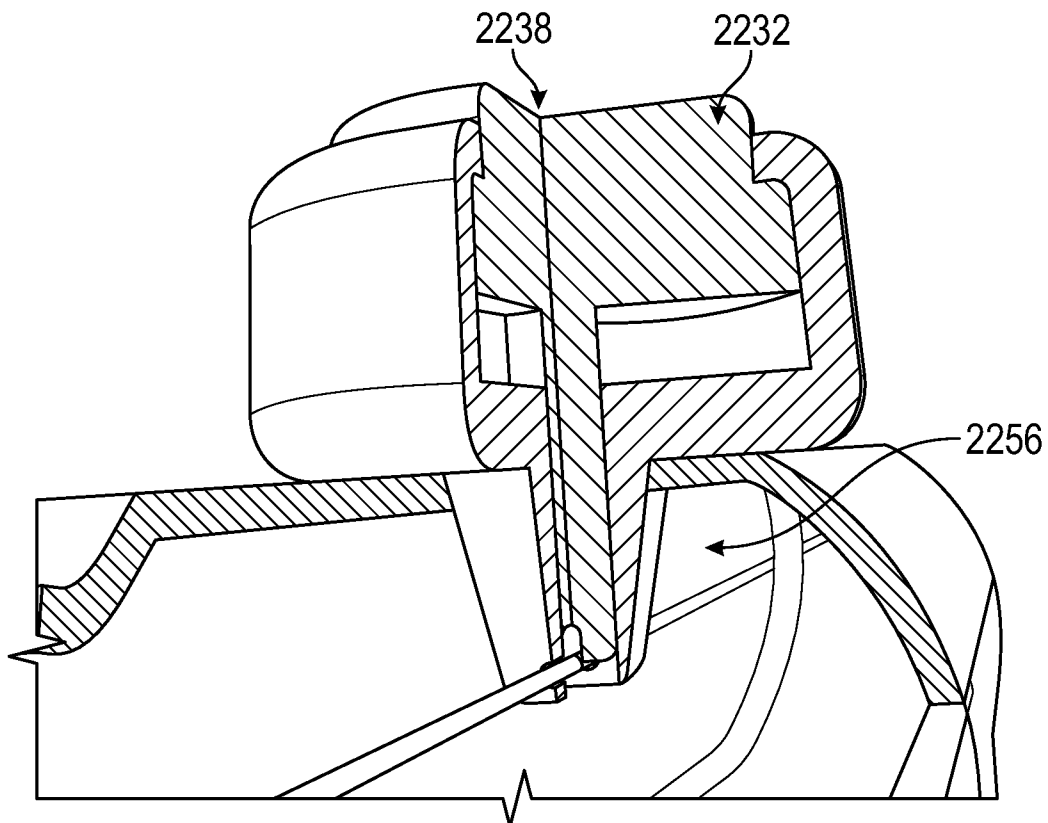


FIG. 22B

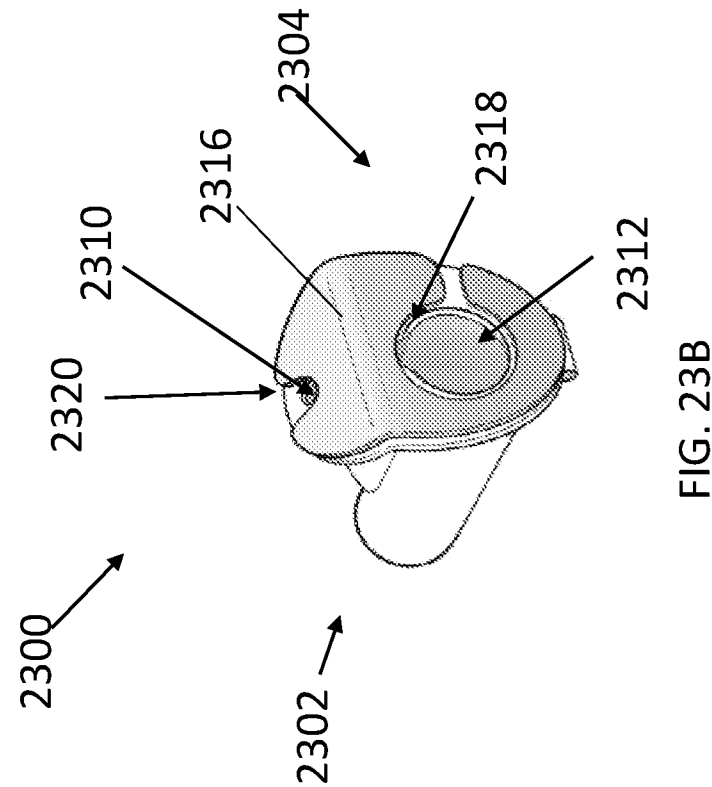


FIG. 23B

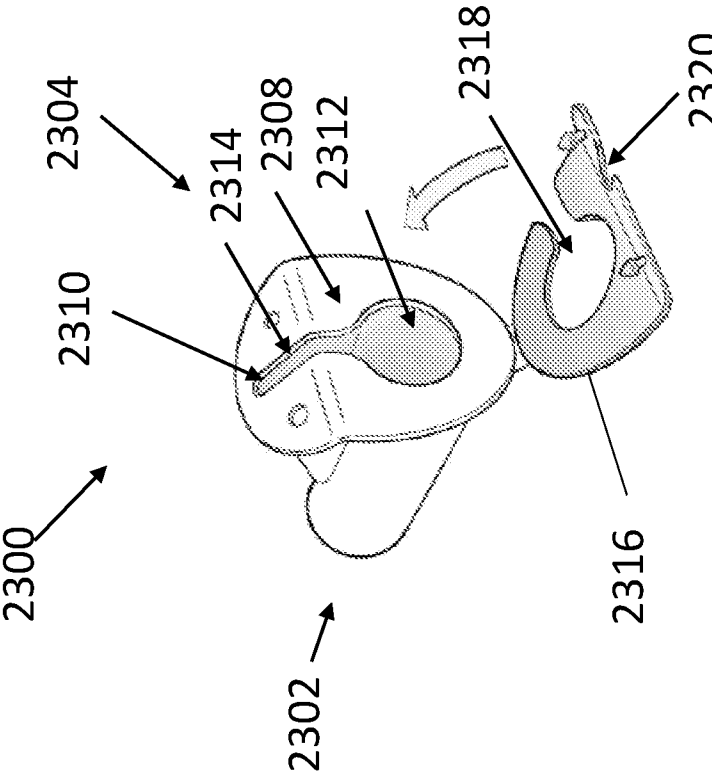


FIG. 23A

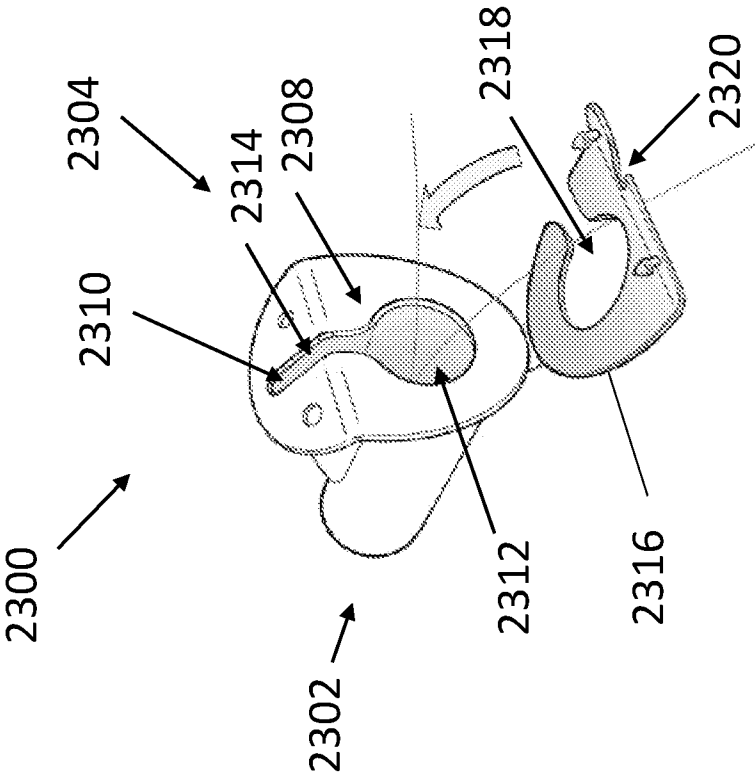


FIG. 23C

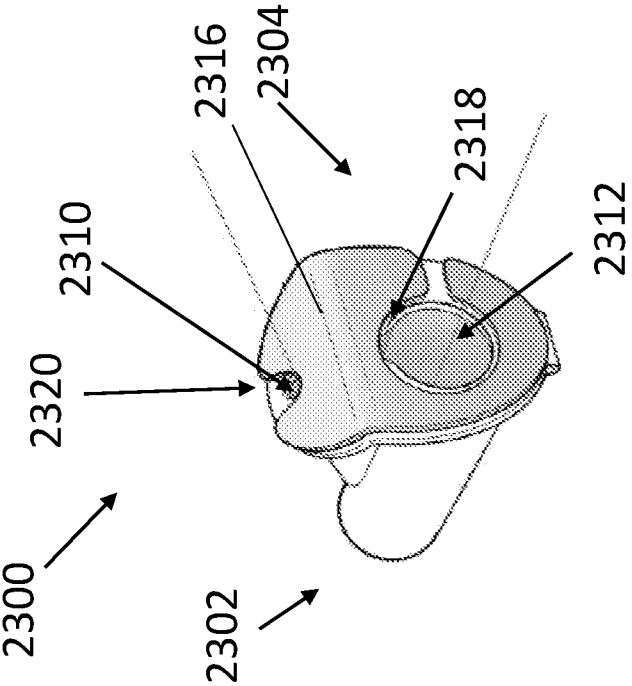


FIG. 23D

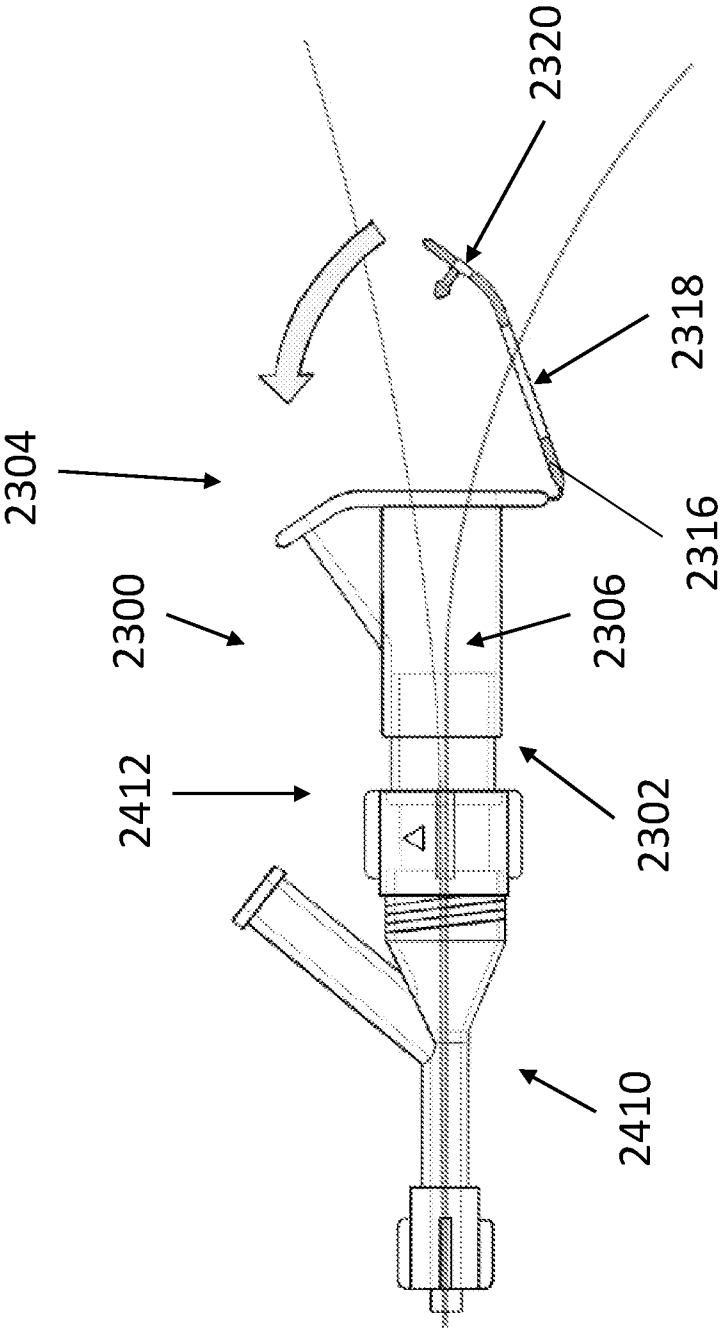


FIG. 24A

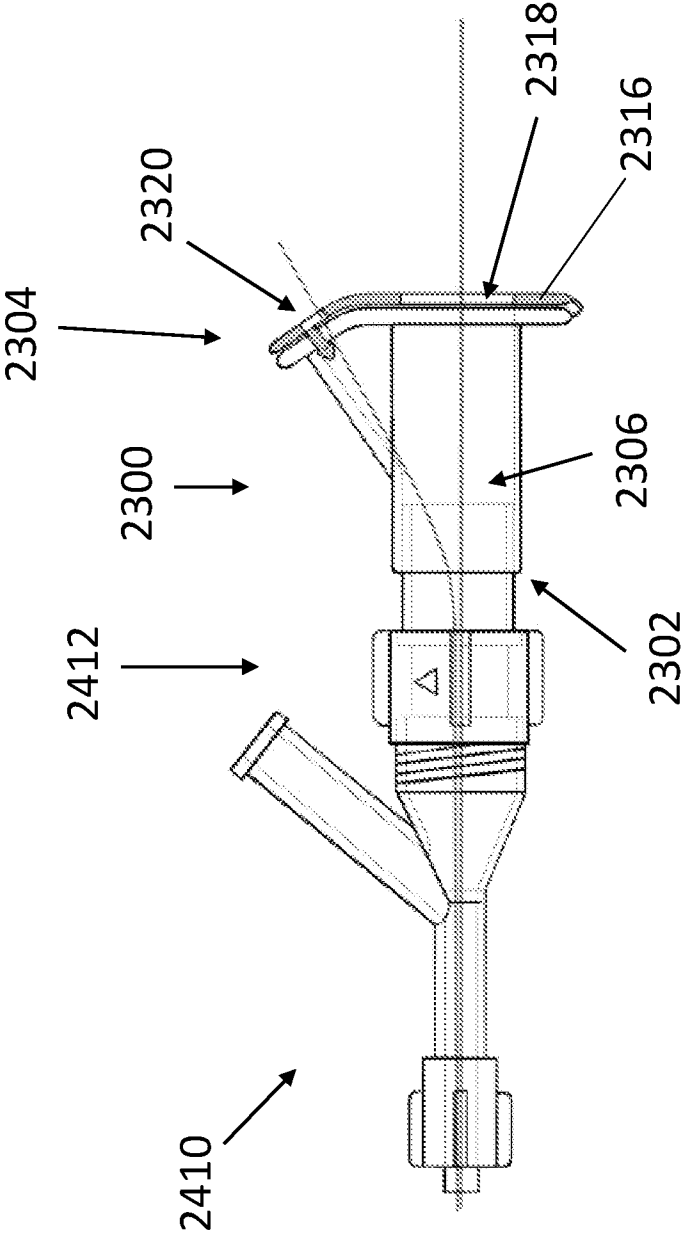


FIG. 24B

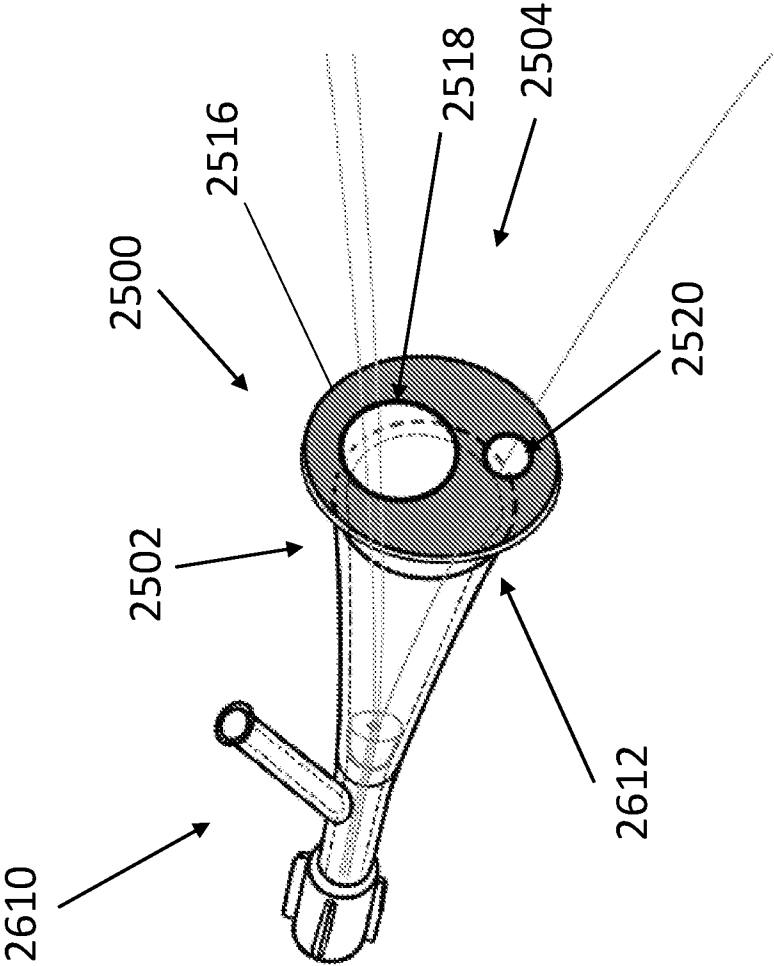


FIG. 25A

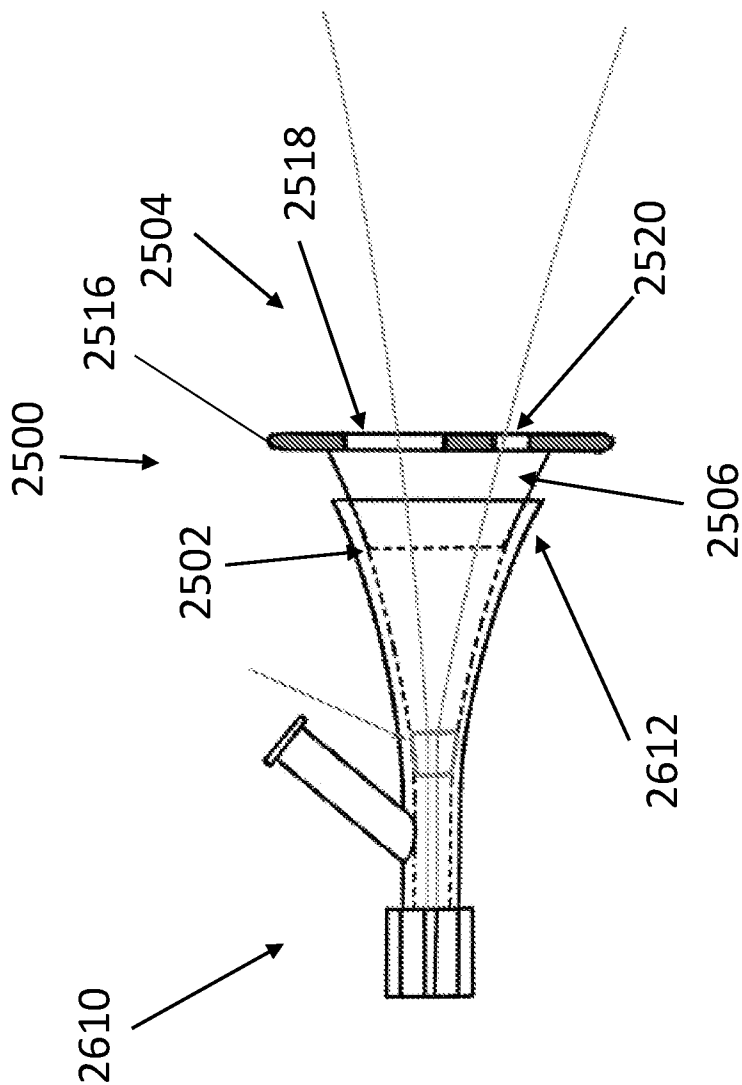


FIG. 25B

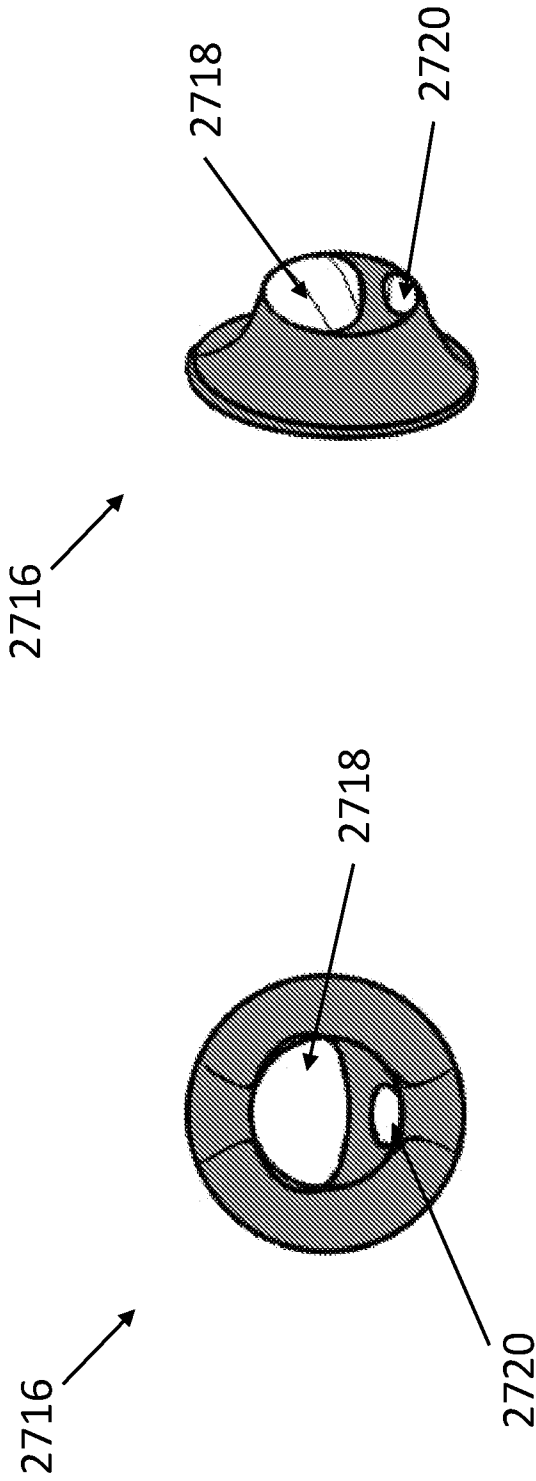


FIG. 26B

FIG. 26A

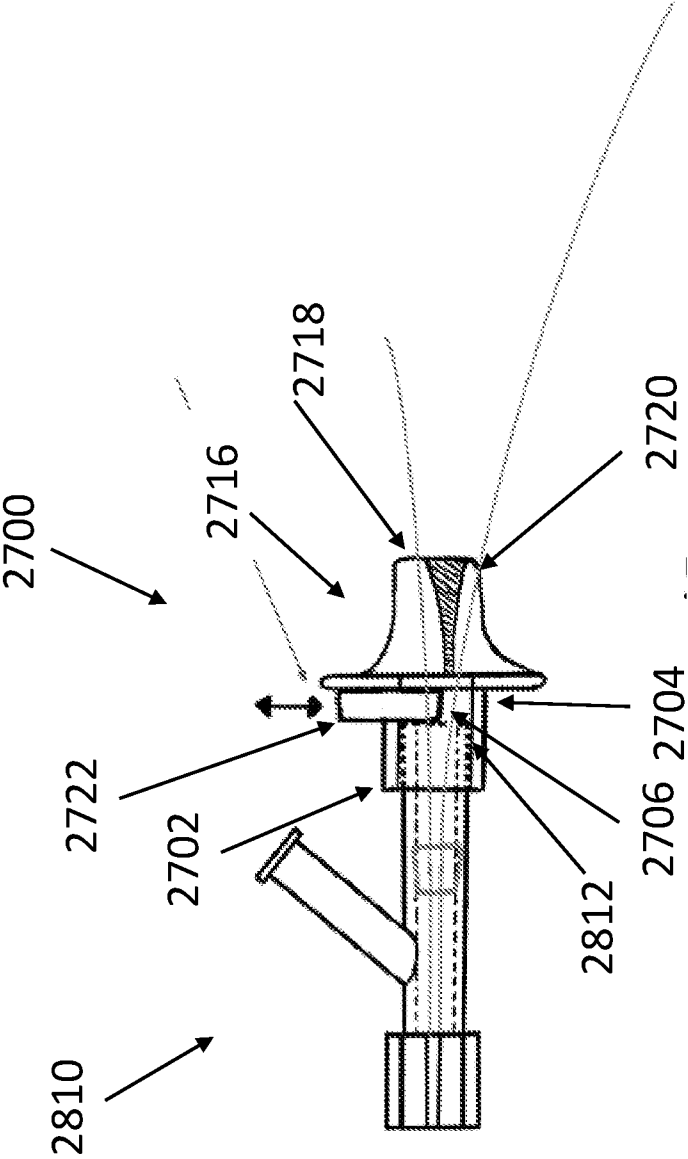


FIG. 26C

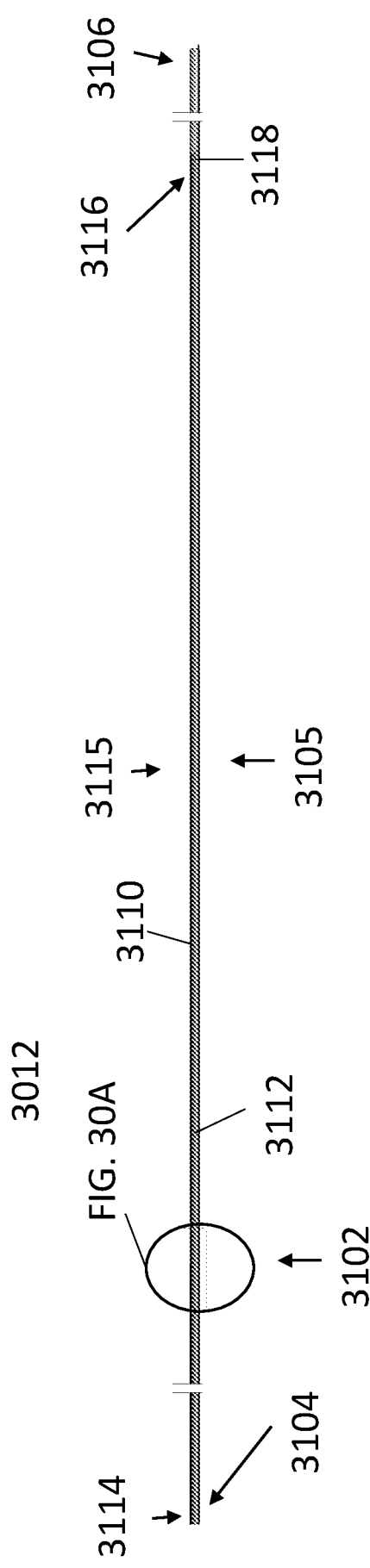
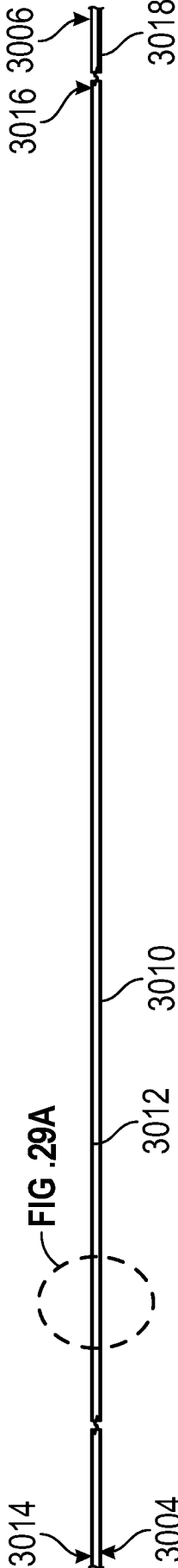
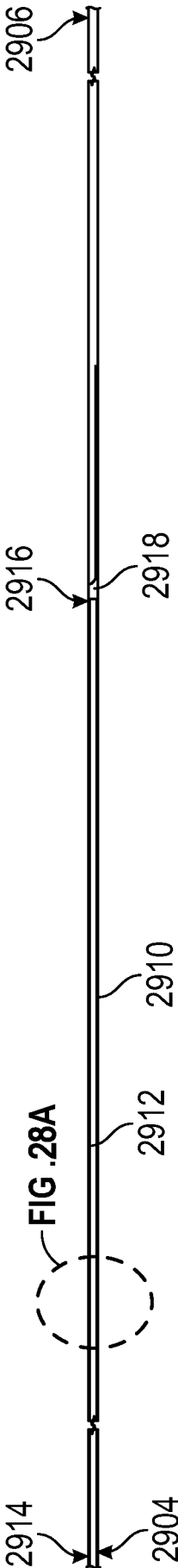


