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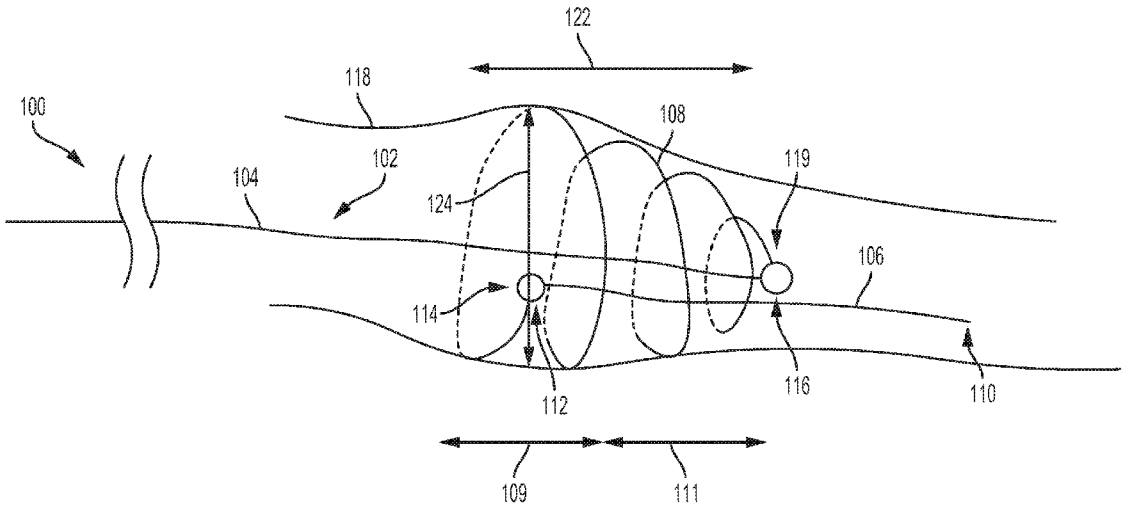

Fig. 1

(57) Abstract: The present disclosure provides an apparatus (100) comprising a guide wire (102) having a non-coiled segment (104), a leading segment (106), and a first expandable segment (108) positioned between the non-coiled segment (104) and the leading segment (106). The first expandable segment (108) has a first end (114) and a second end (116) and is configured to transition between a constrained state and a deployed state. The first end (114) of the first expandable segment (108) is closer to a first end (110) of the leading segment (106) than a second end (116) of the first expandable segment (108) in the constrained state, and a second end (116) of the first expandable segment (108) is closer to the first end (110) of the leading segment (106) than the first end (114) of the first expandable segment (108) in the deployed state.

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Anchoring Guide Wire and Methods for Use Thereof

Related Applications

[1] This application claims the benefit of priority to U.S. Provisional Application No. 62/552,124 entitled "Anchoring Guide Wire and Methods For Use," filed on August 30, 2017, the contents of which are hereby incorporated by reference in their entirety.

Background the Invention

[2] Steerable guide wires known in the art may not achieve active fixation in a lumen in which the guide wires are deployed. In such a configuration, there may be no support for a guide wire in a target vessel having an environment such as an aneurysm. As a result, when a guide catheter is advanced over the guide wire, the guide wire may be pulled out of the target vessel prematurely. This may result in a longer surgery, thereby increasing the time that a patient is subjected to anesthesia, exposing the operating room staff to more radiation, and introducing the patient to more nephrotoxic intravenous contrast, for example. In addition, losing guide wire access to a target vessel may result in the operator not being able to regain access resulting in the patient not having perfusion to a particular end organ as an outcome of the procedure.