FIG. 27

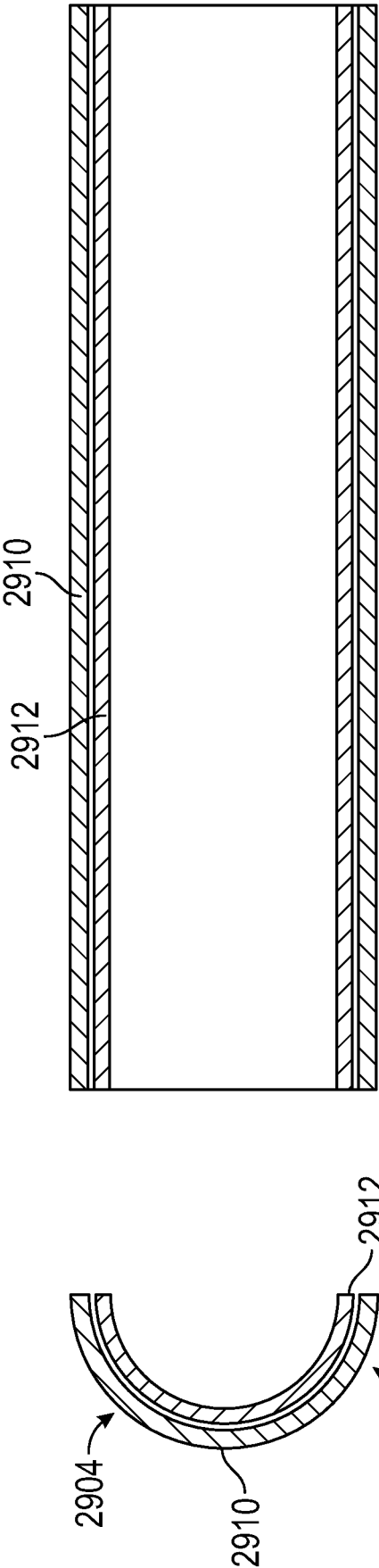


FIG. 28A

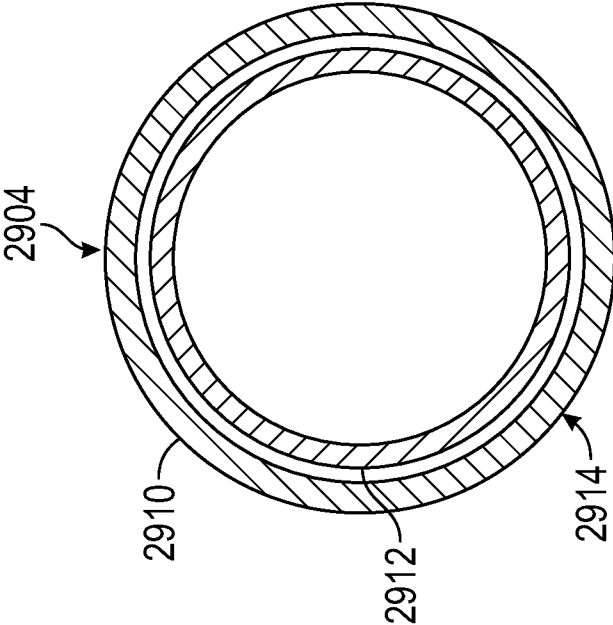


FIG. 28B

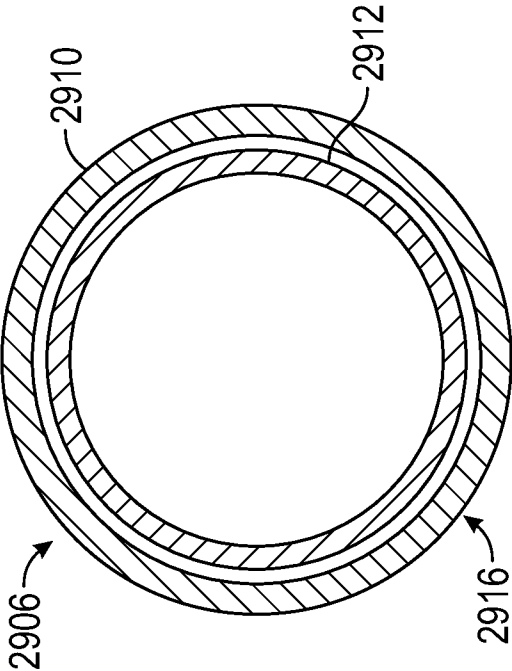


FIG. 28C

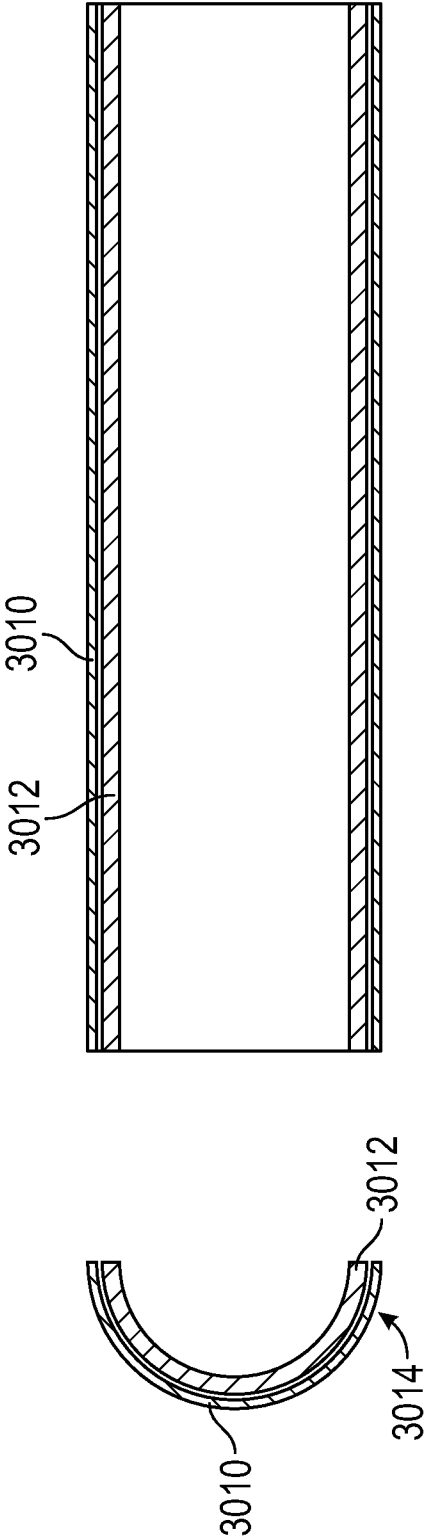


FIG. 29A

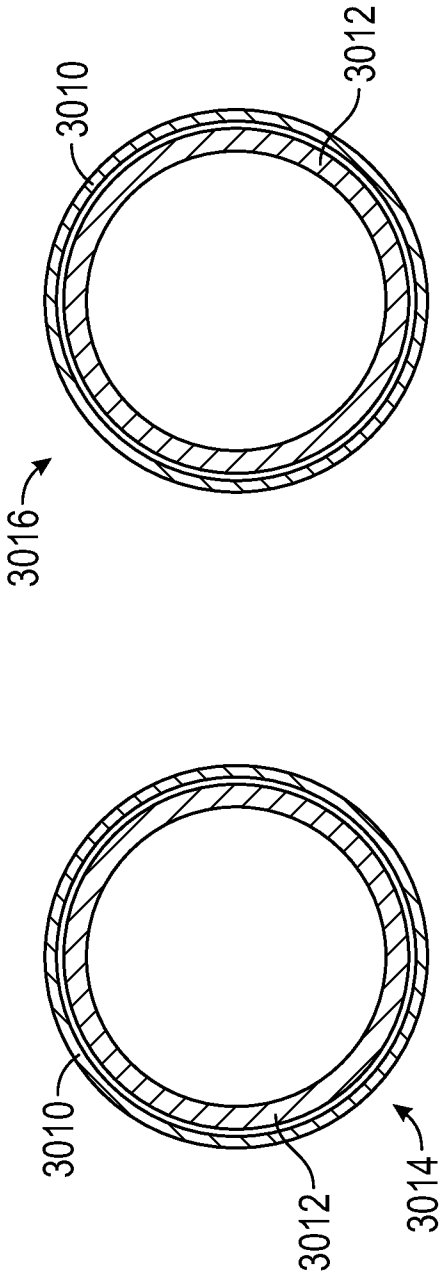
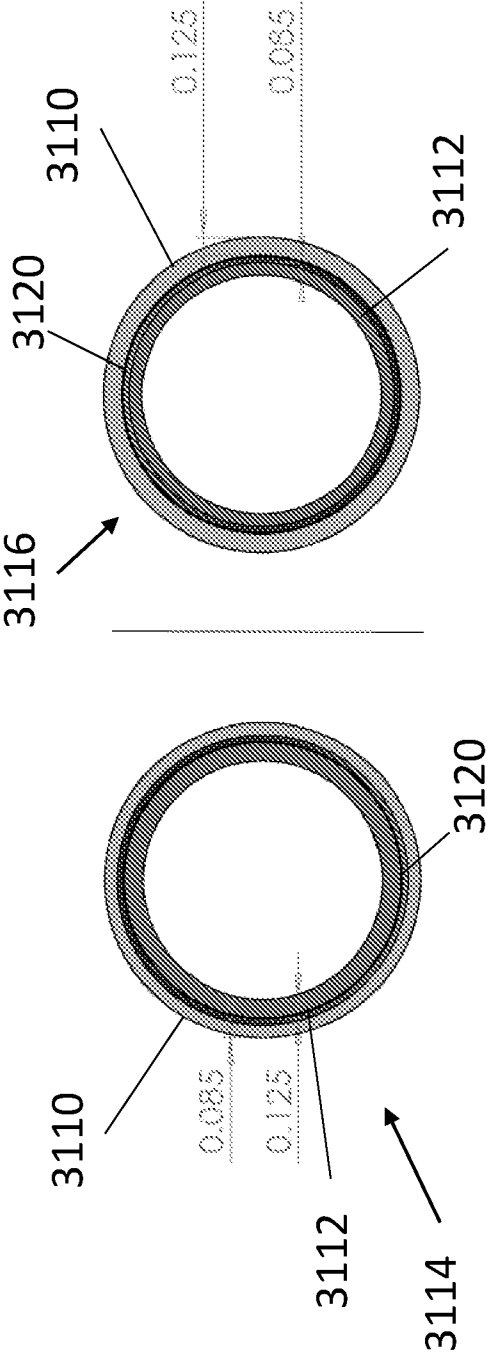
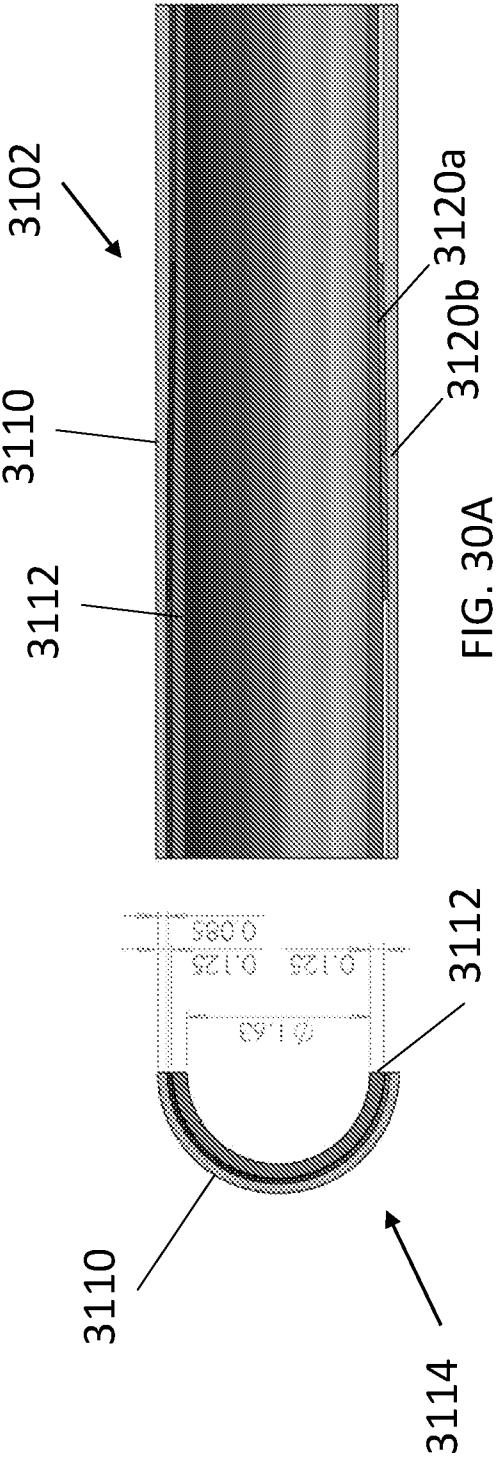


FIG. 29B

FIG. 29C



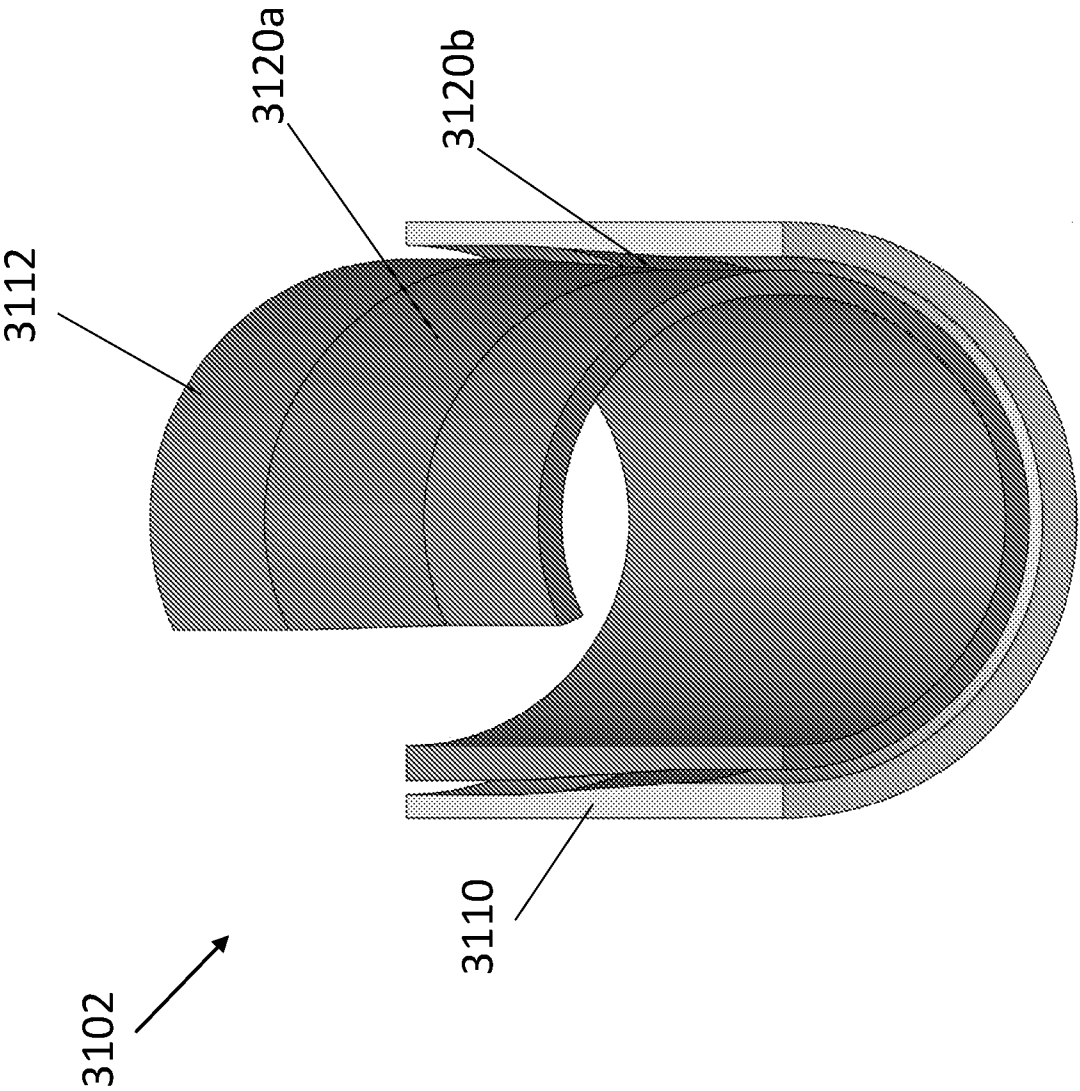


FIG. 30D

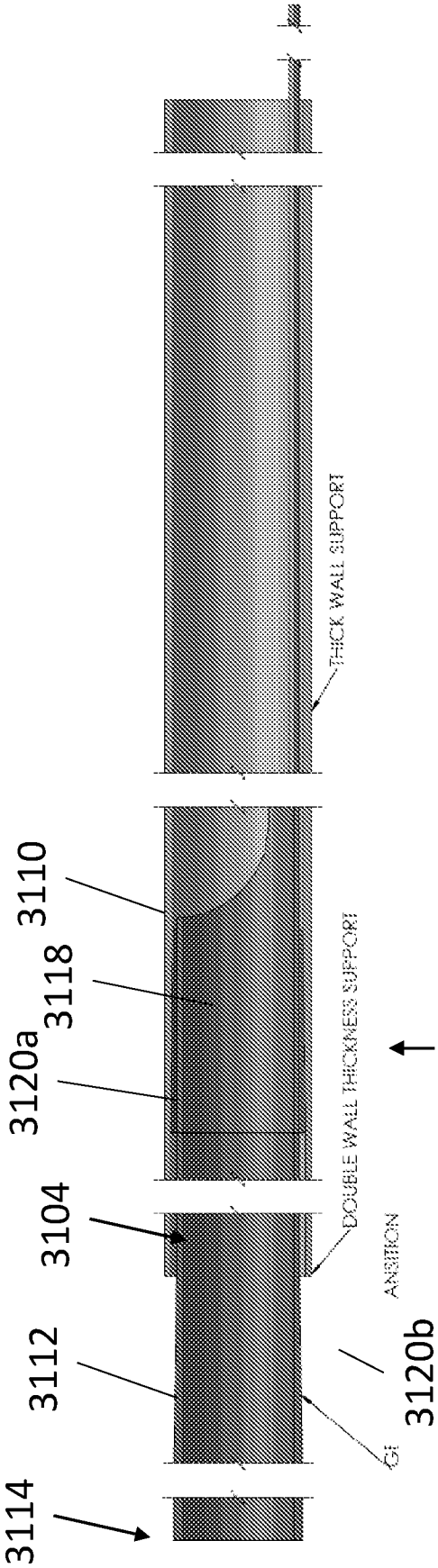


FIG. 30E

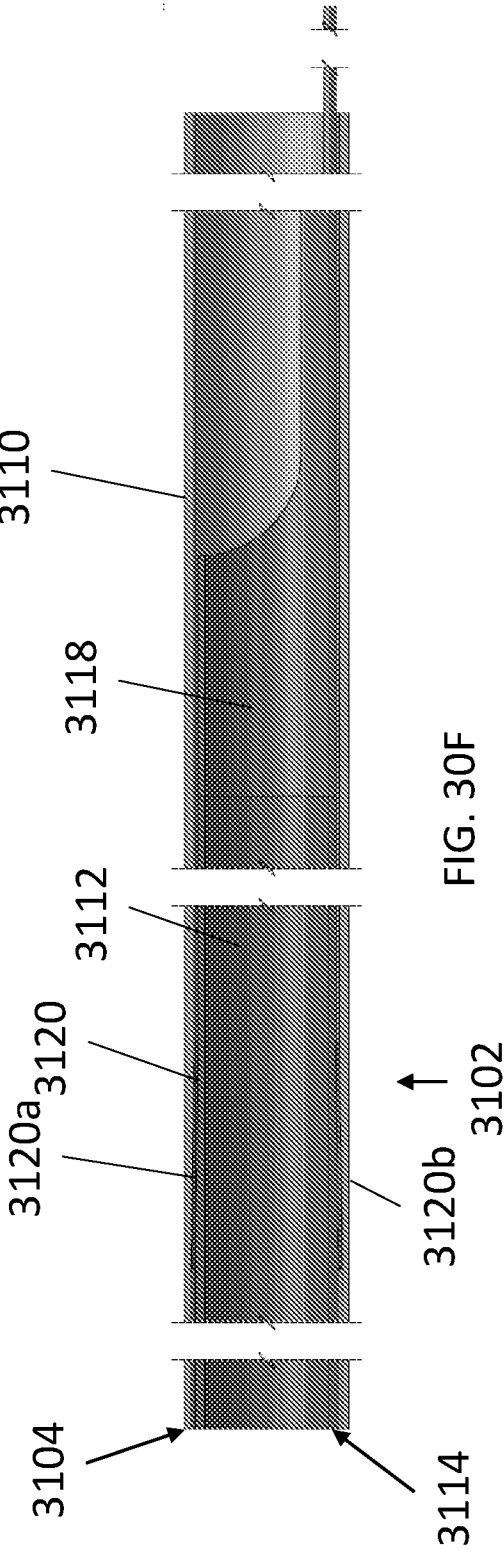


FIG. 30F

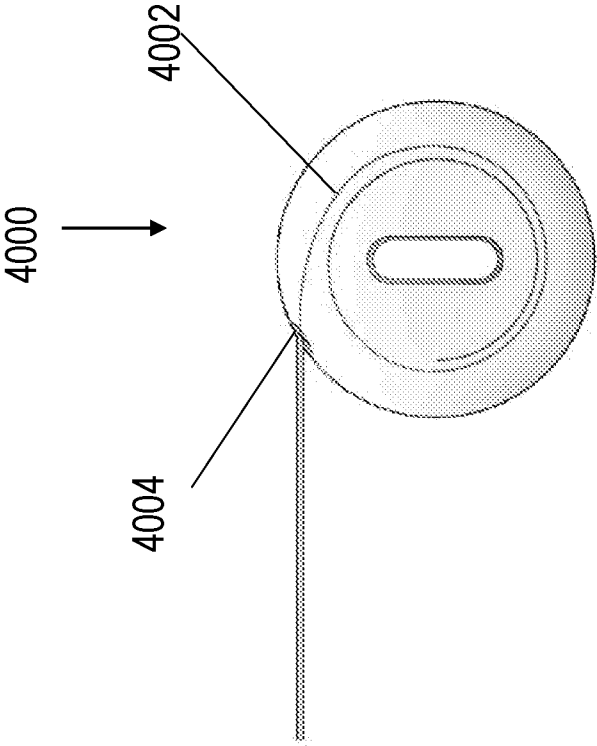


FIG. 31A

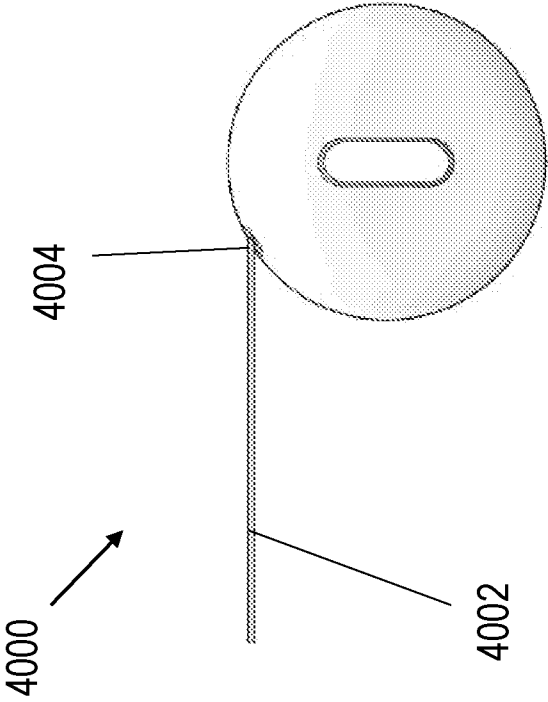


FIG. 31B

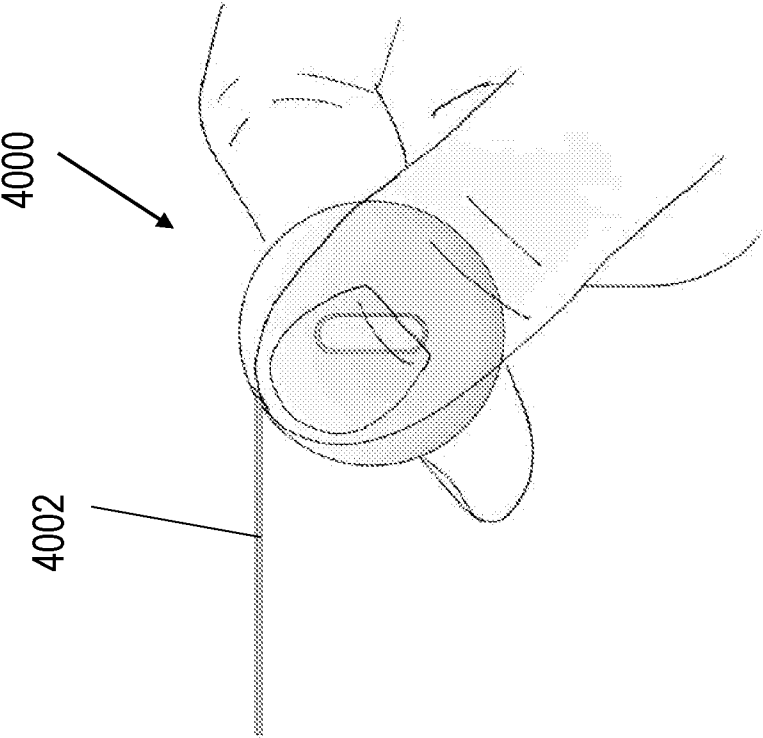


FIG. 31D

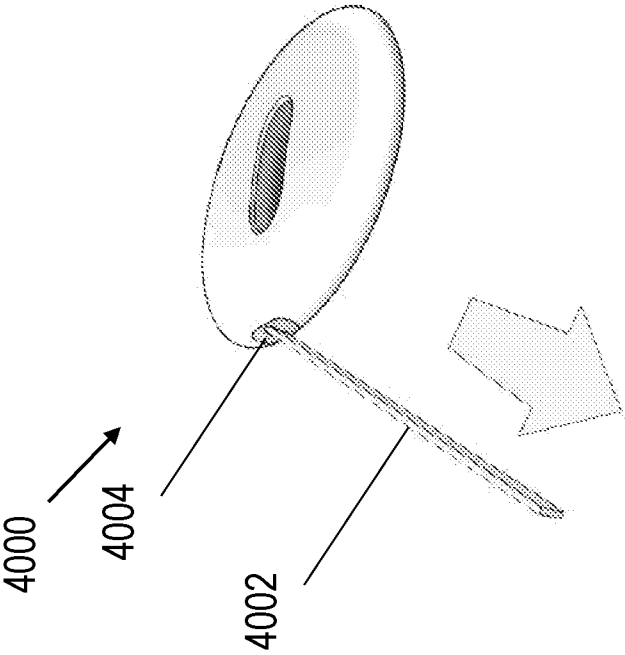


FIG. 31C

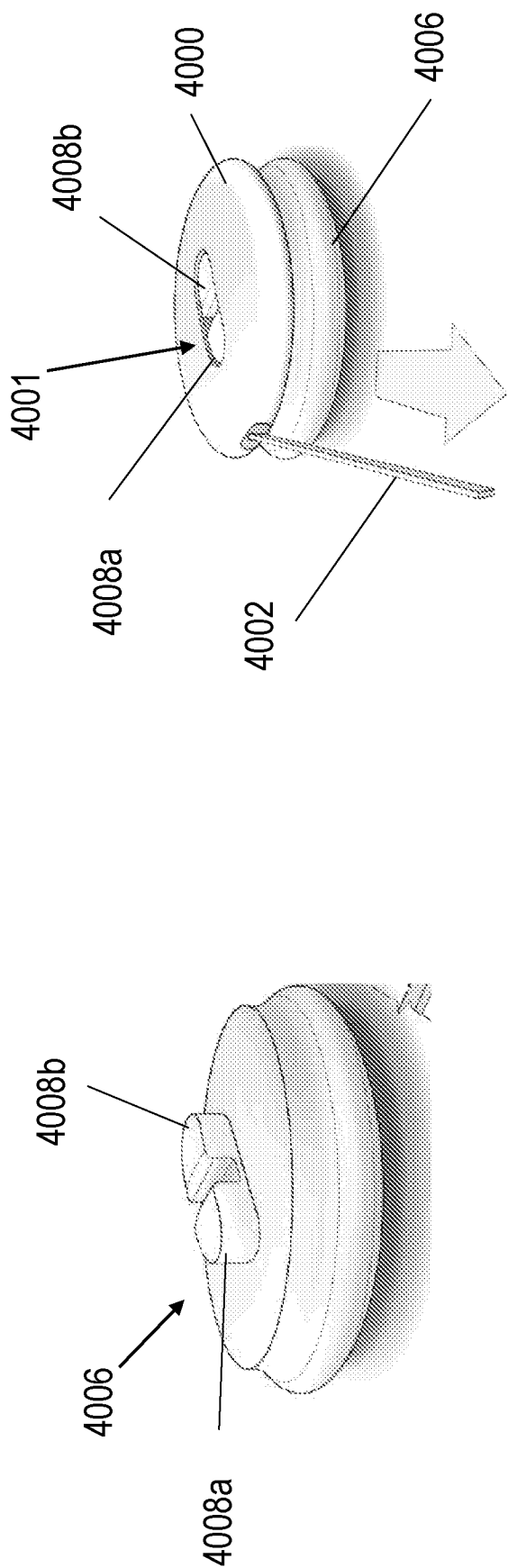


FIG. 32A

FIG. 32B

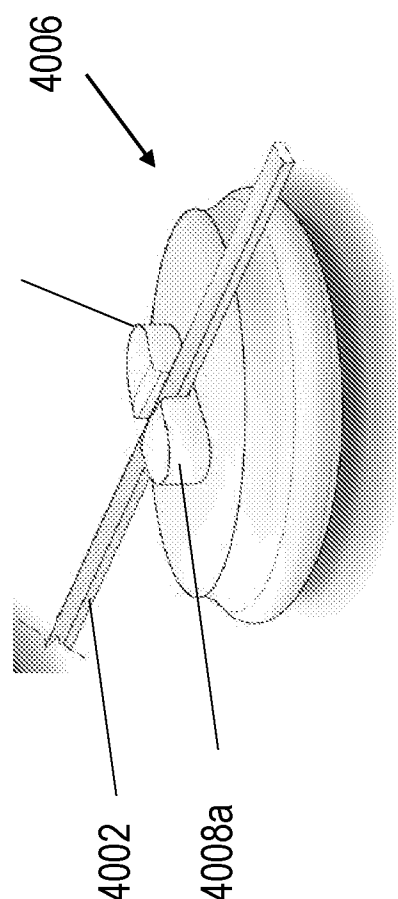


FIG. 32C

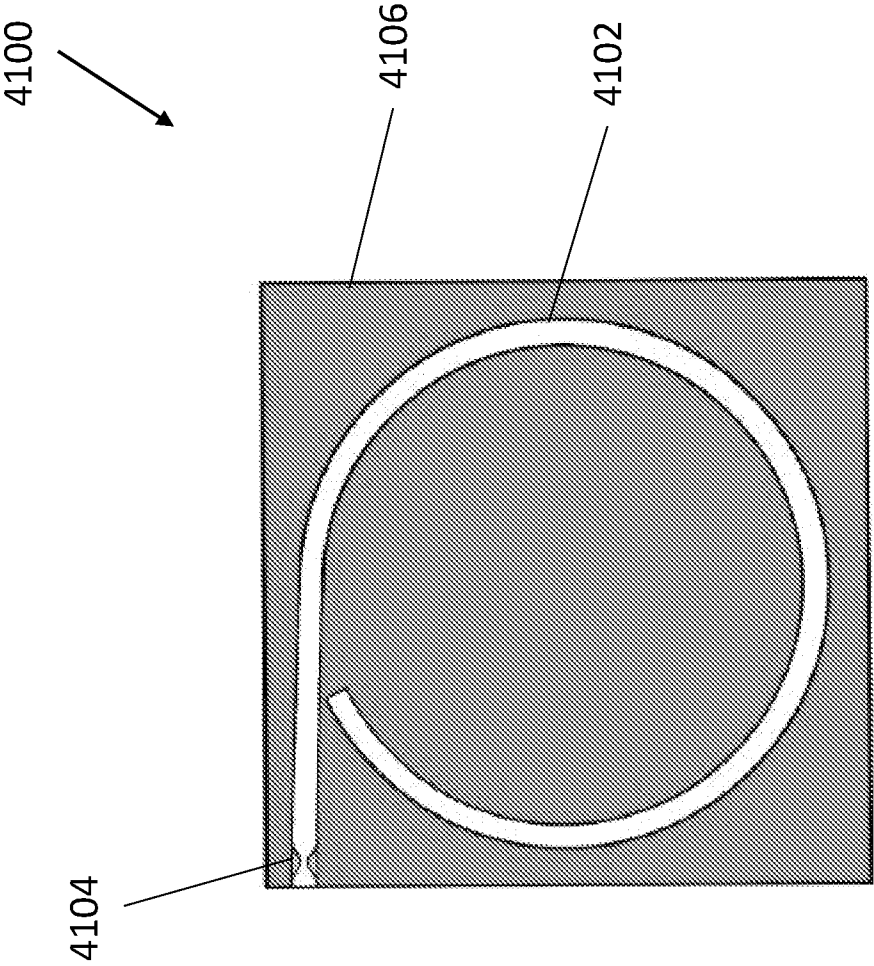
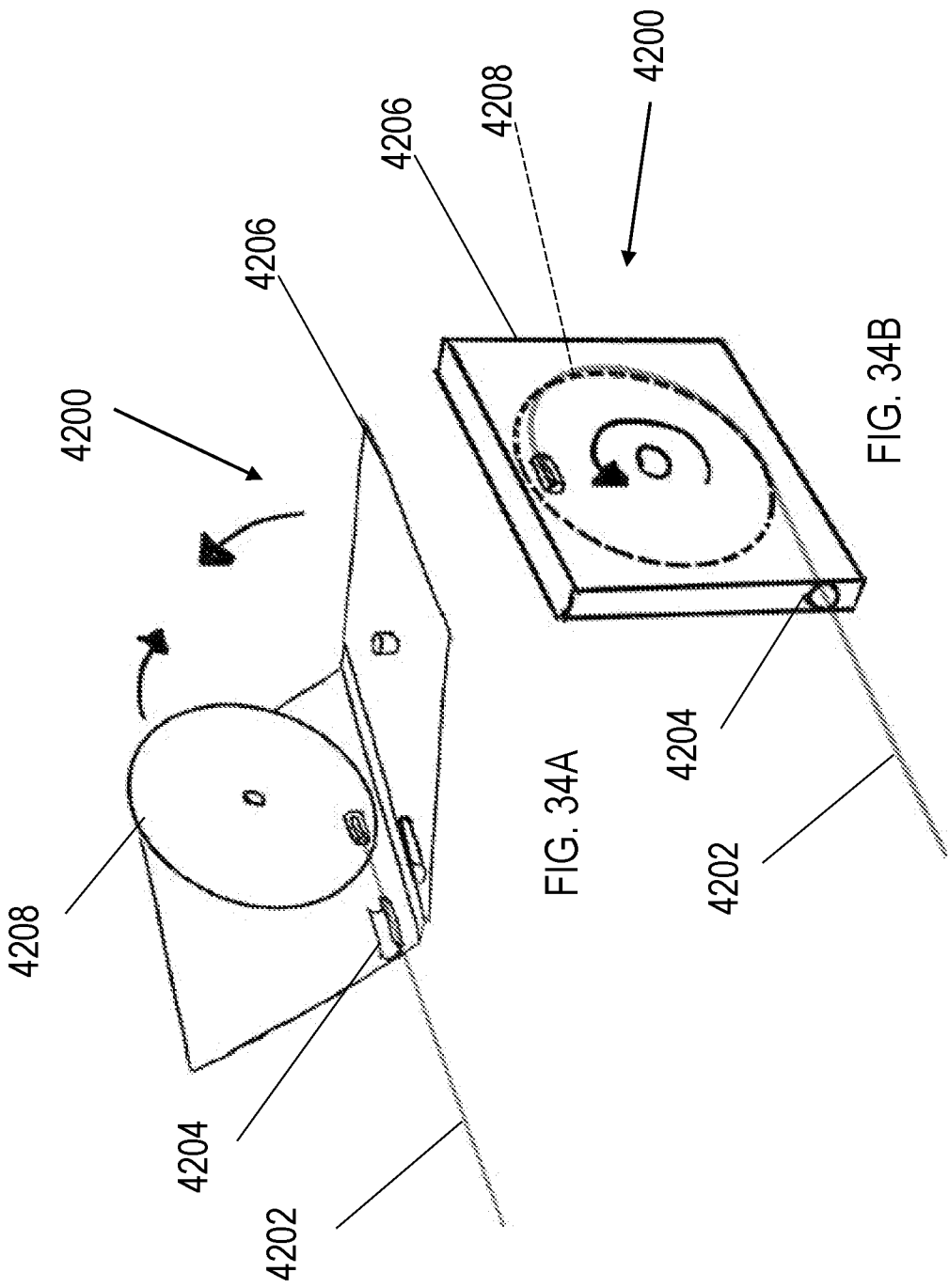