Summary of the Invention

[3] The present disclosure is directed to an apparatus that improves anchoring of a steerable guide wire within a branched vessel, for example, by using an anchoring apparatus to anchor a guide wire to the vasculature prior to advancement and deployment of an over-the-wire medical device. By improving the ease by which stent grafts may be placed in vessels (or other lumens, including, but not limited to ducts, orifices, the digestive tract, and/or any other structure having a lumen), the speed and success of complicated cases may increase while lowering complications. For example, anchoring the guide wire to a subject's

vasculature may have a stabilizing effect for the tip of the catheter and afford greater stability and confidence for the operator of an implantable device to be deployed *in vivo*. Once the anchoring apparatus is deployed, the anchor may hold the guide wire in place against the vasculature. One of the benefits of this design is that the anchoring apparatus may allow blood to continue to flow through the anchor and to downstream vasculature. Once anchored, the guide wire may be used in a similar way to a through-wire, which is a guide wire advanced into one access point such as the groin then through and out of a second access point such as the arm. This through-wire can be secured on both ends thereby preventing movement of the through-wire and providing support to the through-wire as the operator is working. This anchoring guide wire may be used for improving the delivery of therapeutic devices such as bare metal stents, covered stents, as well as any other over-the-wire device.

[4] Thus, in a first aspect, the present disclosure provides an apparatus that includes a guide wire having a non-coiled segment, a leading segment, and a first expandable segment positioned between the non-coiled segment and the leading segment, wherein the leading segment includes a first end and a second end, wherein the first expandable segment has a first end and a second end and is configured to transition between a constrained state and a deployed state, wherein the first expandable segment is straight and extends between the first end of the first expandable segment and the second end of the first expandable segment in the constrained state, wherein the first expandable segment has a coiled arrangement configured to exert pressure on a lumen in the deployed state, wherein the first end of the first expandable segment is closer to the first end of the leading segment than the second end of the first expandable segment in the constrained state, and wherein the second end of the first expandable segment is closer to the first end of the leading segment than the first end of the first expandable segment in the deployed state.

[5] In a second aspect, the present disclosure provides a method that includes: (a) introducing an apparatus according to the first aspect into a lumen via arterial access, wherein the guide wire is disposed in a catheter such that a first expandable segment is in the constrained state, and (b) transitioning the first expandable segment from the constrained state to the deployed state, thereby anchoring the guide wire in the lumen.

[6] These as well as other aspects, advantages, and alternatives, will become apparent to those of ordinary skill in the art by reading the following detailed description, with reference where appropriate to the accompanying drawings.

Brief Description of the Drawings

[7] Figure 1 is a perspective view of a guide wire in a deployed state, according to an example embodiment.

[8] Figure 2 is a perspective view of the guide wire of Figure 1 in a constrained state, according to an example embodiment.

[9] Figure 3 is a perspective view of another guide wire in a deployed state, according to an example embodiment.

[10] Figure 4 is a perspective view of the guide wire of Figure 3 in a constrained state, according to an example embodiment.

[11] Figure 5 is a side view of a guide wire disposed within a catheter, in accordance with one embodiment of the invention.

[12] Figure 6 is a flow chart depicting functions that can be carried out in accordance with example embodiments of the disclosed methods.

Detailed Description of the Invention

[13] The description of the different advantageous arrangements are presented for purposes of illustration and description, and are not intended to be exhaustive or limited to the examples in the form disclosed. Many modifications and variations will be apparent to

those of ordinary skill in the art. Further, different examples may provide different advantages as compared to other examples. The example or examples selected are chosen and described in order to best explain the principles of the examples, the practical application, and to enable those of ordinary skill in the art to understand the disclosure for various examples with various modifications as are suited to the particular use contemplated.

[14] As used herein, with respect to measurements, "about" means +/- 5 %.

[15] As used herein, "coupled" means associated directly, as well as indirectly. For example, a member A may be directly associated with a member B, or may be indirectly associated therewith, e.g., via another member C. It will be understood that not all relationships among the various disclosed elements are necessarily represented.

[16] Unless otherwise indicated, the terms "first," "second," etc. are used herein merely as labels, and are not intended to impose ordinal, positional, or hierarchical requirements on the items to which these terms refer. Moreover, reference to, e.g., a "second" item does not require or preclude the existence of, e.g., a "first" or lower-numbered item, and/or, e.g., a "third" or higher-numbered item.