FIG. 33



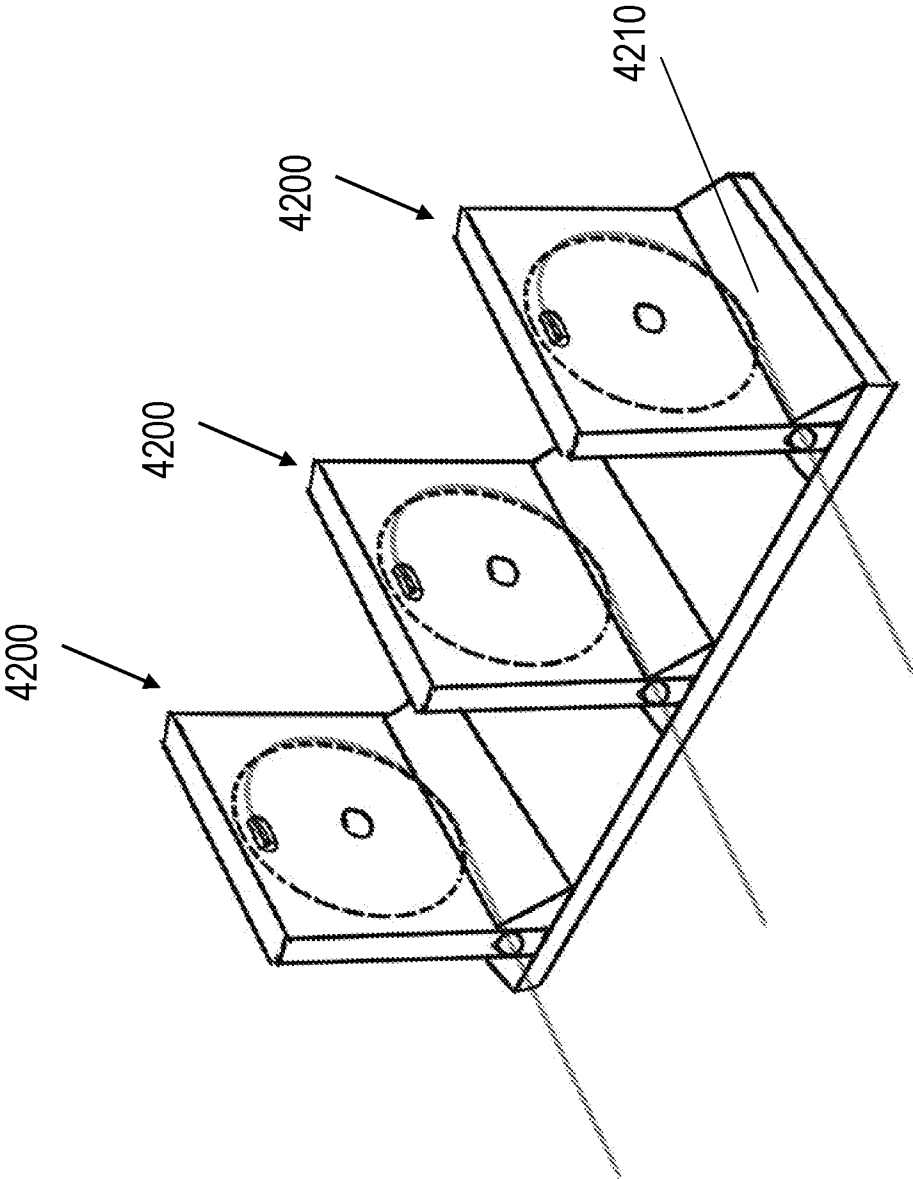


FIG. 35

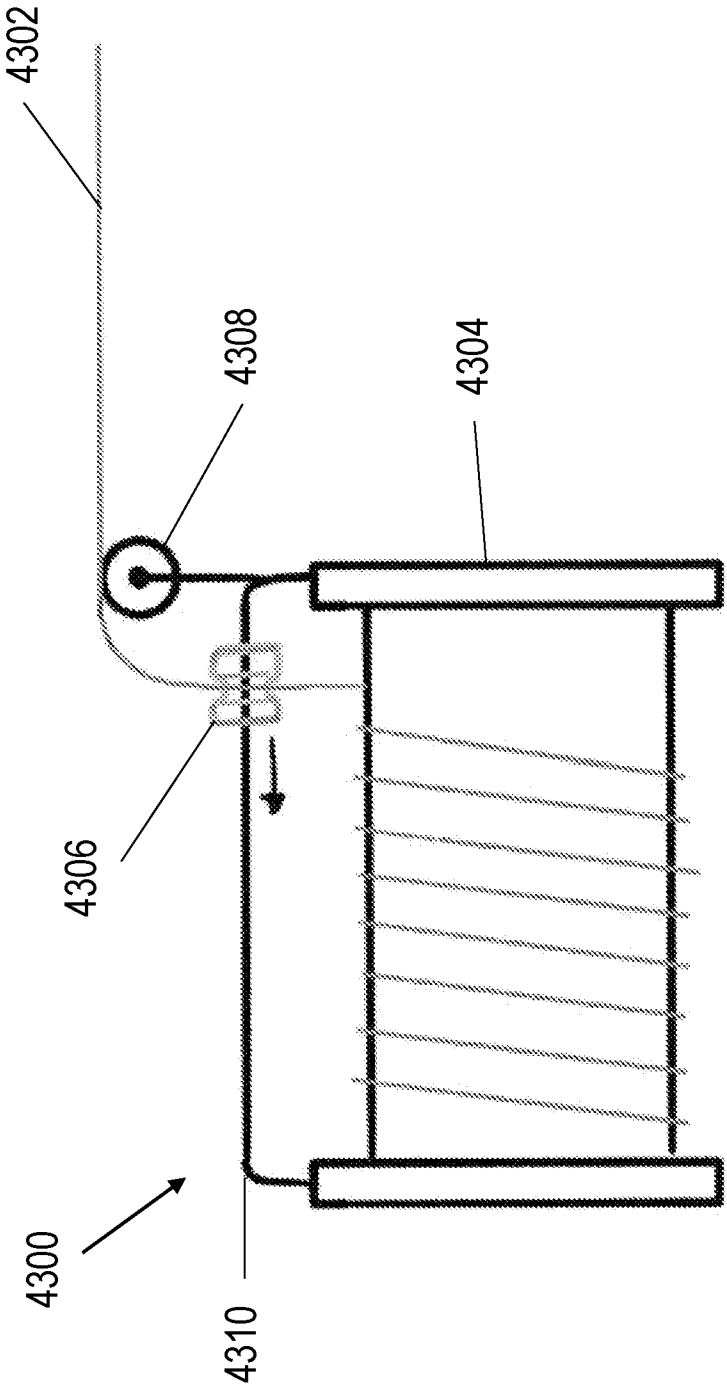


FIG. 36

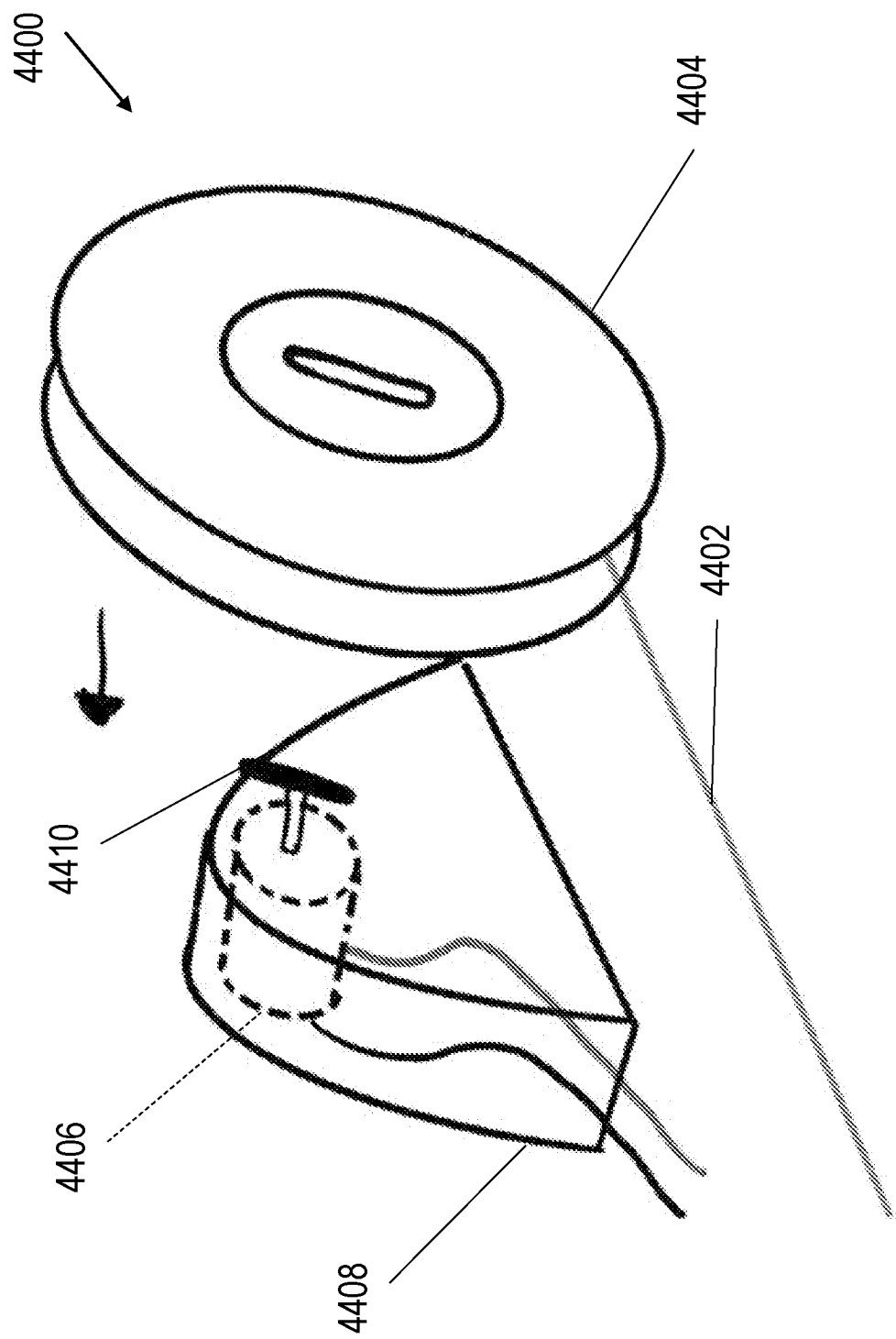


FIG. 37

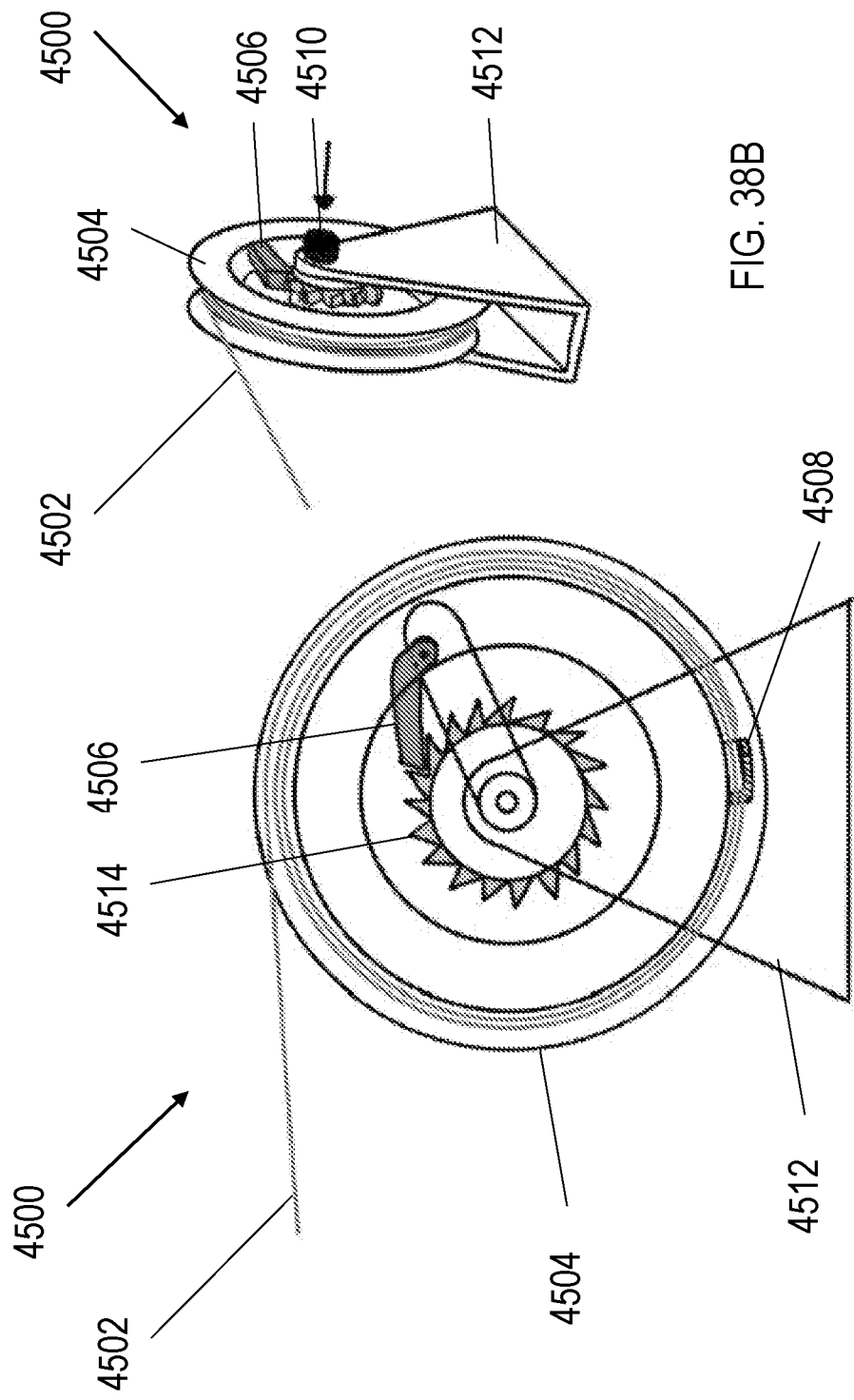


FIG. 38B

FIG. 38A

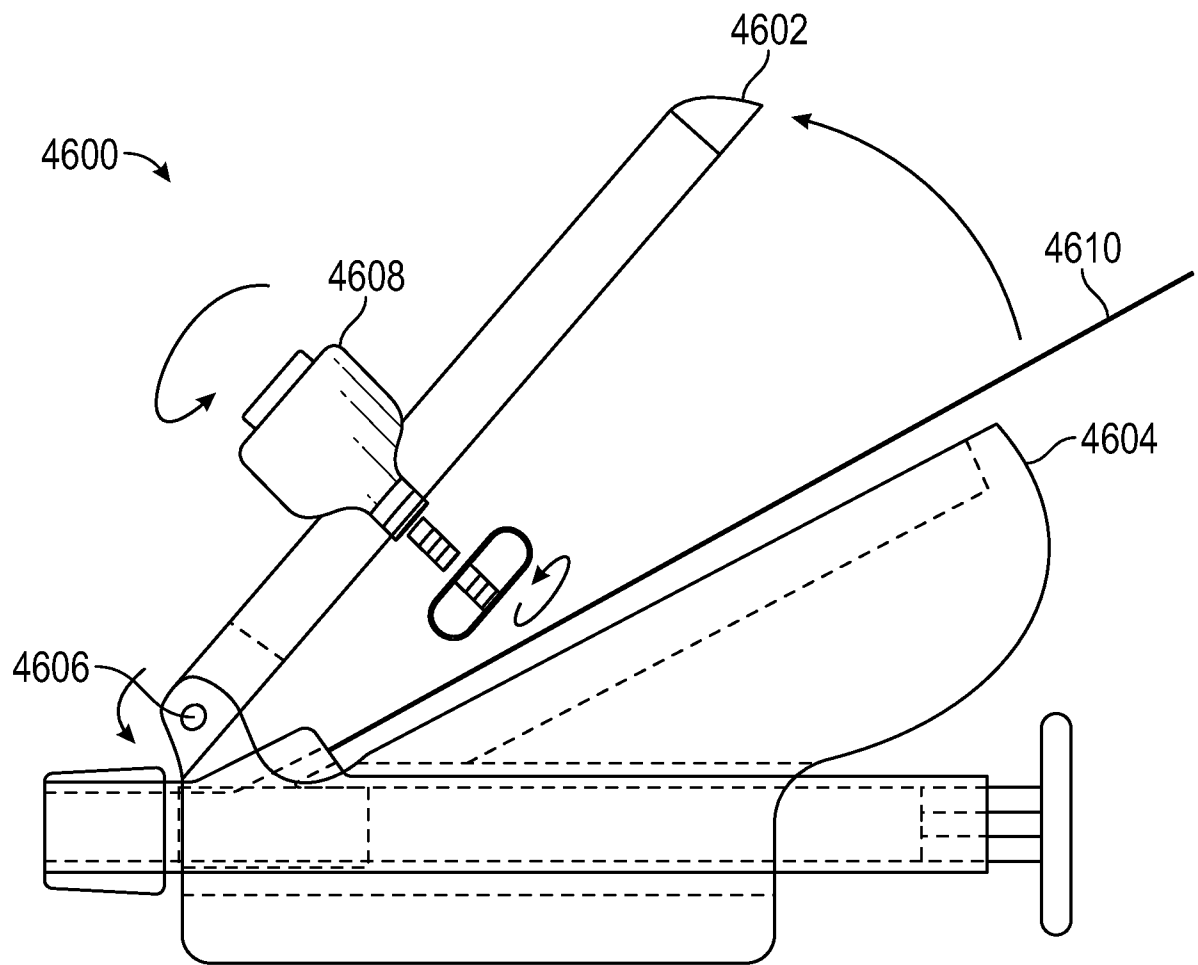


FIG. 39

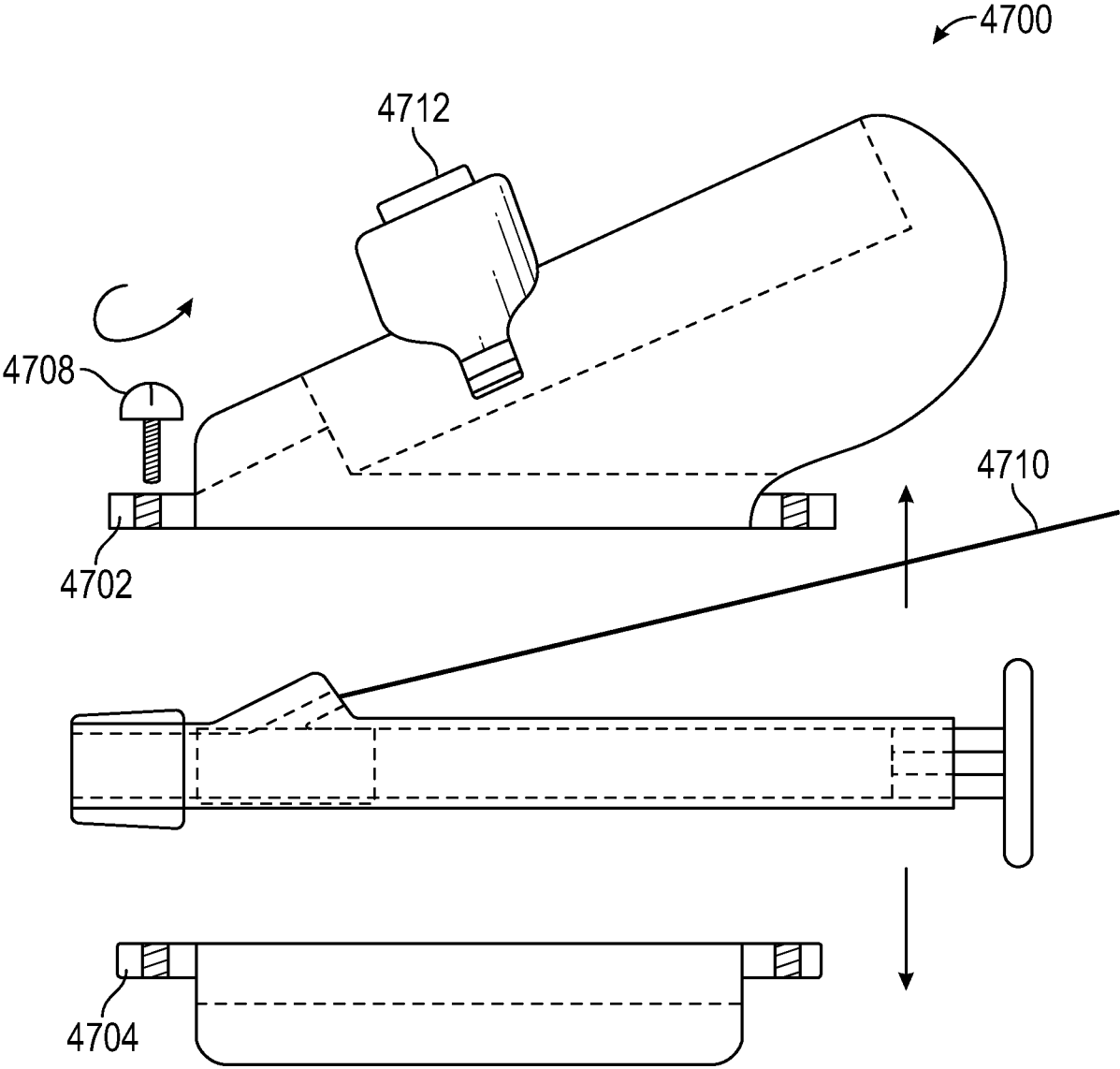


FIG. 40

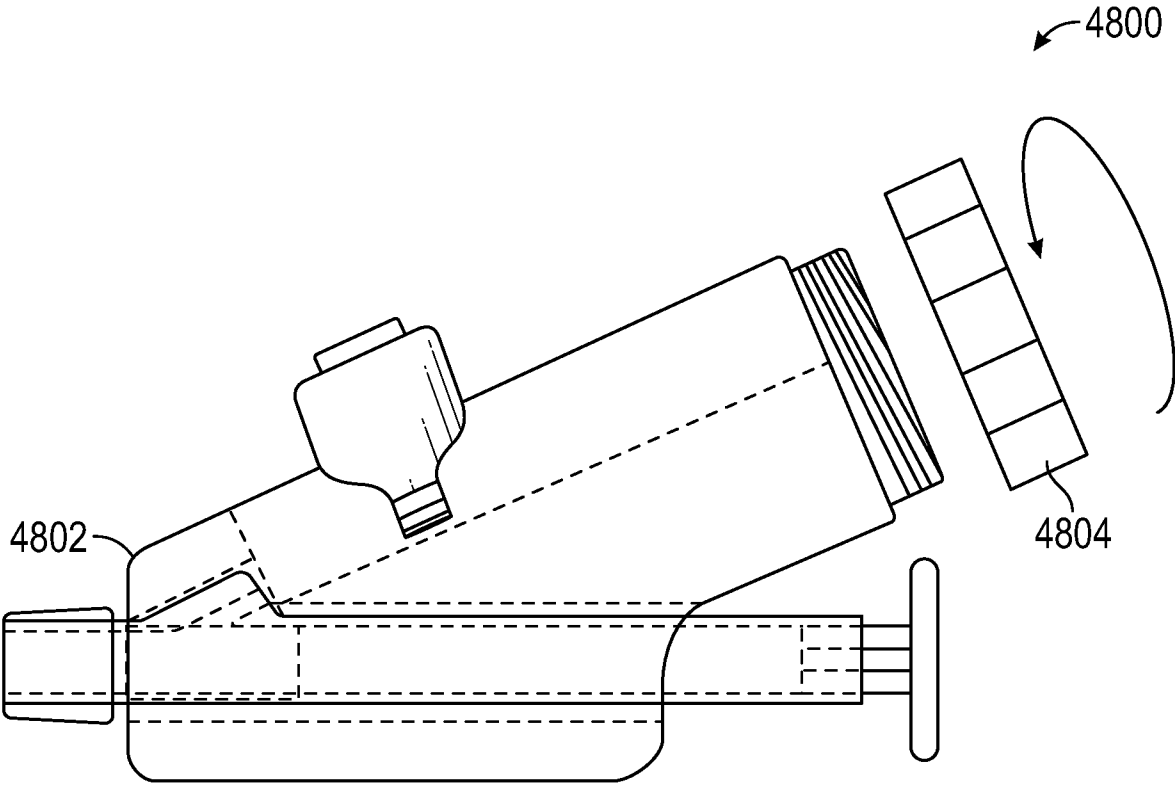


FIG. 41

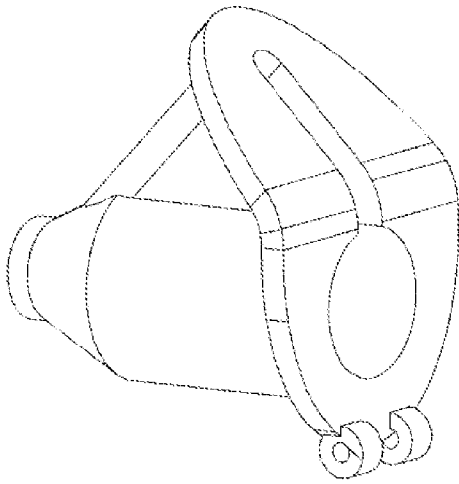


FIG. 42A

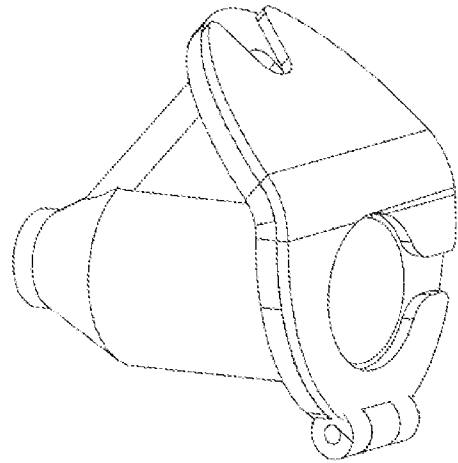


FIG. 42B

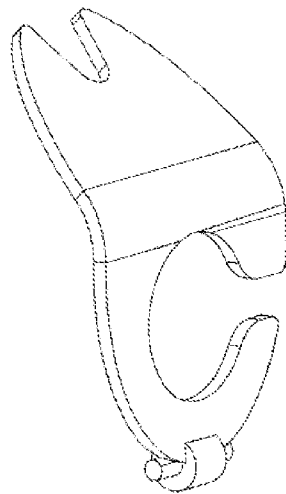


FIG. 42C

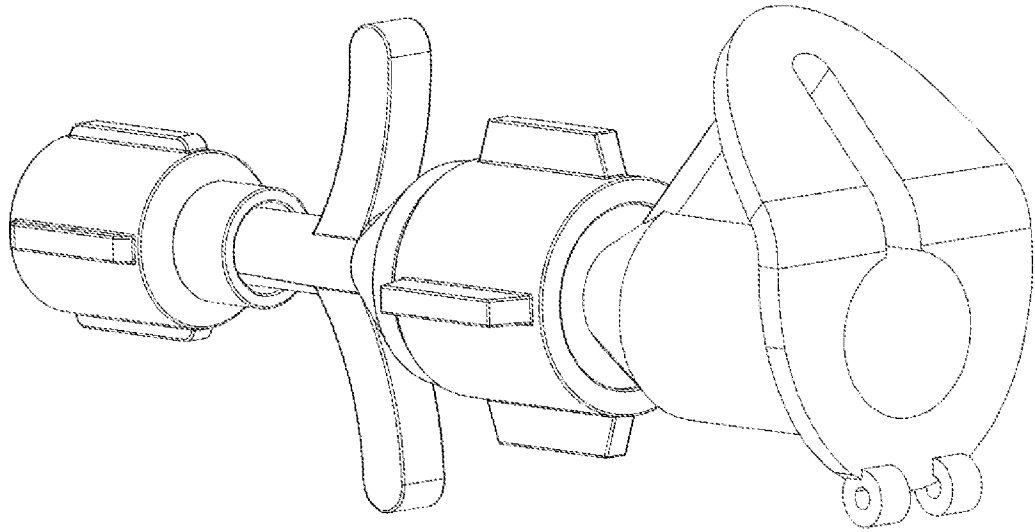


FIG. 42D

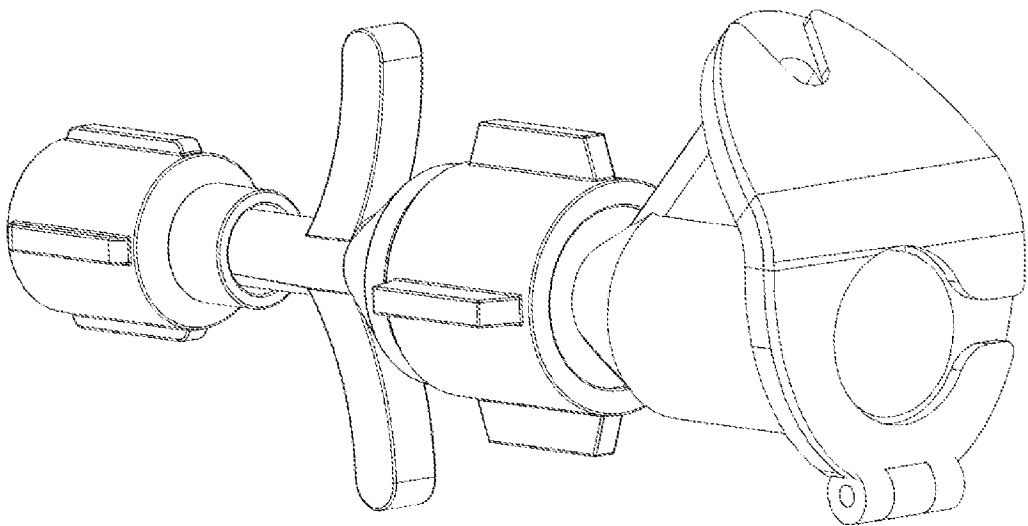


FIG. 42E

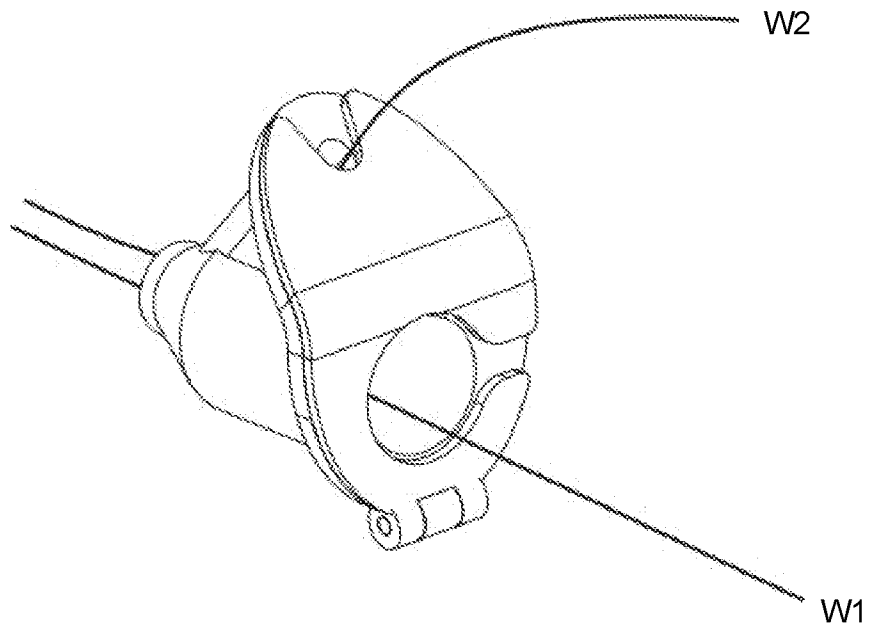


FIG. 42F

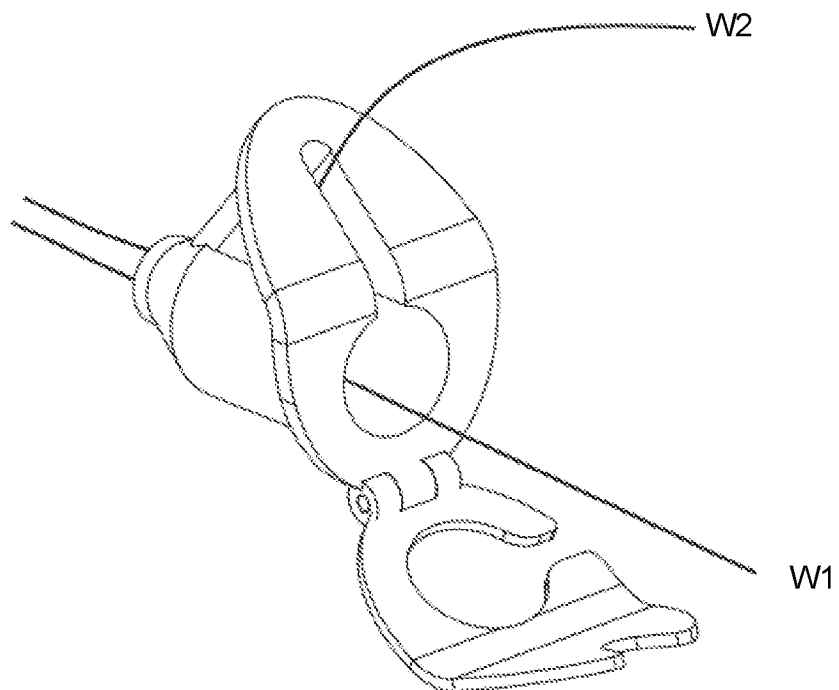


FIG. 42G

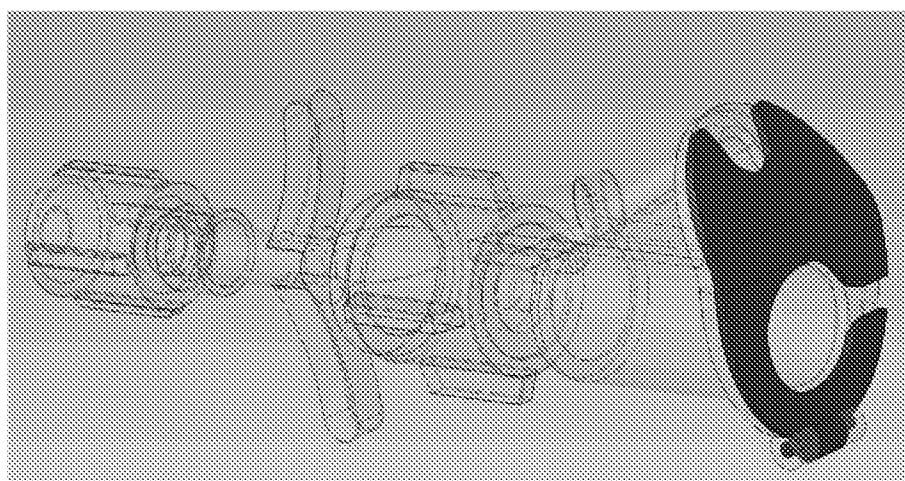


FIG. 43A

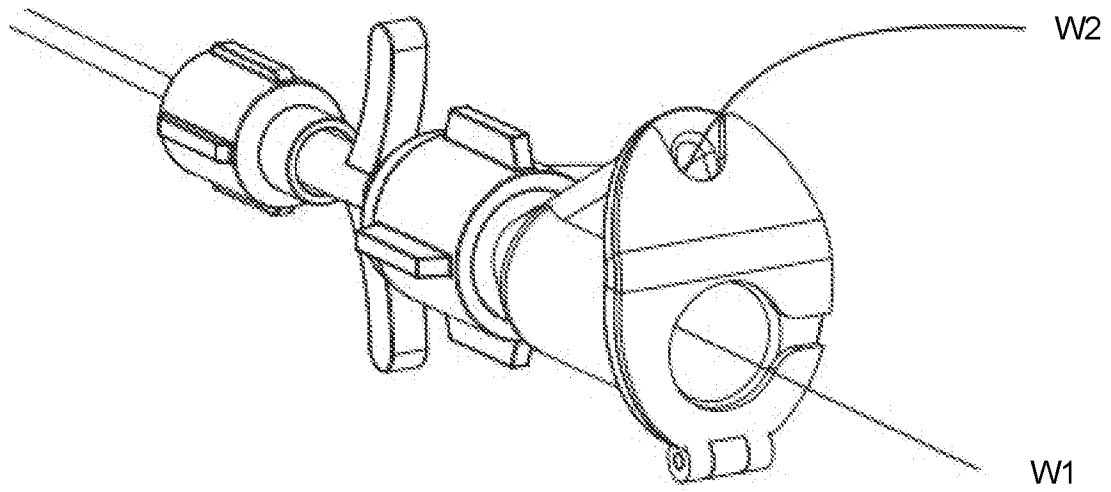


FIG. 43B

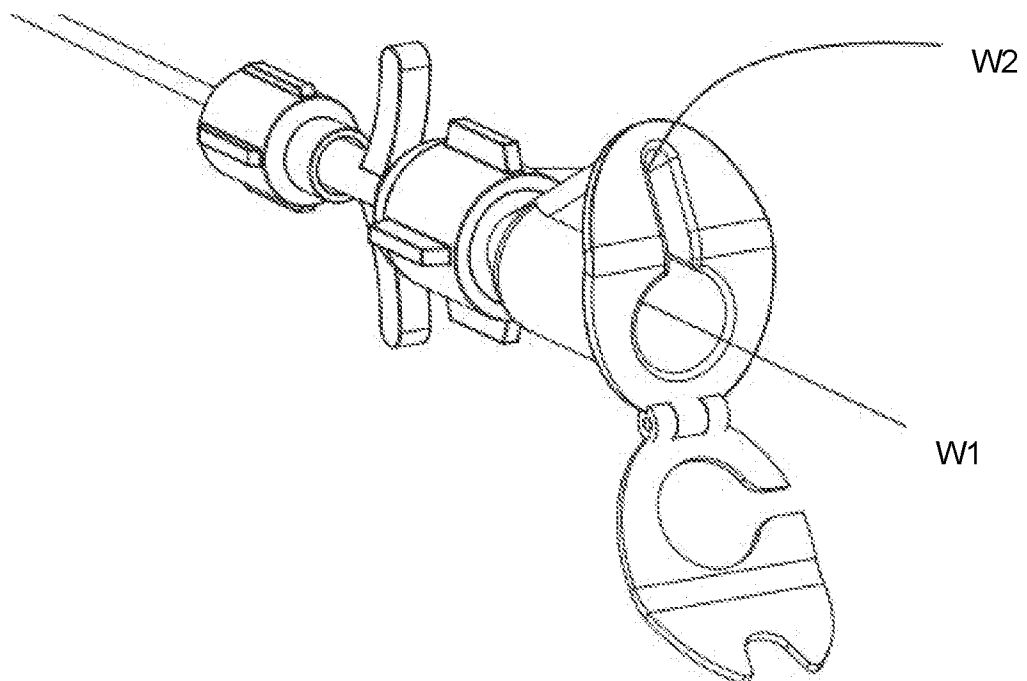


FIG. 43C

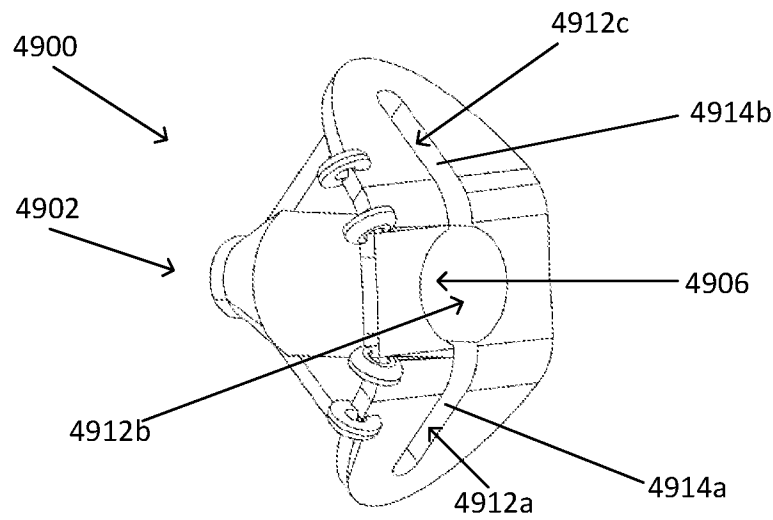


FIG. 44A

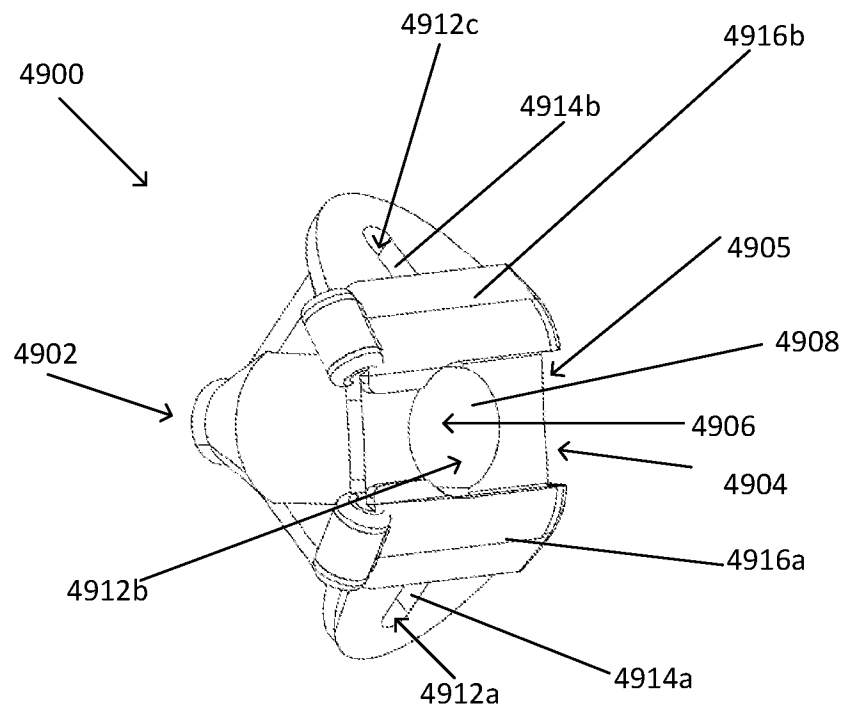


FIG. 44B

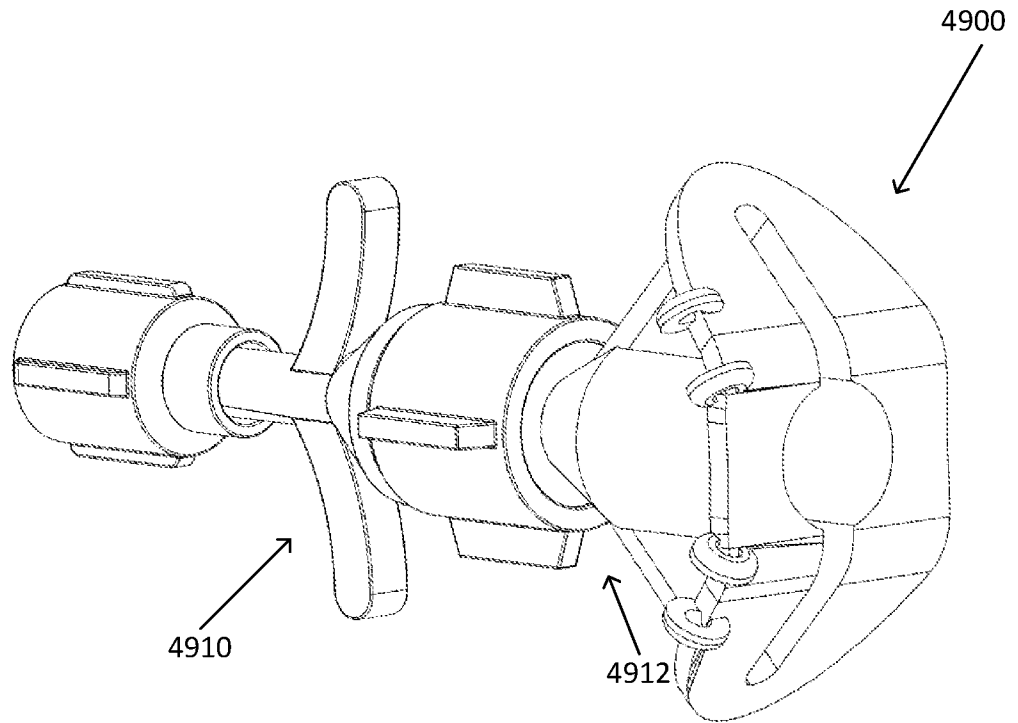


FIG. 44C

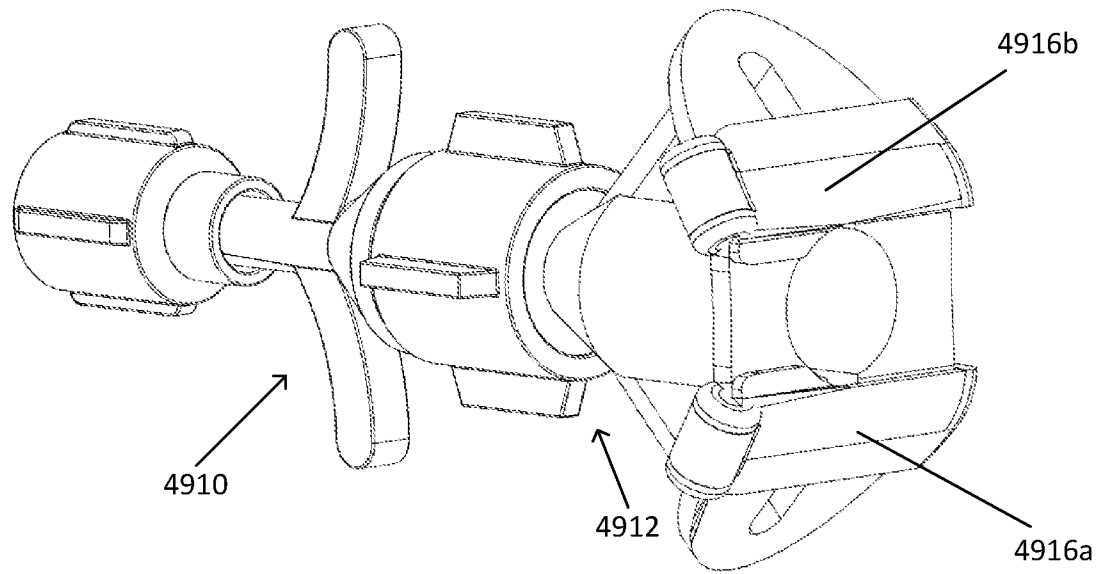


FIG. 44D

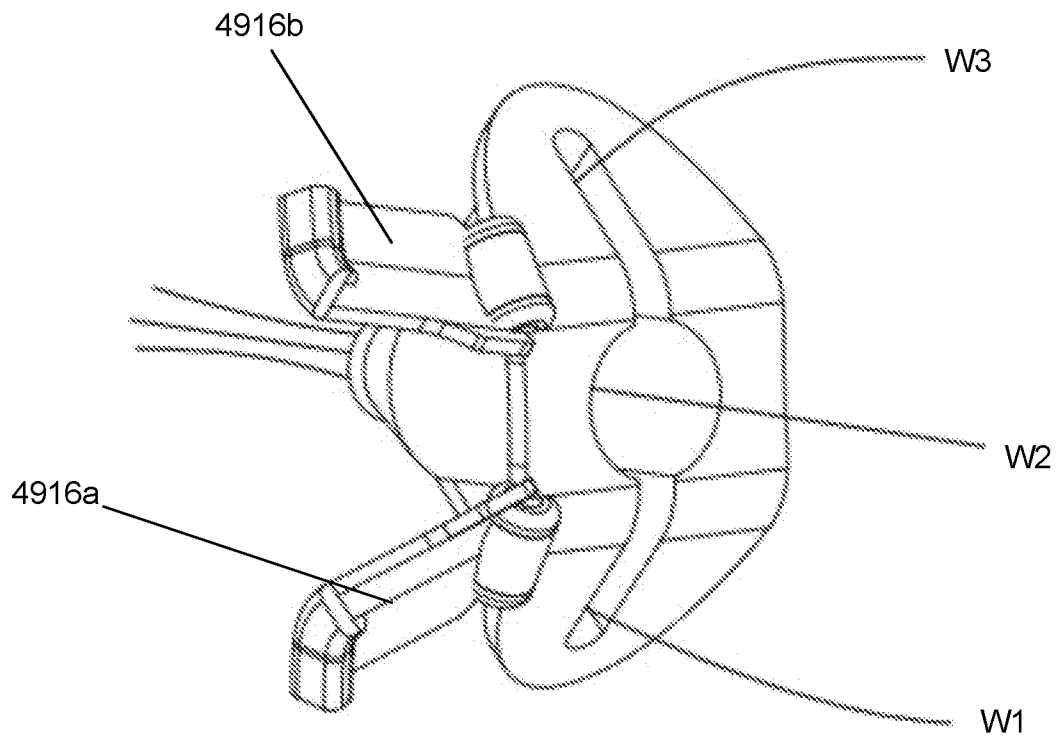


FIG. 44E

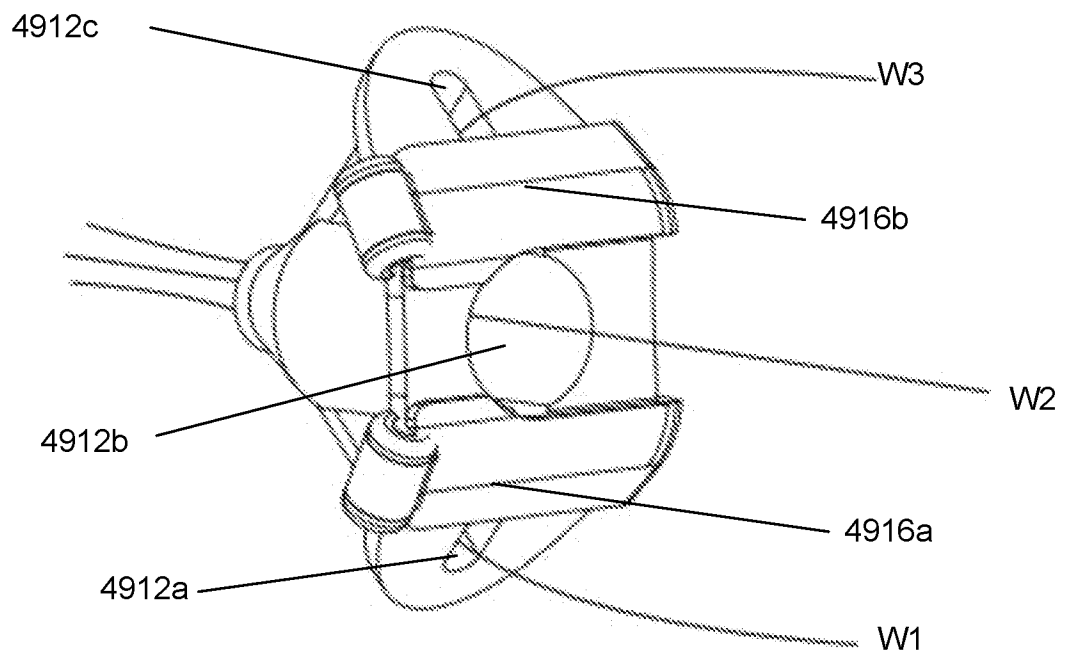


FIG. 44F

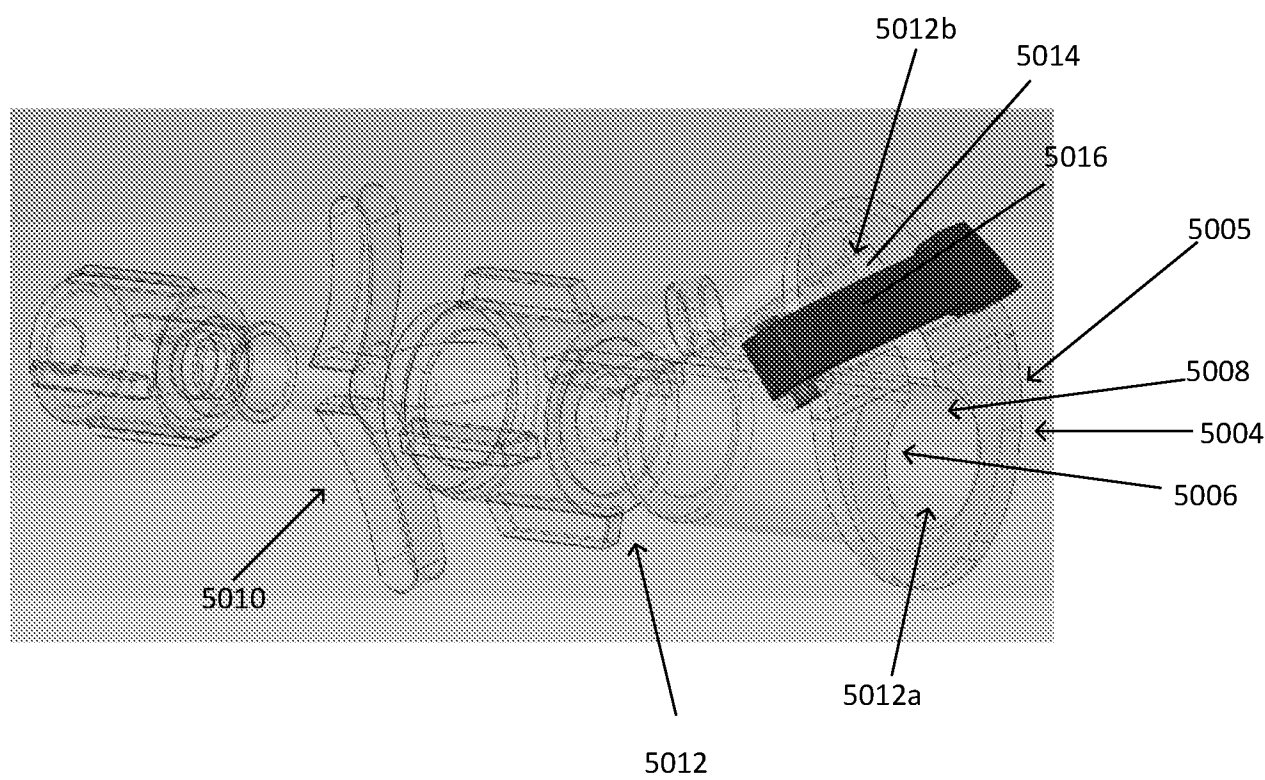


FIG. 45A

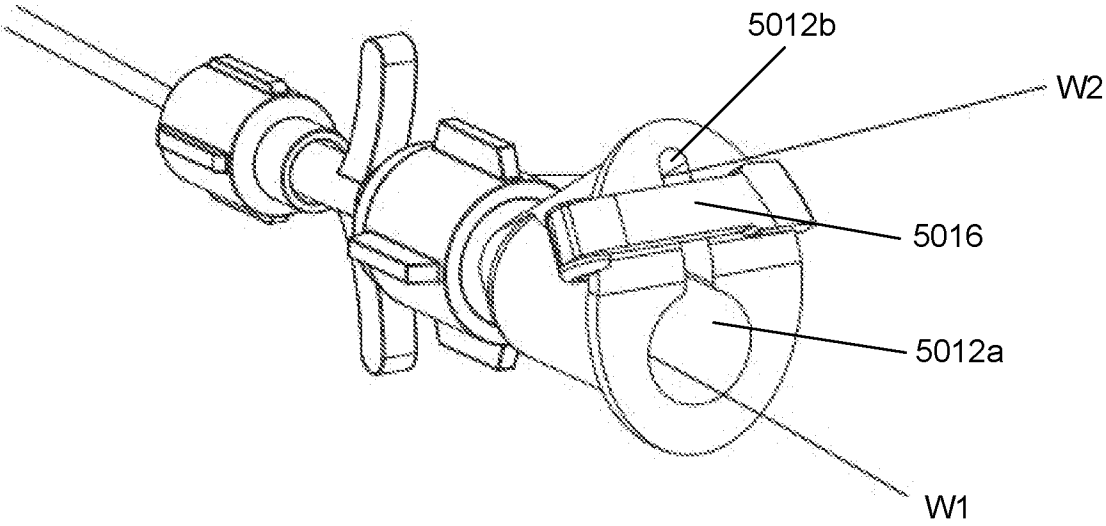


FIG. 45B

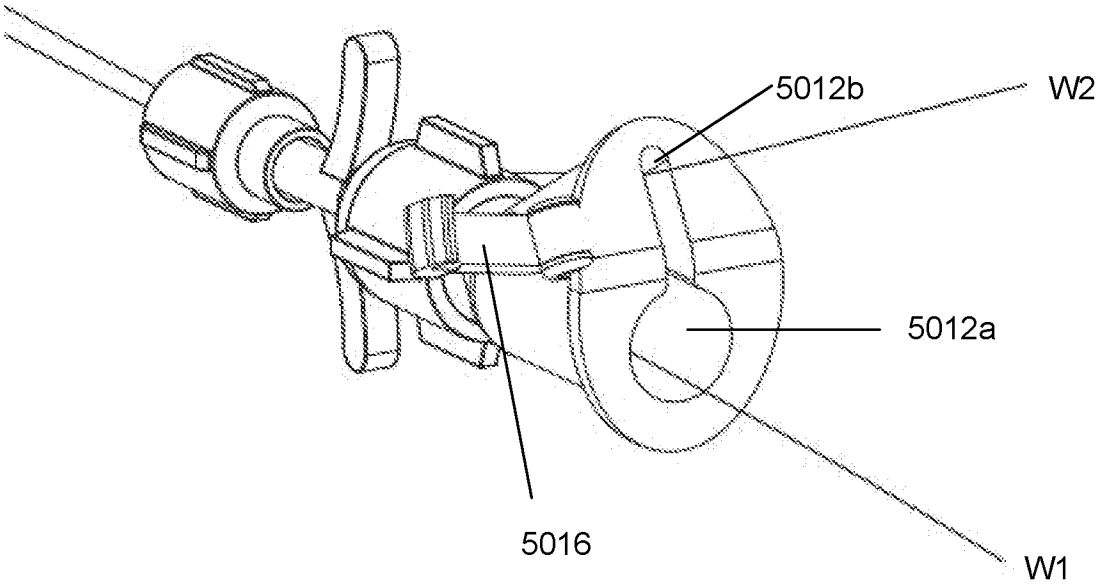


FIG. 45C

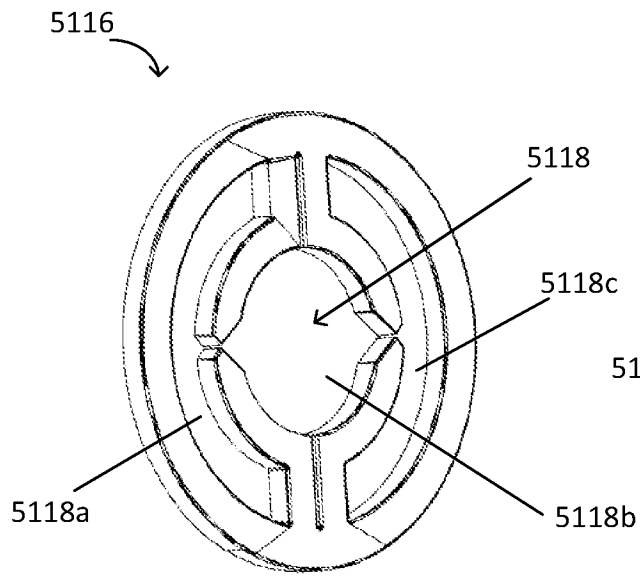


FIG. 46A

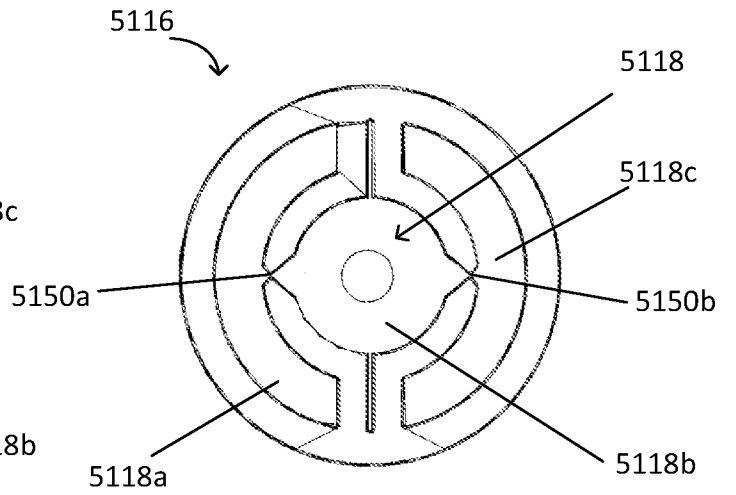


FIG. 46B

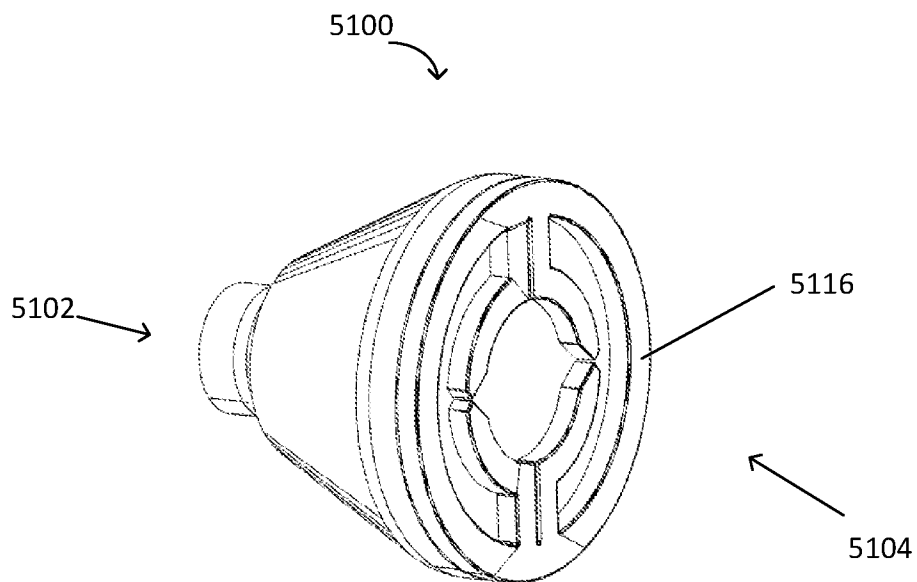


FIG. 46C

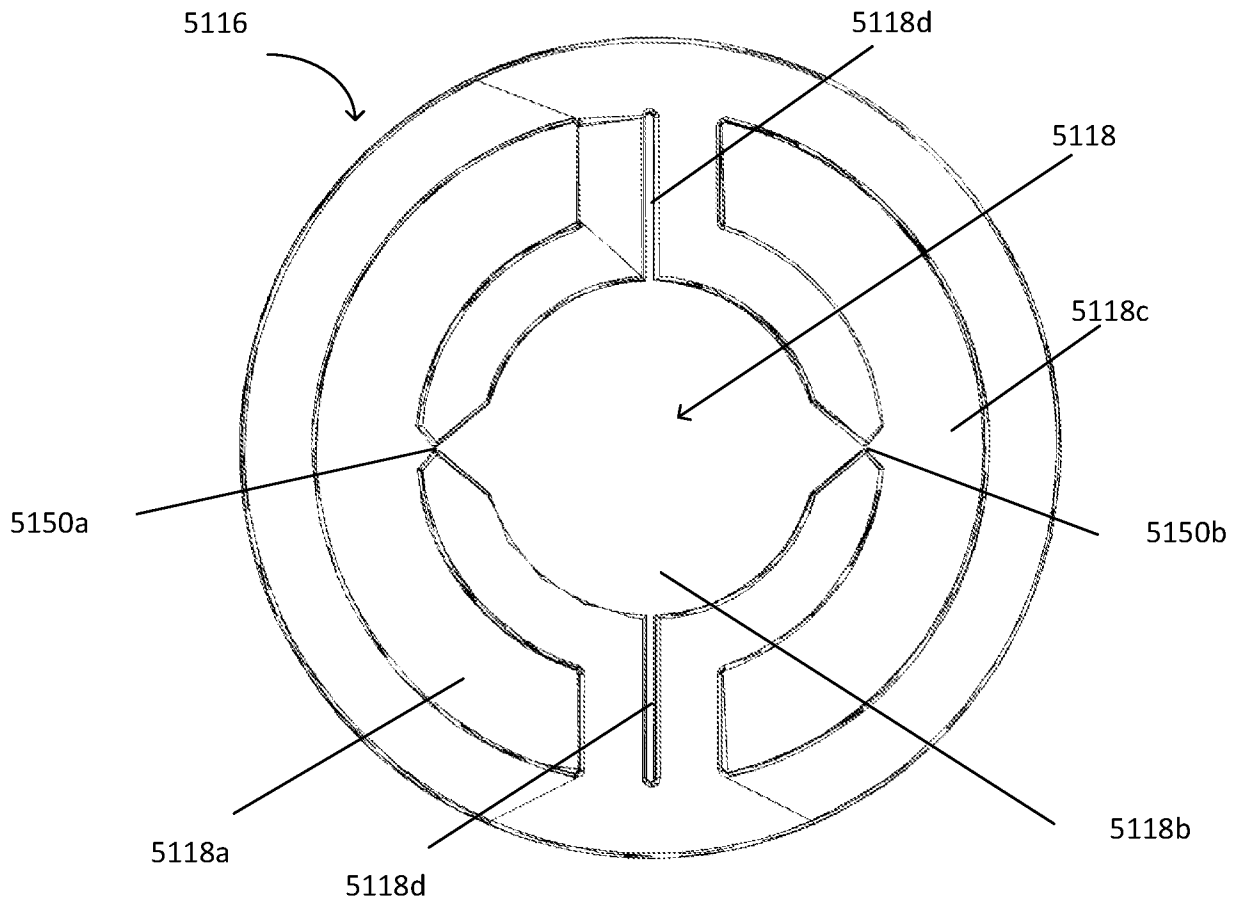


FIG. 46D

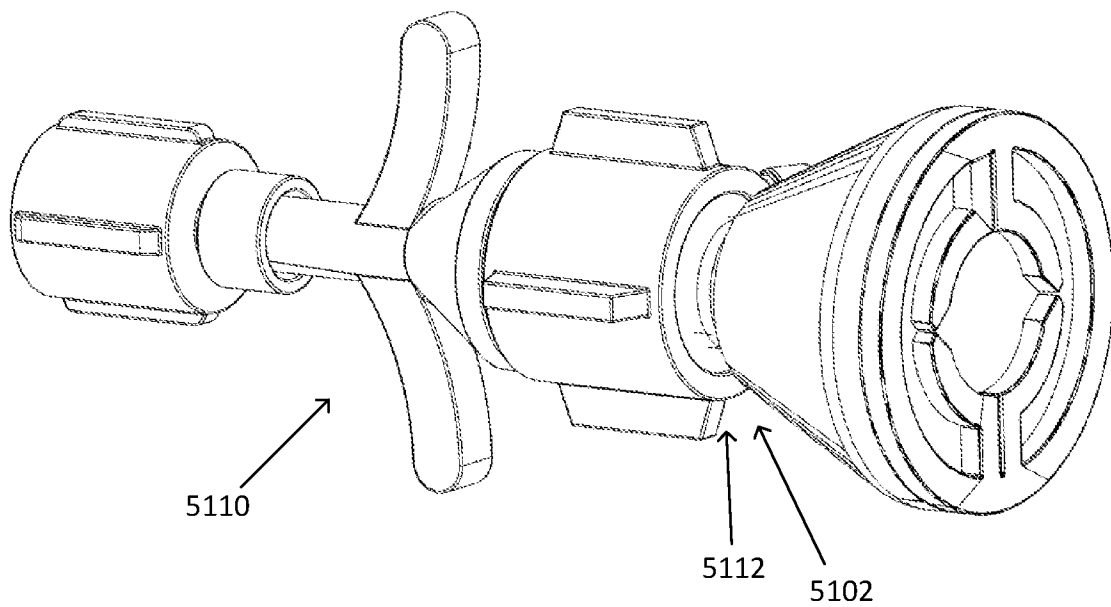


FIG. 46E

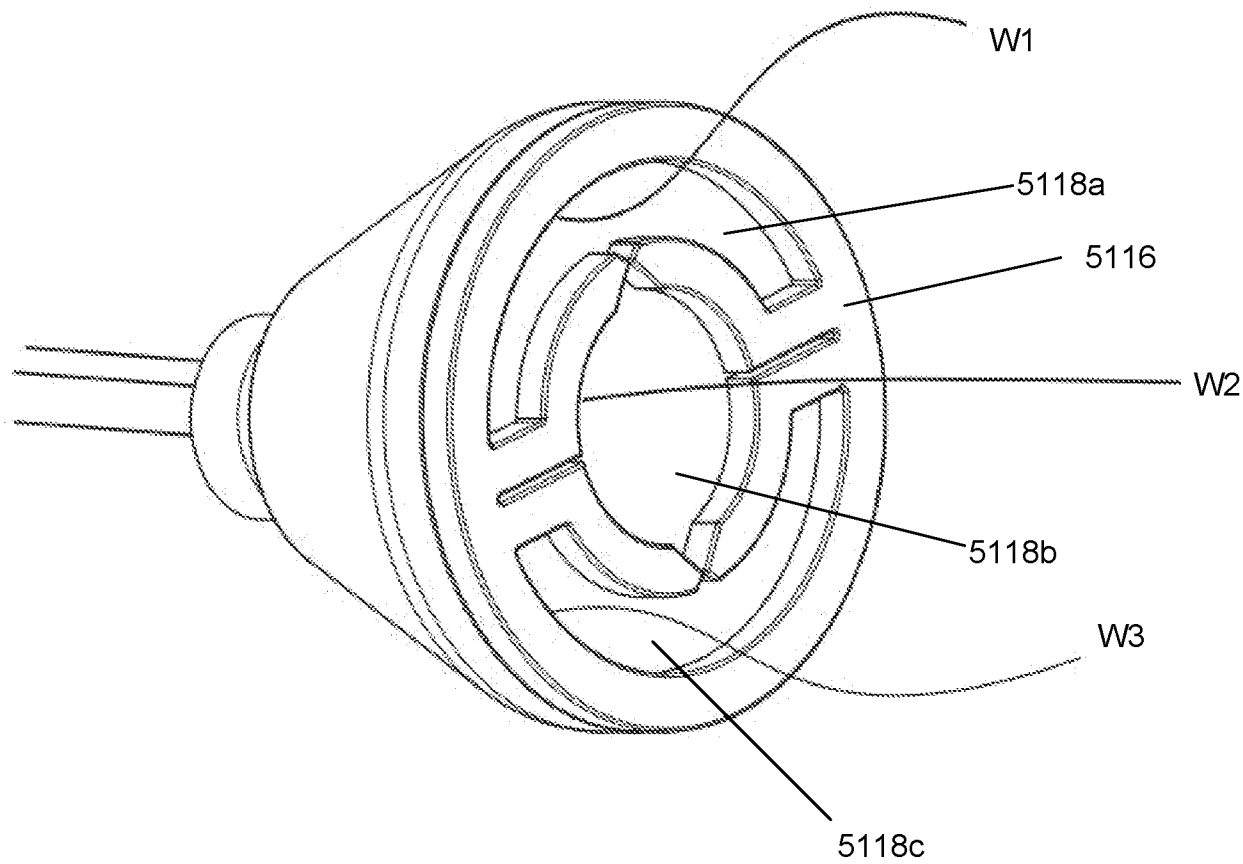


FIG. 46F

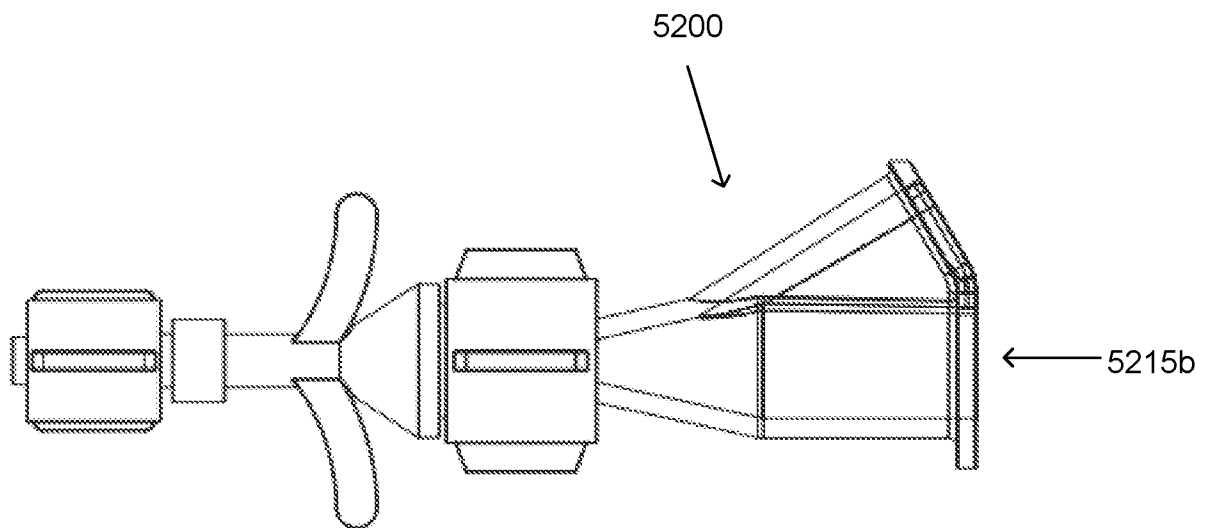


FIG. 47A

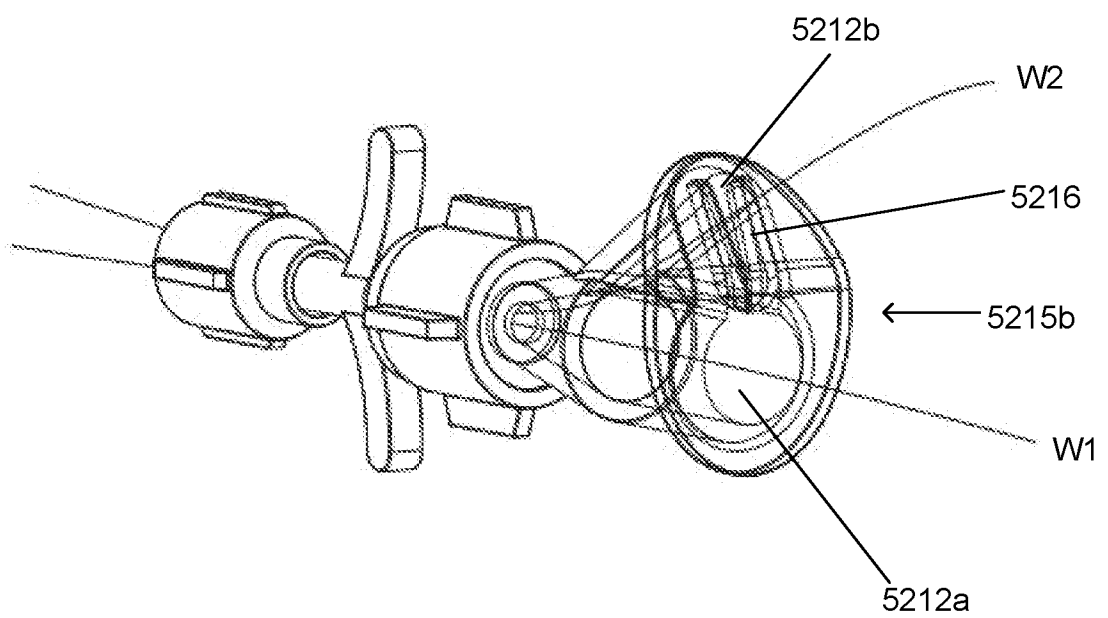


FIG. 47B

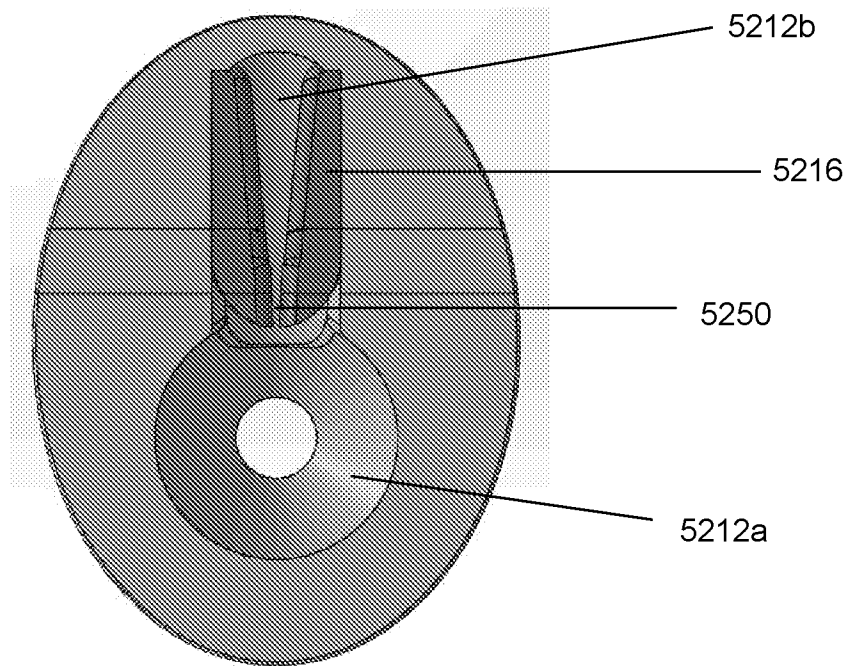


FIG. 47C

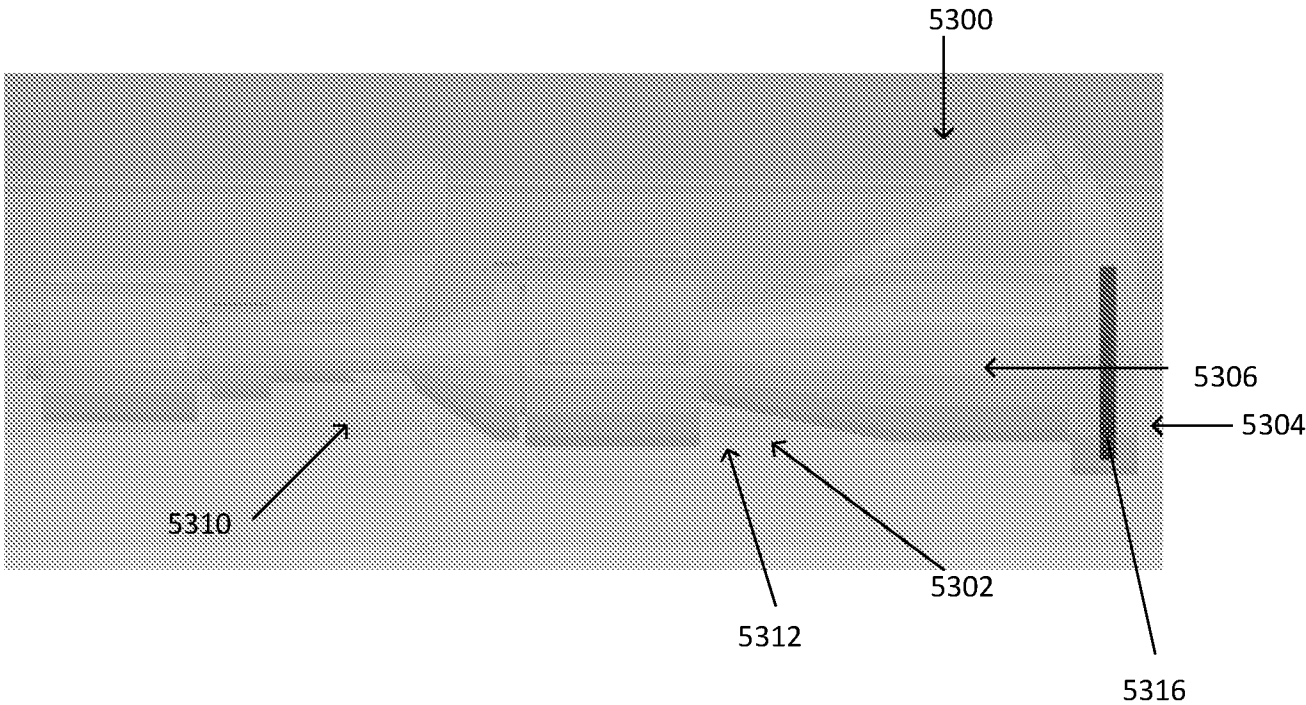


FIG. 48A

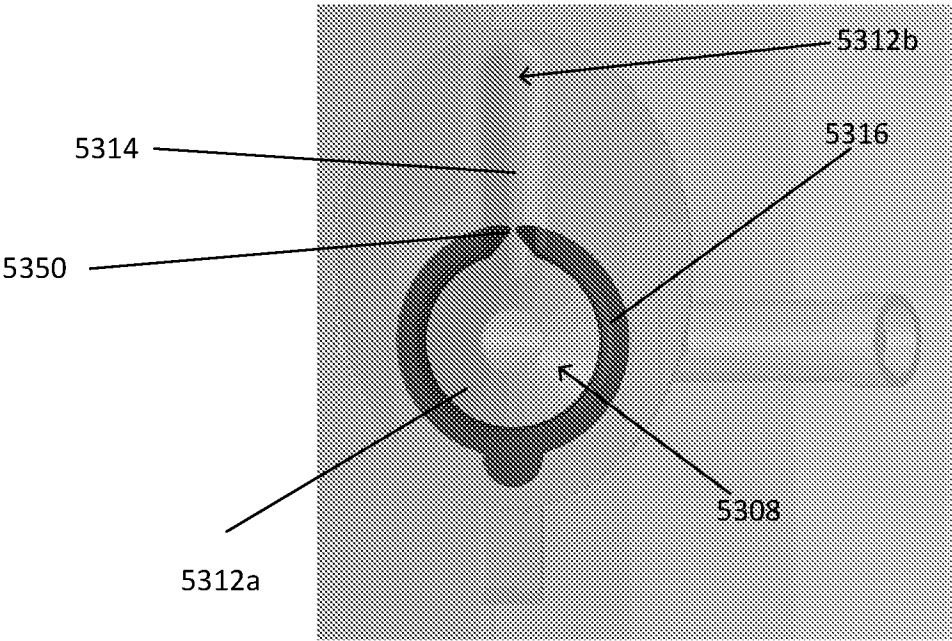


FIG. 48B

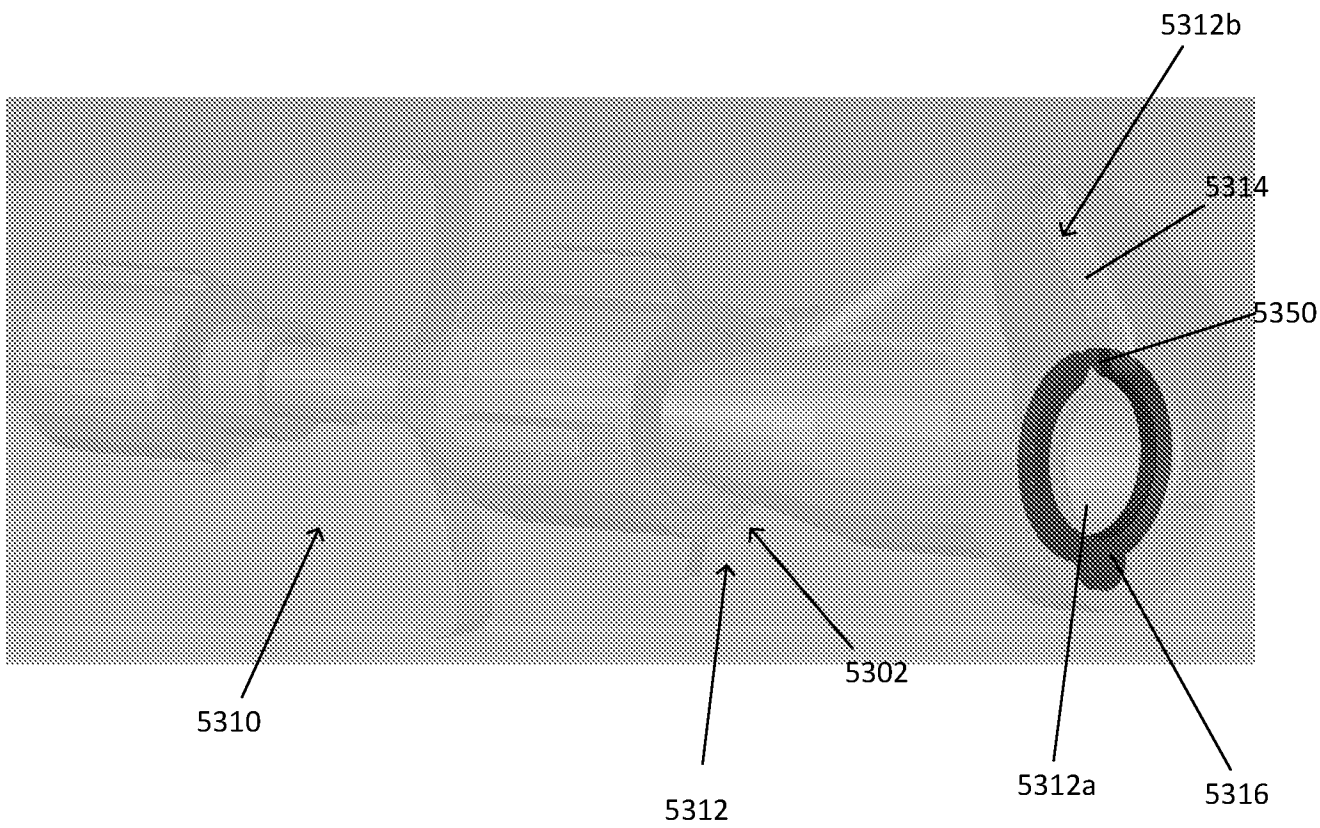


FIG. 48C

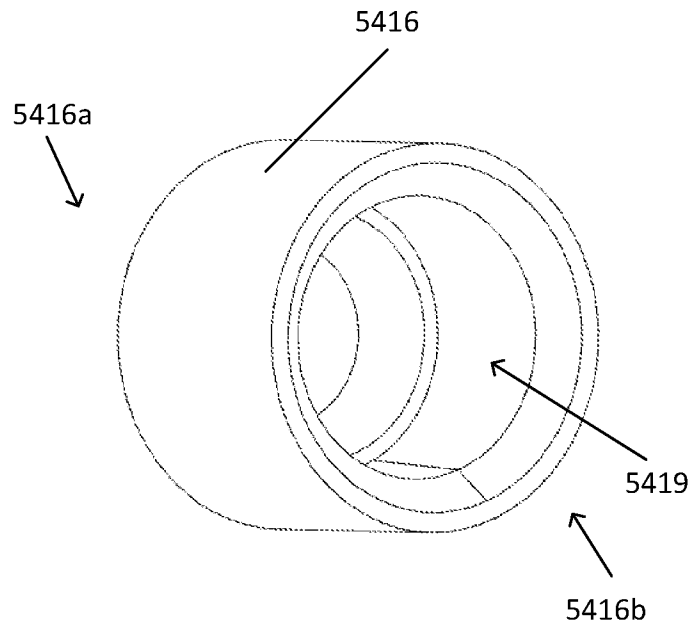


FIG. 49A

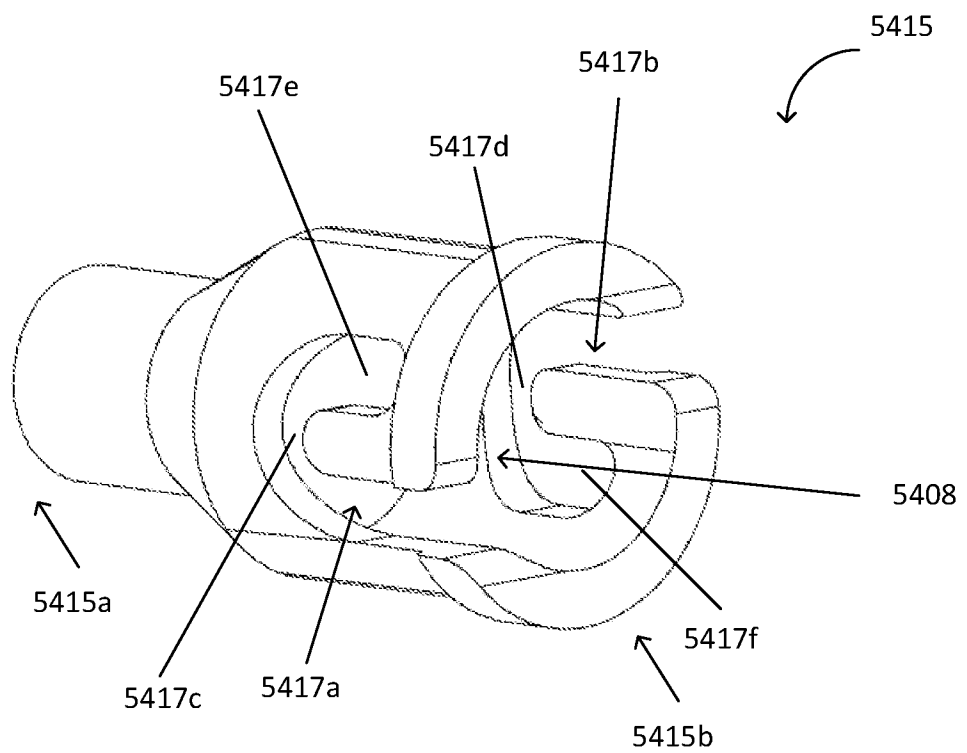


FIG. 49B

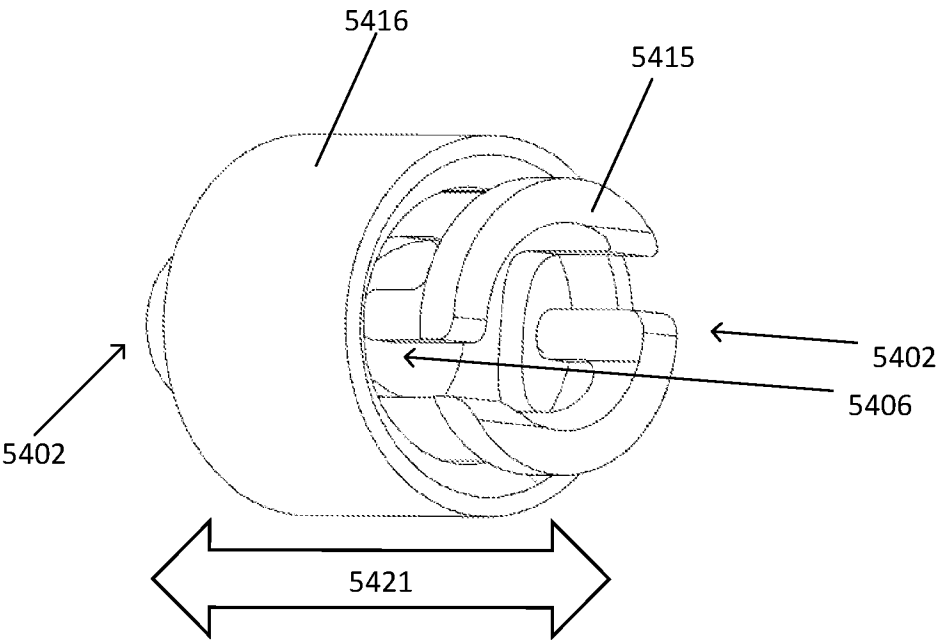


FIG. 49C

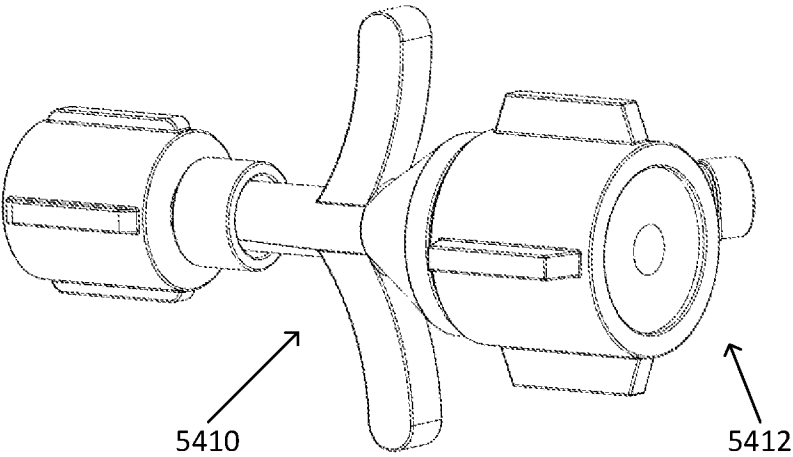


FIG. 49D

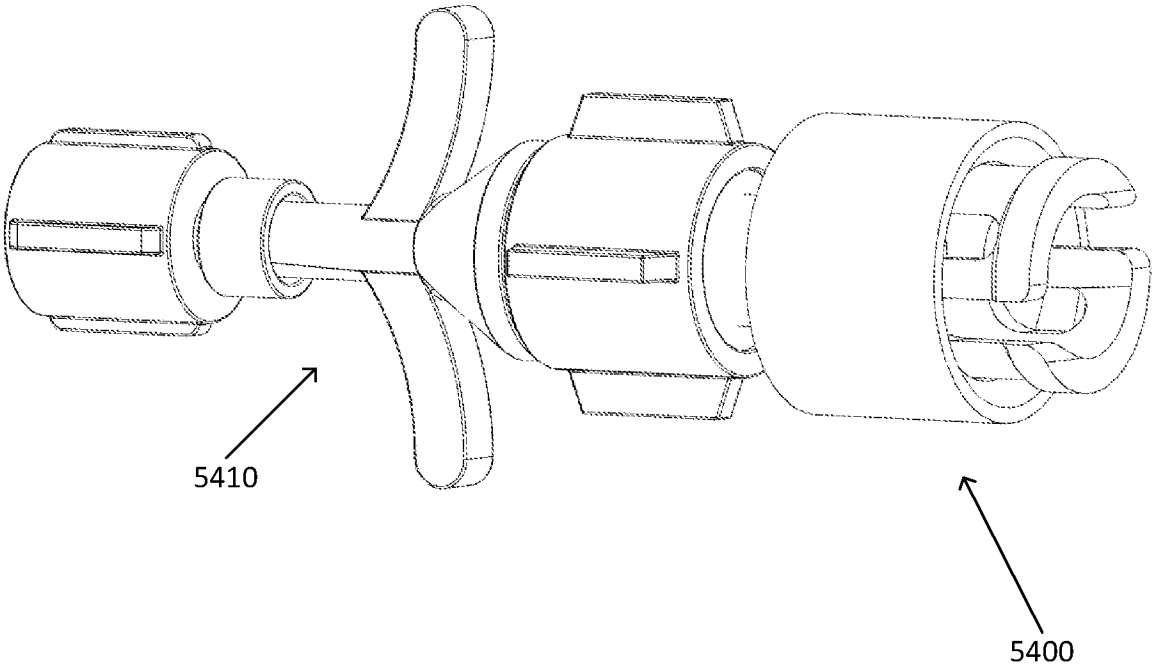


FIG. 49E

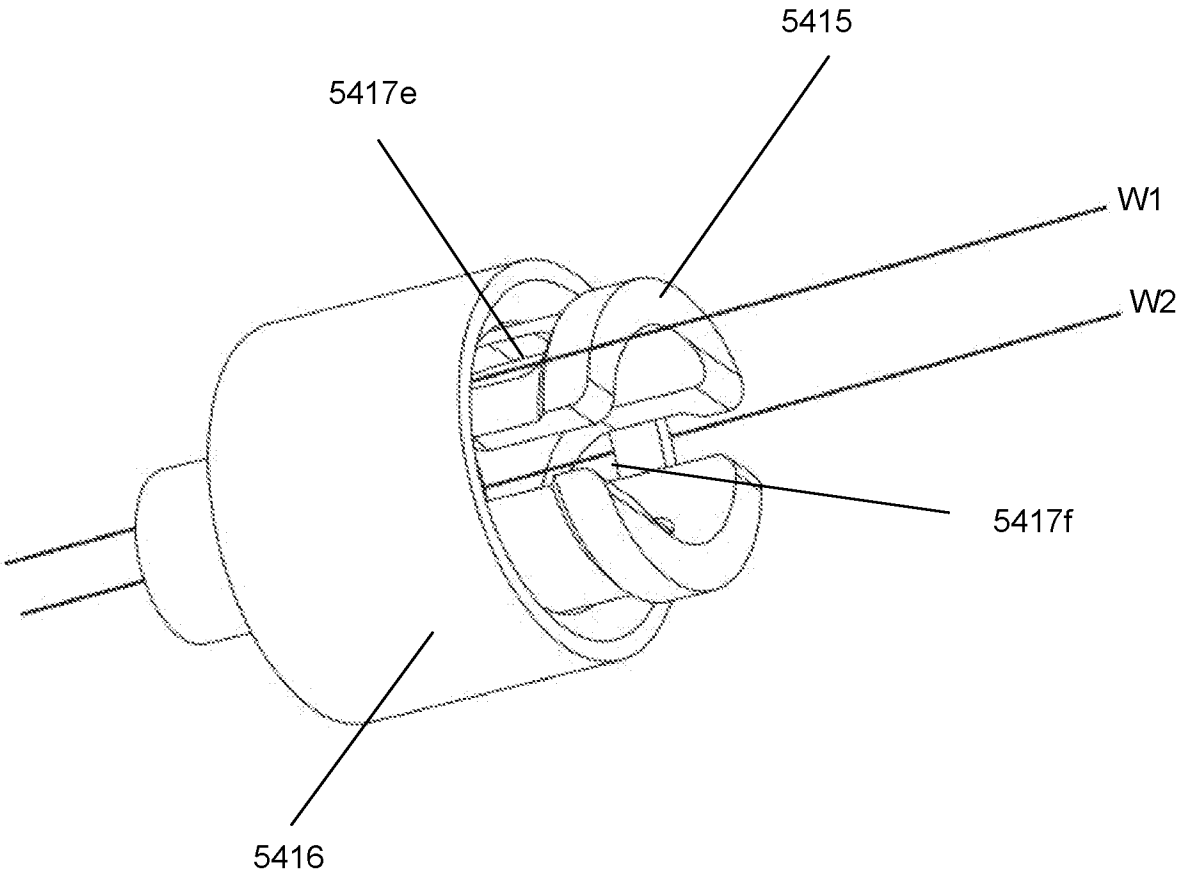


FIG. 49F

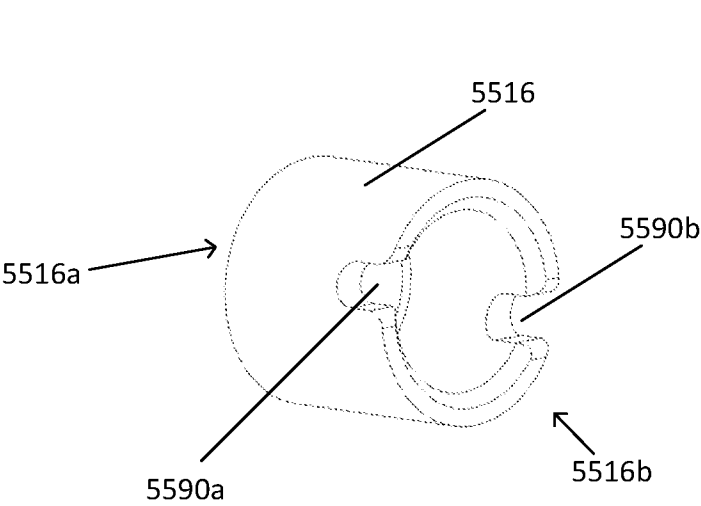


FIG. 50A

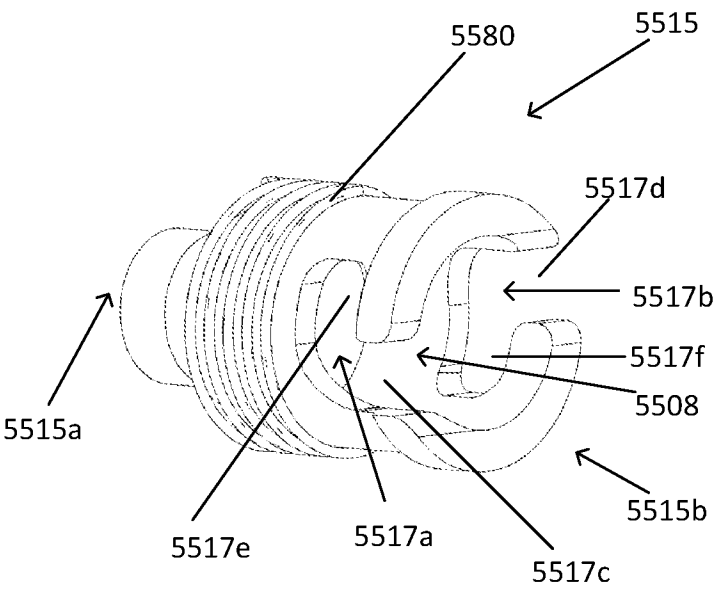


FIG. 50B

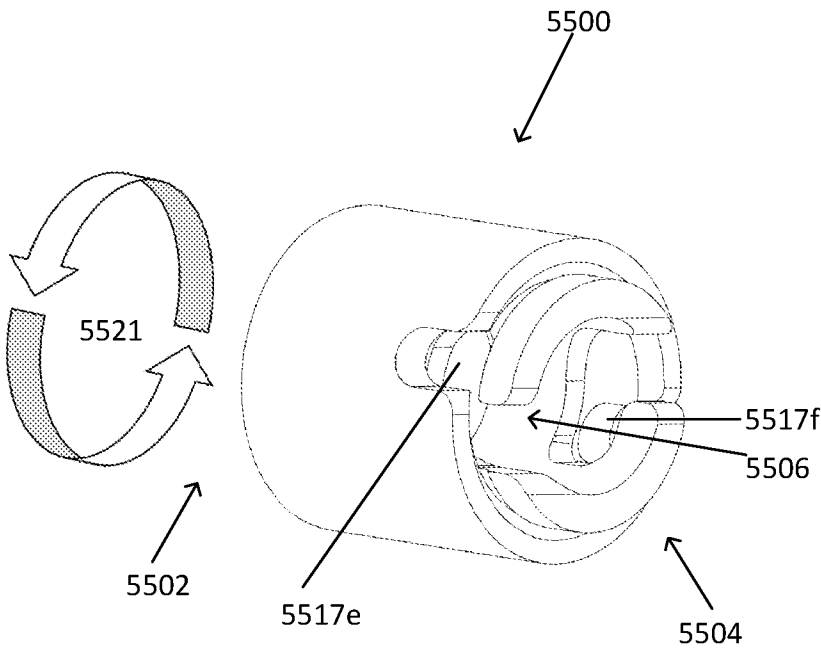


FIG. 50C

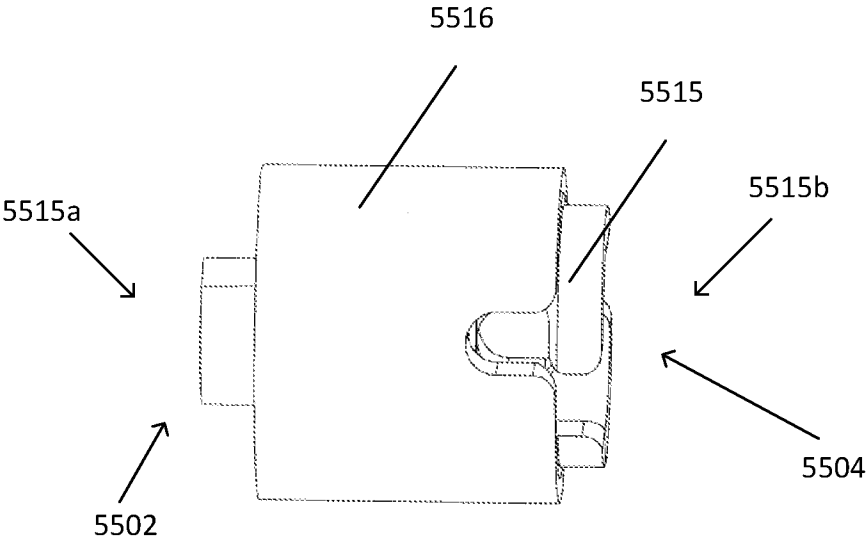


FIG. 50D

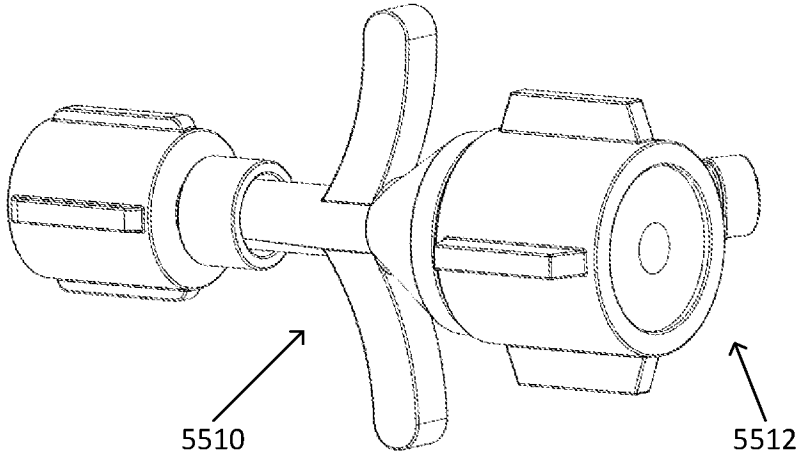


FIG. 50E

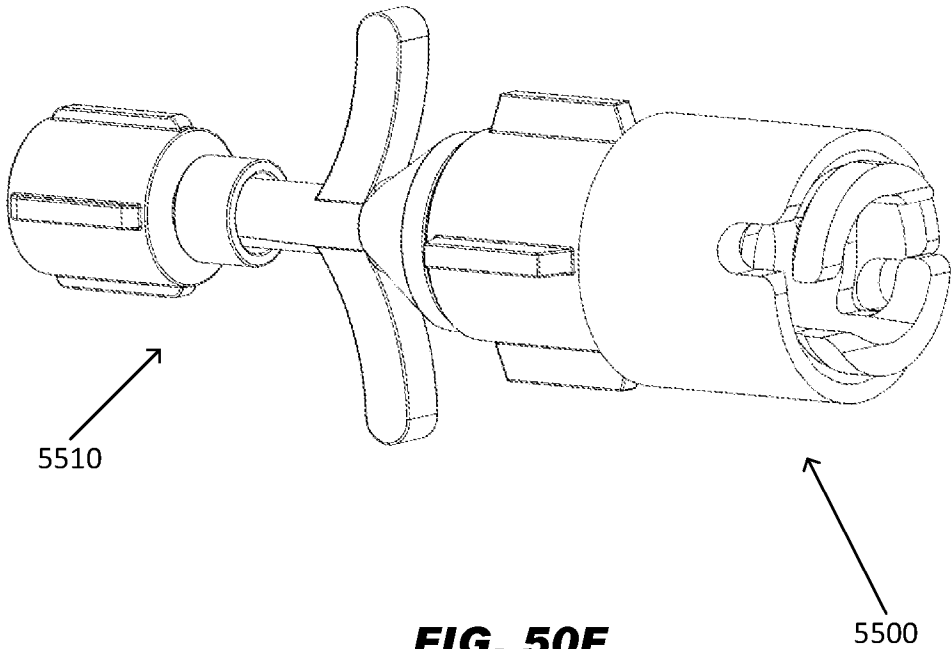


FIG. 50F

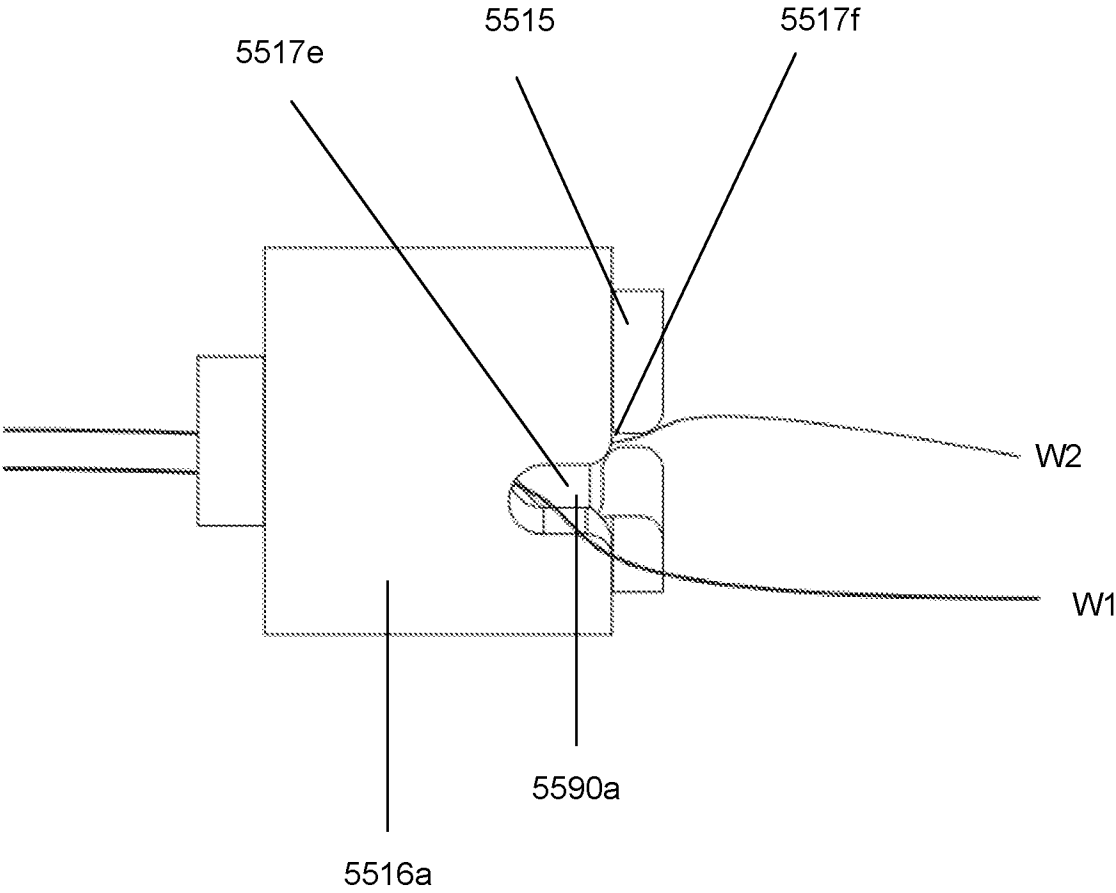


FIG. 50G

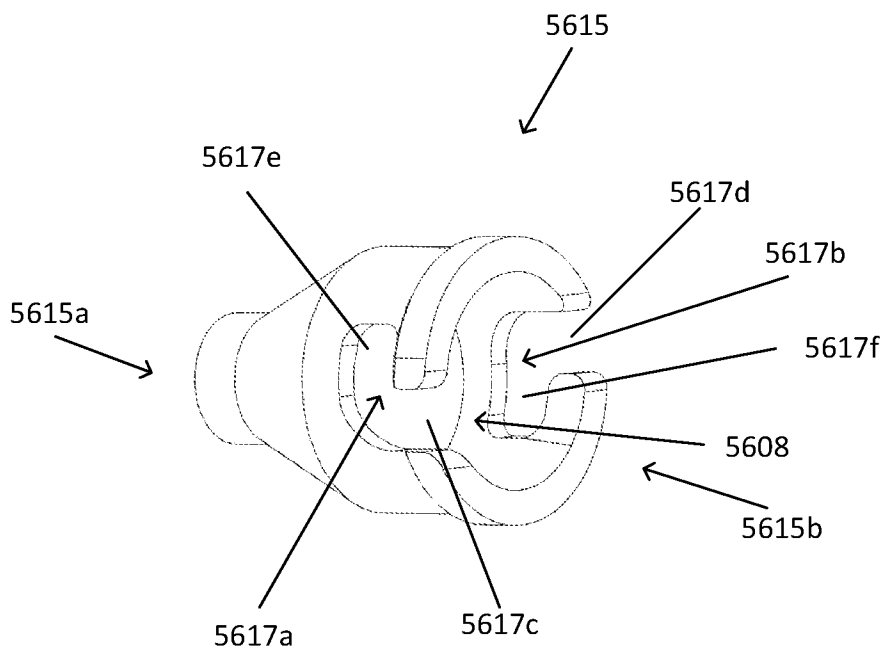


FIG. 51A

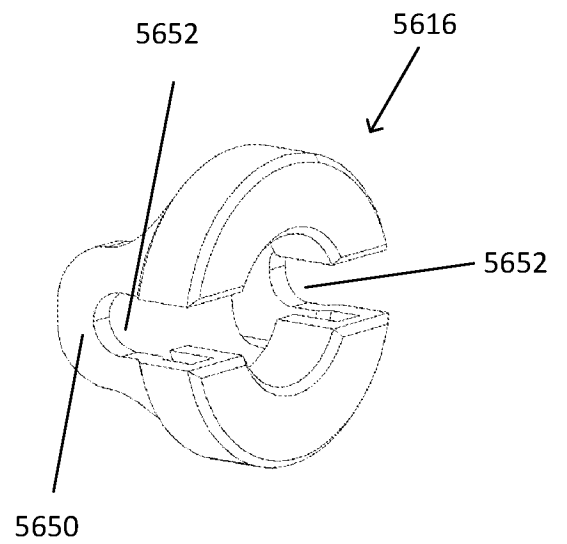


FIG. 51B

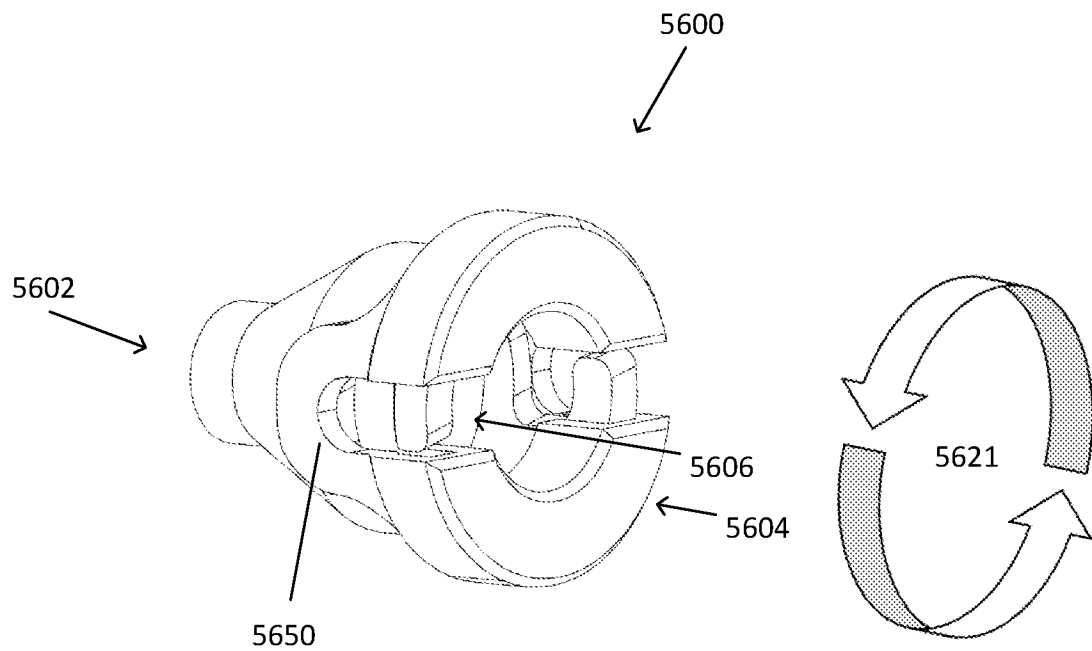


FIG. 51C

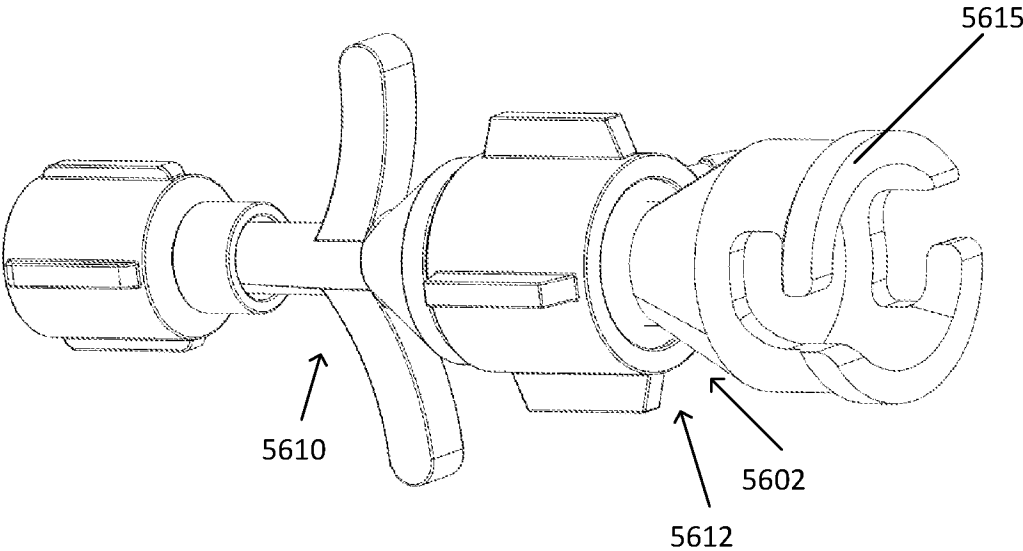


FIG. 51D

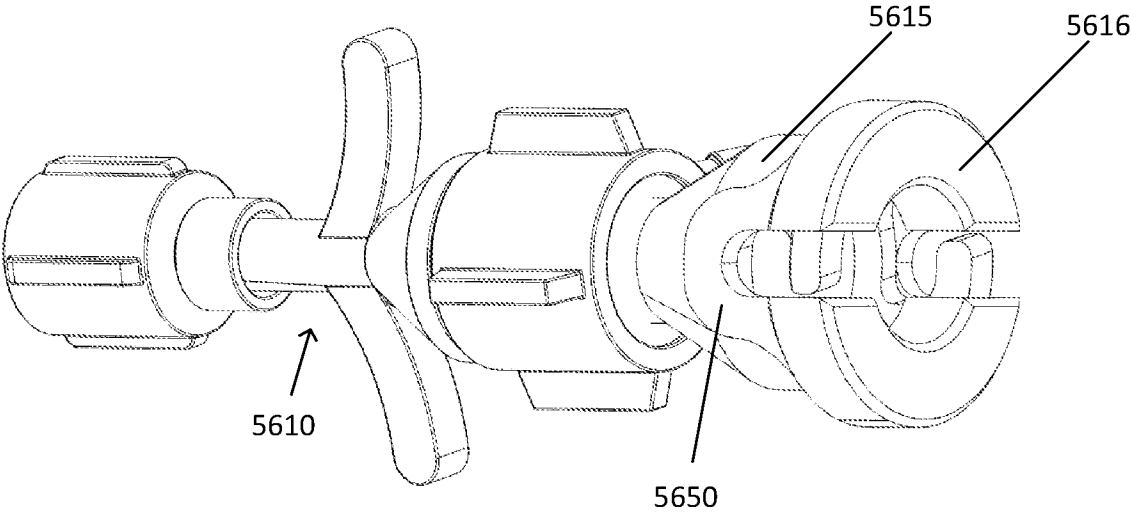


FIG. 51E

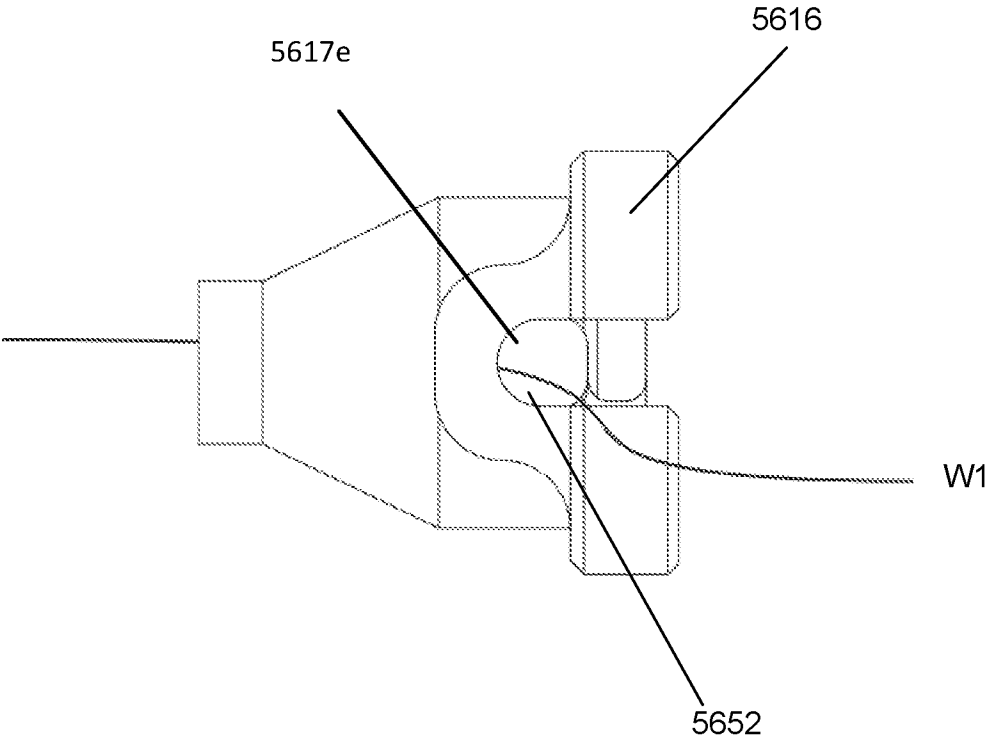


FIG. 51F

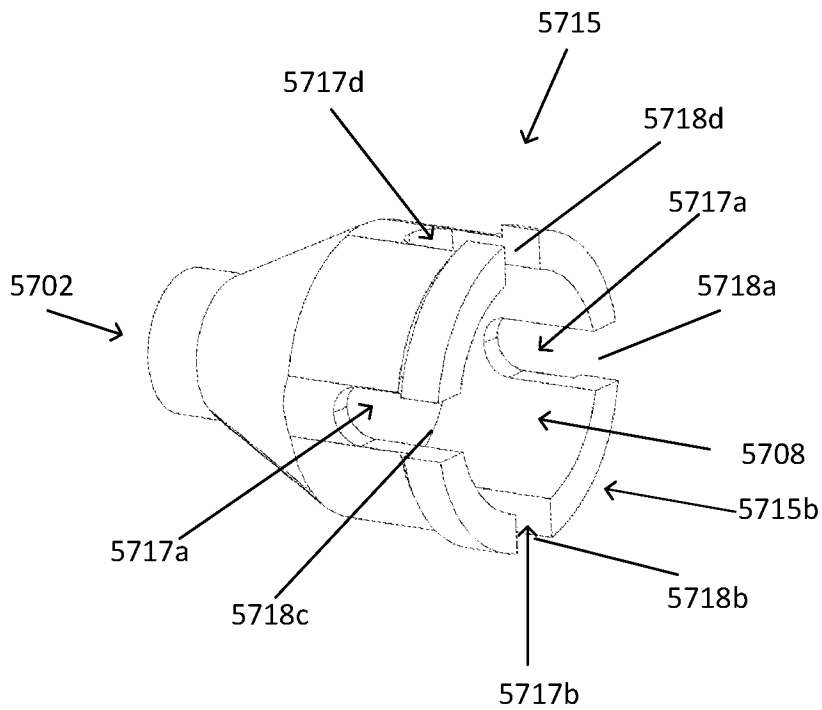


FIG. 52A

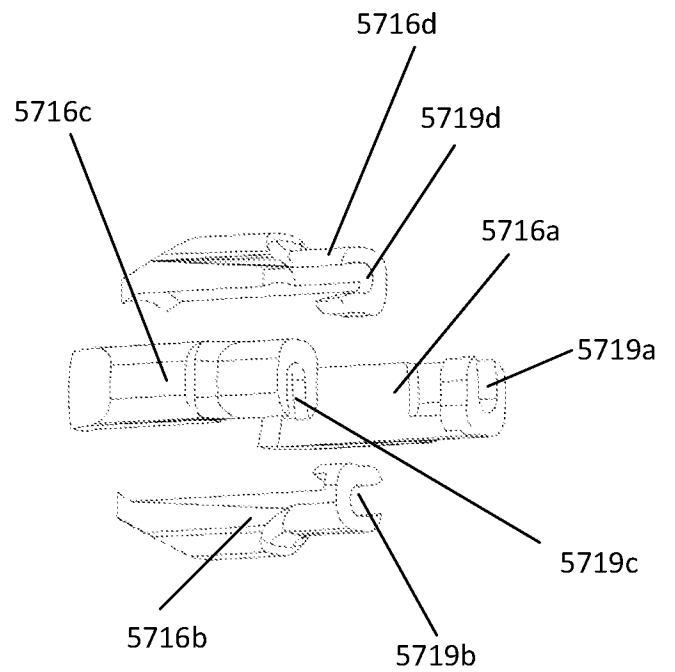


FIG. 52B

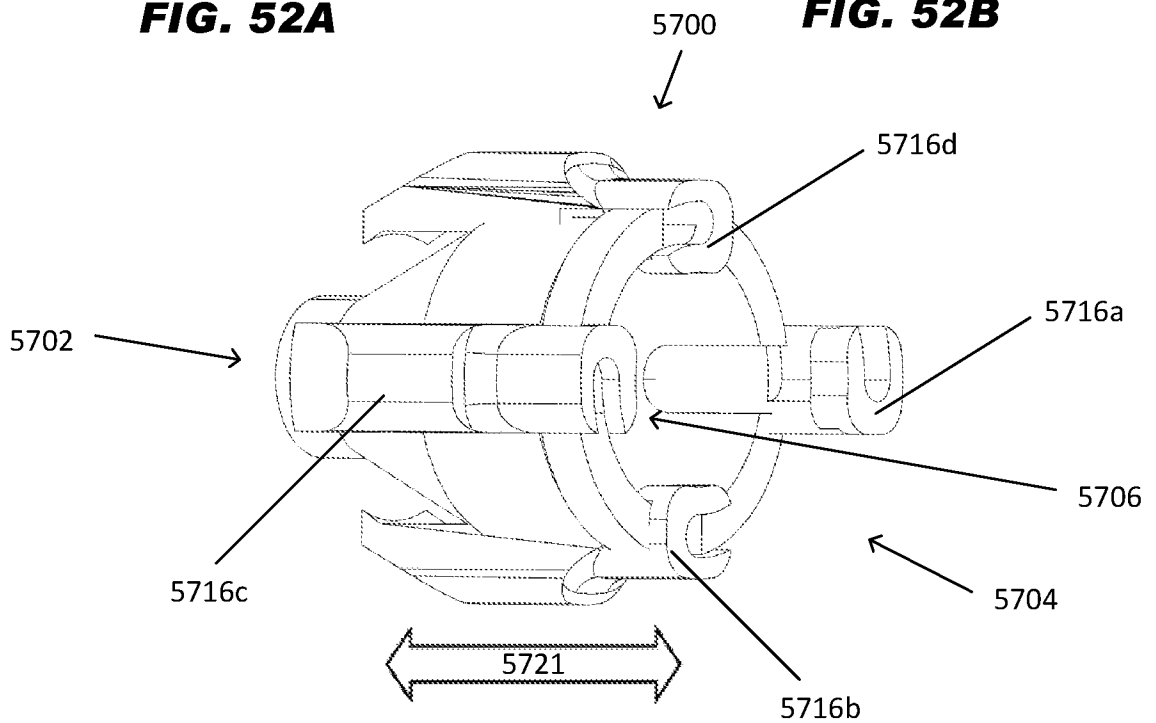


FIG. 52C

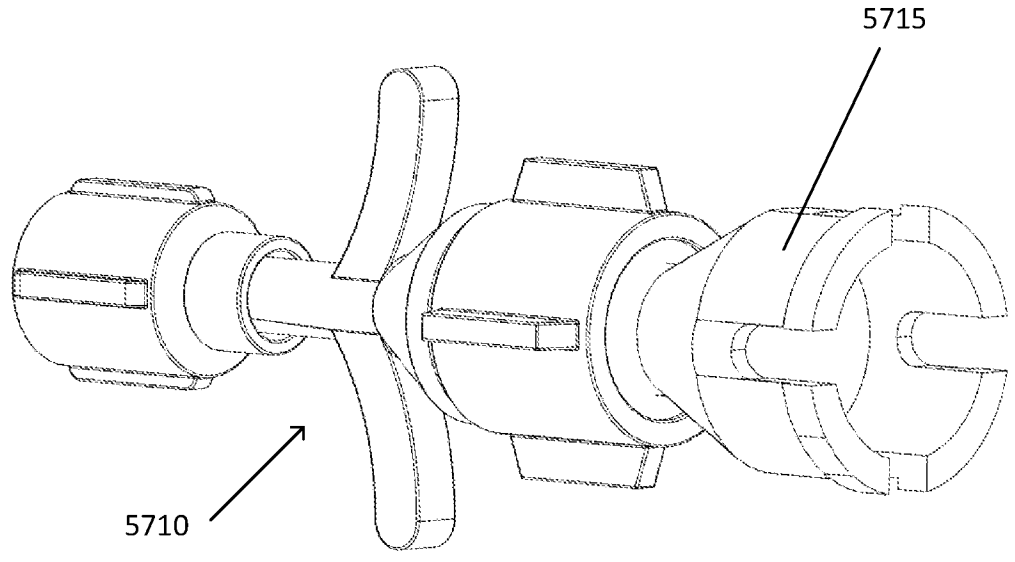


FIG. 52D

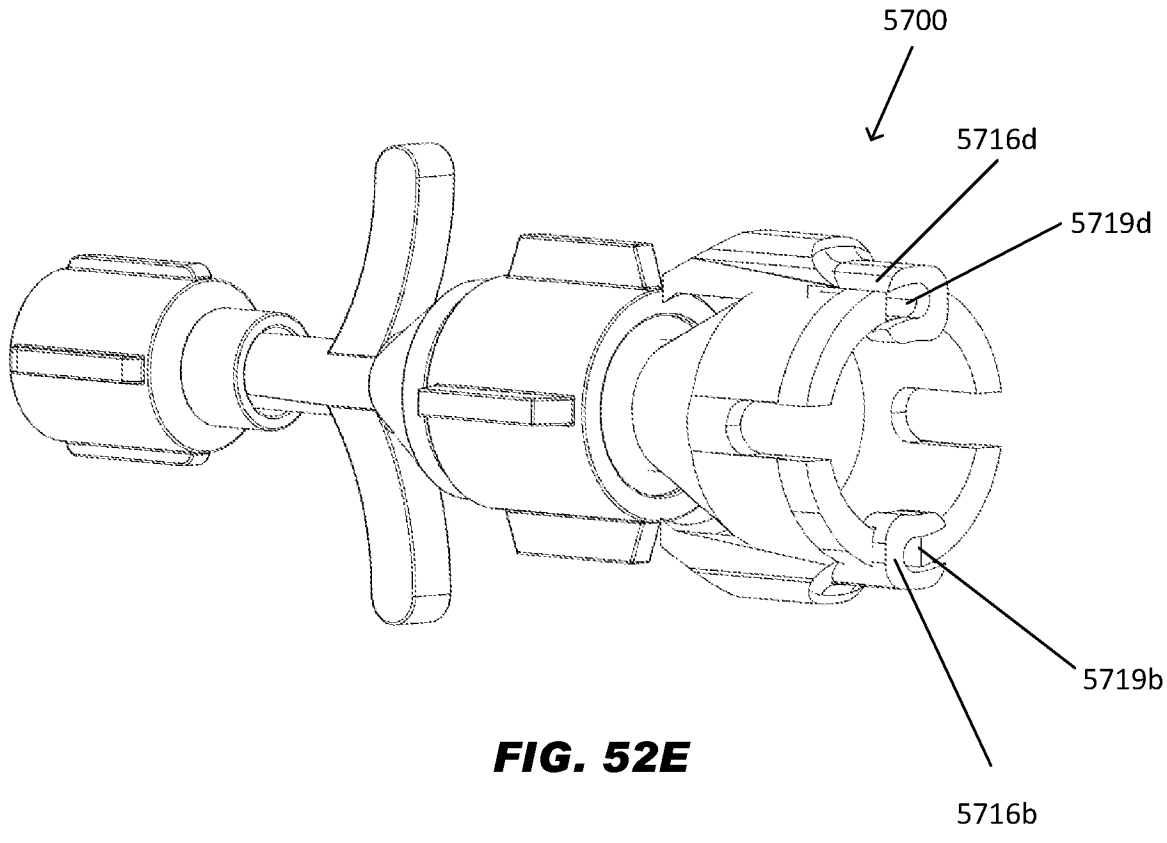


FIG. 52E