[17] Reference herein to "one embodiment" or "one example" means that one or more features, structures, or characteristics described in connection with the example are included in at least one implementation. The phrases "one embodiment" or "one example" in various places in the specification may or may not be referring to the same example.

[18] As used herein, apparatus, element and method "configured to" perform a specified function is indeed capable of performing the specified function without any alteration, rather than merely having potential to perform the specified function after further modification. In other words, the apparatus, element, and method "configured to" perform a specified function is specifically selected, created, implemented, utilized, programmed, and/or designed for the purpose of performing the specified function. As used herein,

"configured to" denotes existing characteristics of an apparatus, element, and method which enable the apparatus, element, and method to perform the specified function without further modification. For purposes of this disclosure, an apparatus, element, and method described as being "configured to" perform a particular function may additionally or alternatively be described as being "adapted to" and/or as being "operative to" perform that function.

[19] As used herein, a "catheter" is an apparatus that is connected to a deployment mechanism and is configured to house a prosthetic device that can be delivered over a guide wire. The catheter may include a guide wire lumen for over-the-wire guidance and may be used for delivering the medical device to a target lumen.

[20] As used herein, a "guide wire" is an elongated cable comprised of one or more biocompatible materials including metals and polymers. Guide wires may be used for selecting target lumens and guiding catheters to target deployment locations. Guide wires are typically defined as wires used independently of other devices that do not come as part of an assembly.

[21] As used herein, "lumen" refers to a passage within an arterial or tubular structure, such as the pulmonary arteries or a passage within the tubular housings or catheters through which a guide wire may be disposed.

[22] As used herein, "first end" refers to the end of the apparatus that will be a "distal end" upon deployment *in vivo*.

[23] As used herein, "second end" refers to the end of the apparatus that will be a "proximal end" upon deployment *in vivo*.

[24] As used herein, "constrained state" refers to when the apparatus is disposed in a catheter and is substantially straight.

[25] As used herein, "deployed state" refers to when the apparatus has been positioned in the target lumen and is unsheathed from the catheter and is actively being expanded. The apparatus has a greater diameter in the deployed state than in the constrained state.

[26] With reference to the Figures, Figure 1 illustrates an apparatus 100 including a guide wire 102 having a non-coiled segment 104, a leading segment 106, and a first expandable segment 108 positioned between the non-coiled segment 104 and the leading segment 106. The leading segment 106 has a first end 110 and a second end 112. The first expandable segment 108 has a first end 114 and a second end 116 and is configured to transition between a constrained state (shown in Figure 2) and a deployed state (shown in Figure 1). The circles shown at the first end 114 and the second end 116 of the expandable segment 108 are for illustrative purposes only. As such, the guide wire 102 may be a continuous wire including the non-coiled segment 104, leading segment 106, and first expandable segment 108. As shown in Figure 2, the first expandable segment 108 is straight and extends between the first end 114 of the first expandable segment 108 and the second end 116 of the first expandable segment 108 in the constrained state. As shown in Figure 1, the first expandable segment 108 has a coiled arrangement configured to exert pressure on a lumen 118 in the deployed state. The first end 114 of the first expandable segment 108 is closer to the first end 110 of the leading segment 106 than the second end 116 of the first expandable segment 108 in the constrained state (as shown in Figure 2), and the second end 116 of the first expandable segment 108 is closer to the first end 110 of the leading segment 106 than the first end 114 of the first expandable segment 108 in the deployed state (as shown in Figure 1).

[27] In one particular example, the first end 110 of the leading segment 106 comprises a distal end of the guide wire 102, the first end 114 of the first expandable segment 108 is located distal to the second end 116 of the first expandable segment 108 in the constrained

state, and the first end 114 of the first expandable segment 108 is located proximal to the second end 116 of the first expandable segment 108 in the deployed state. As such, the distal first end 114 of the first expandable segment 108 is not the most distal portion of the first expandable segment 108 when the apparatus 100 is in the deployed state, as shown in Figure 1.