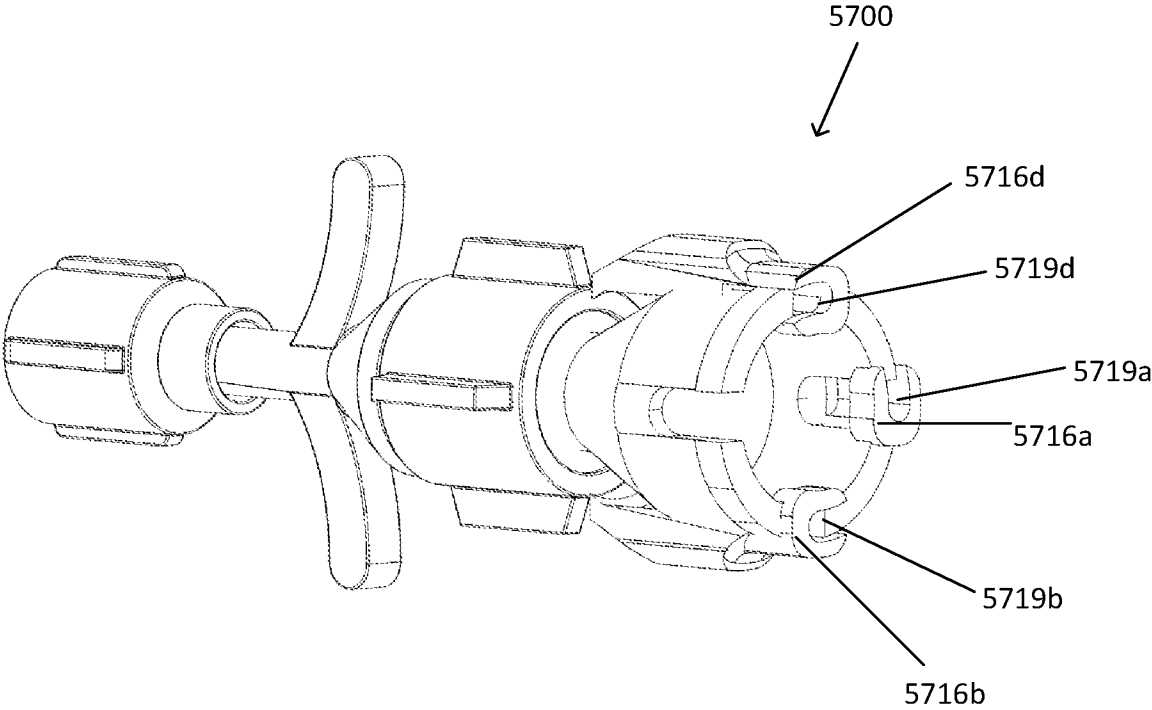


FIG. 52F

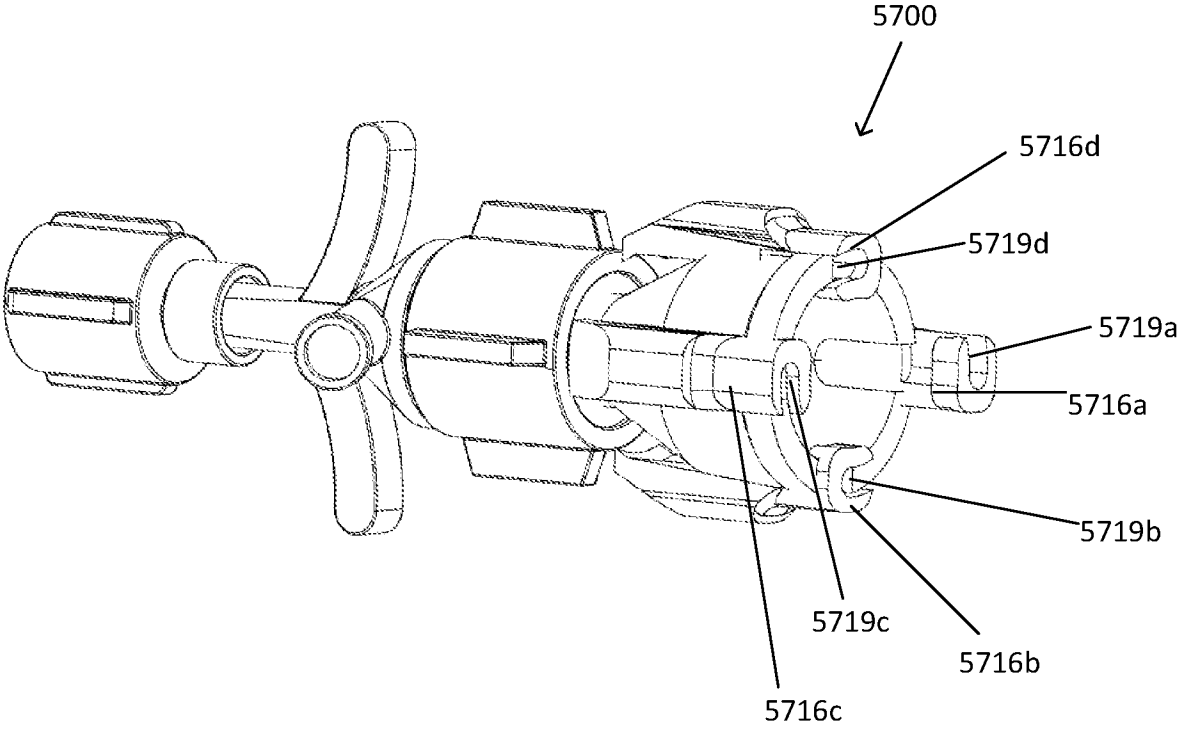


FIG. 52G

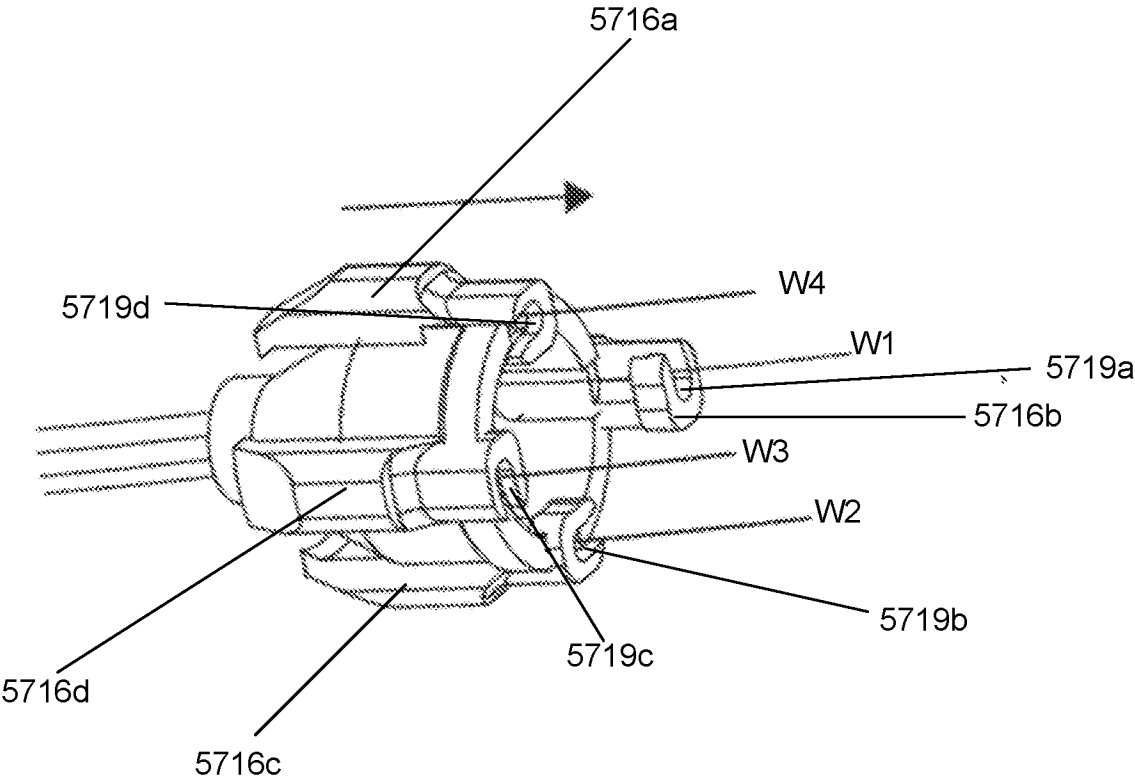


FIG. 52H

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 22/74029

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. A61M 25/01 (2022.01)

ADD. A61M 39/06 (2022.01)

CPC - INV. A61M 25/01, A61M 25/0113, A61M 39/06

ADD. A61M 2025/0004, A61M 2025/0175, A61M 2025/09116, A61M 25/0147, A61M 2039/062

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/0064130 A1 (Carter) 1 April 2004 (01.04.2004), entire document, especially Fig 1, Fig 2, para [0026]-[0027], para [0043]	1-4
A	US 2008/0194913 A1 (Tinkham et al.) 14 August 2008 (14.08.2008), entire document, especially Fig 4, Fig 4A, Fig 4B, Fig 11B, para [0003], para [0047]-[0049], para [0099]	28-30, 36-38, 44-45, 63-65, 73-75, 89-91, 102-105, 111-115, 119-121, 133-135, 139 and 147
A	US 2021/0128888 A1 (Georgia Tech Research Corporation) 6 May 2021 (06.05.2021), entire document, especially Fig 1d, para [0042]-[0043], para [0050]-[0054]	28-30, 36-38, 44-45, 63-65, 73-75, 89-91, 102-105, 111-115, 119-121, 133-135, 139 and 147
A	US 2019/0046781 A1 (Merit Medical Systems Inc) 14 February 2019 (14.02.2019), entire document, especially Fig 1A, Fig 1D, para [0036]-[0038], para [0042], para [0067]	28-30, 36-38, 44-45, 63-65, 73-75, 89-91, 102-105, 111-115, 119-121, 133-135, 139 and 147
A, P	WO 2021/226050 A1 (Stallion Cardio, Inc.) 11 November 2021 (11.11.2021), entire document	1-4, 28-30, 36-38, 44-45, 63-65, 73-75, 89-91, 102-105, 111-115, 119-121, 133-135, 139 and 147

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 October 2022