[28] The non-coiled segment 104, the first expandable segment 108, and the leading segment 106 may generally be co-axial and constructed of a single wire with a thickness in the range of about 0.254 mm to about 1.016 mm. The length of the leading segment 106 has a length in a range from about 2 mm to about 200 mm. In some embodiments, the total length of the guide wire 102 may range from about 100 cm to about 500 cm, and preferably from about 100 cm to about 300 cm. The guide wire 102 may comprise a shape memory wire, for example, nitinol (nickel-titanium), titanium, titanium alloys, copper-aluminum-nickel alloys, various plastics, or any other suitable material capable of retaining shape memory.

[29] As discussed above, the first expandable segment 108 may be configured to exist in one of two different states: a constrained state (as shown in Figure 2) and a deployed state (as shown in Figure 1). As shown in Figures 1 and 2, the first expandable segment 108 is substantially straight in the constrained state and has a coiled arrangement in the deployed state. As such, the effective diameter of the guide wire 102 increases in the deployed state. In one embodiment, in the constrained state, the first expandable segment 108 is substantially non-coiled and is disposed within a catheter 120, as discussed in additional detail below. And in the deployed state, the first expandable segment 108 has a coiled arrangement configured to exert pressure against the walls 118 of the vessel or lumen 119 into which the apparatus 100 is introduced.

[30] In some embodiments, when in the deployed state, the coiled arrangement of the first expandable segment 108 may exert a pressure against the walls 118 of the target vessel or lumen 119 that may range from about 0.25 ATM to about 3.0 ATM, and preferably from about 0.5 ATM to about 1.5 ATM. The pressure exerted by the first expandable section 108 against the walls 118 of the target vessel or lumen 119 should be substantially small such that the pressure does not cause a dissection in the walls 118 of the target vessel or lumen 119 but large enough that the first expandable section 108 provides an adequate amount of anchorage so that the guide wire 102 does not slip out of the target vessel or lumen 119. In the deployed state, coiled arrangement of the first expandable segment 108 may have a length 122 in the range of about 10 mm to about 100 mm, and an expanded diameter 124 in the range of about 1 mm to about 80 mm, where the expanded diameter corresponds to the largest effective diameter of the coiled arrangement. In one example, the expanded diameter 124 of the coiled arrangement of the first expandable segment 108 in the deployed state may be approximately 20 percent larger than a diameter of the target vessel or lumen 119 in which the apparatus 100 is deployed.

[31] In some arrangements, different portions of the first expandable segment 108 may exert different pressures on the lumen 118. For instance, one portion 109 of the first expandable segment 108 may be a more tightly-wound coil and thereby exert more pressure against the wall 118 of the target vessel or lumen than other portions 111 of the first expandable segment 108. In another arrangement, coils of one portion 109 of the first expandable segment 108 may have a larger effective diameter and may therefore exert more pressure on the wall 118 of the target vessel or lumen than coils of another portion 111 of the first expandable segment 108. In another arrangement, one portion 109 of the guidewire forming part of the first expandable segment 108 may have a greater diameter that may exert more pressure against the wall 118 of the target vessel or lumen than other portions 111 of

the first expandable segment 108. In still another arrangement, coils of one portion 109 of the first expandable segment 108 may be at a different pitch than coils of another portion 111 of the first expandable segment 108. Thus, one portion of the first expandable segment 108 may exert a different pressure against the wall 118 of the target vessel or lumen than other portions. However, in other arrangements, each portion of the first expandable segment 108 may exert substantially the same pressure against the wall 118 of the target vessel or lumen as the other portions.