Date of mailing of the international search report

NOV 21 2022

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Kari Rodriguez

Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 22/74029

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 26-27 and 148-154
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
because they are improper omnibus type claims, not drafted in accordance with Rule 6.2(a).

3. ☒ Claims Nos.: 5-25, 31-35, 39-43, 46-62, 66-72, 76-88, 92-101, 106-110, 116-118, 122-132, 136-138, and
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

.*- see extra sheet -*

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 22/74029

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I: Claims 1-4 directed to a dynamic catheter system with a guide catheter with varying wall thickness and a guide extension catheter within the guide catheter with varying wall thickness.

Group II: Claims 28-30, 36-38, 44-45, 63-65, 73-75, 89-91, 102-105, 111-115, 119-121, 133-135, 139 and 147 directed to a valve and wire control mechanism for a catheter.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

SPECIAL TECHNICAL FEATURES

The invention of Group I includes the special technical feature of a guide catheter comprising a first wall, wherein a first wall thickness of the first wall varies from the proximal end to the distal end; and a guide extension catheter comprising a second wall, wherein the guide extension catheter is positioned within the guide catheter, wherein a second wall thickness of the second wall varies from the proximal end to the distal end, not required by the claims of Groups II.

The invention of Group II includes the special technical features of a valve and a wire control mechanism in communication with the valve, the wire control mechanism comprising a distal end comprising a distal opening, a proximal end comprising a proximal opening, wherein the proximal opening comprises a first portion and a second portion, one or more channels comprising a central channel and an exchange channel extending radially outward from the central channel, a cap comprising a first cutout and a second cutout, a second exchange channel extending radially outward from the central channel, a first door and a second door, a disc comprising a cutout defining three portions, wherein a proximal end of the wire control mechanism comprises a main portion and a plurality of cutouts, a sleeve, a cap comprising a first arm and a second arm, a plurality of sliding components, a liner comprising a bridge portion, and an insert comprising a bridge portion, not required by the claims of Group I.

COMMON TECHNICAL FEATURES

Groups I-II share no common technical features.

Therefore, Groups I-II lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.

*Item 4 (contd): Claims 5-27, 31-35, 39-43, 46-62, 66-72, 76-88, 92-101, 106-110, 116-118, 122-132, 136-138, 140-146, 148-154 have been found to be unsearchable and therefore have not been included with any invention. Specifically: Claims 5-25, 31-35, 39-43, 46-62, 66-72, 76-88, 92-101, 106-110, 116-118, 122-132, 136-138, and 140-146 are not drafted in accordance with the second and third sentences of Rule 6.4(a); Claims 26-27 and 148-154 are improper omnibus type claims, not drafted in accordance with Rule 6.2(a).