[32] The leading segment 106 may extend beyond the first expandable segment 108 in order to help guide the anchoring apparatus 100 (while in the constrained state) through the target lumen 119 to a suitable deployment position. Additionally, the leading segment 106 may be shaped or constructed in such a way as to mitigate inadvertent injury to portions of the walls 118 of the target vessel or lumen 119 with which the leading segment 106 comes into contact. For instance, the distal first end 110 of the leading segment 106 may be rounded or smoothed. Additionally or alternatively, the leading segment 106 may be constructed of a different material than the rest of the guide wire 102, such as a conformable material that is less stiff than the other portions of the apparatus 100 (e.g., less stiff than both the non-coiled segment 104 and the first expandable segment 108), or less stiff than other, traditional *in vivo* materials. As such, the leading segment 106 may be considered "atraumatic."

[33] The leading segment 106 may also beneficially be substantially straight, making loading the guide wire 102 into a catheter 120 easier. The substantially straight leading segment 106 allows the operator loading the guide wire 102 into a catheter 120 to get the guide wire 102 started in the catheter 120 before trying to advance the first expandable segment 108. The leading segment 106 also makes advancing the guide wire 102 through the catheter 120 easier. If the terminal extent of the leading segment 106 were coiled, the coiled nature would push the tip of the guide wire 102 into the inner surface of the catheter 120

making advancement of the guide wire 102 challenging. Instead, the substantially straight leading segment 106 enables the operator to more easily advance the guide wire 102 to the desired location. The leading segment 106 remains substantially straight even when the guide wire 102 is in the deployed state, unless the wall 118 of a target vessel or lumen 119 is acting upon the leading segment 106. As such, the leading segment 106 need not be constructed from a shape memory material. In some examples, the leading segment 106 may extend beyond the first expandable segment 108 at a length of about 2 mm to about 200 mm, and preferably extend a length of about 3 mm to about 50 mm.

[34] In another example, as shown in Figures 3 and 4, the guide wire 102 may further include a second expandable segment 126 positioned between the non-coiled segment 104 and the first expandable segment 108. The second expandable segment 126 may be configured to transition between a constrained state (shown in Figure 4) and a deployed state (shown in Figure 3) similar to the first expandable segment 108. As such, the second expandable segment 126 may have a first end 128 and a second end 130 and is configured to transition between a constrained state and a deployed state. The circles shown at the first end 114 and the second end 116 of the expandable segment 108 as well as the circles shown at the first end 128 and the second end 130 of the second expandable segment 126 are for illustrative purposes only. As such, the guide wire 102 may be a continuous wire including the non-coiled segment 104, leading segment 106, first expandable segment 108, and second expandable segment 126. As shown in Figure 4, the second expandable segment 126 is straight and extends between the first end 128 of the second expandable segment 126 and the second end 130 of the second expandable segment 126 in the constrained state. As shown in Figure 3, the second expandable segment 126 is arranged as a coiled wire configured to exert pressure on a wall 118 of the target vessel or lumen 119 in the deployed state. The first end 128 of the second expandable segment 126 is closer to the first end 110 of the leading

segment 106 than the second end 130 of the second expandable segment 126 in the constrained state, and the second end 130 of the second expandable segment 126 is closer to the first end 110 of the leading segment 106 than the first end 128 of the second expandable segment 126 in the deployed state.

[35] In the constrained state, the second expandable segment 126 may be disposed within a catheter 120. In one embodiment, the second expandable segment 126 is arranged as a second coiled wire configured to exert pressure on the walls 118 of the target vessel or lumen 119 in which the apparatus 100 is disposed. In some embodiments, the first expandable segment 108 and the second expandable segment 126 are arranged to exert the same pressure on a wall 118 of the target vessel or lumen 119; however, in other embodiments, the first expandable segment 108 is arranged to exert a different pressure on the wall 118 of the target vessel or lumen 119 than the second expandable segment 126. In one example, the first expandable segment 108 is arranged to exert a greater pressure on the wall 118 of the target vessel or lumen 119 than the second expandable segment 126. In another example, the second expandable segment 126 is arranged to exert a greater pressure on the wall 118 of the target vessel or lumen 119 than the first expandable segment 108. Other examples are possible as well.

[36] Figure 5 illustrates the apparatus 100 disposed within a catheter 120. In order to transition between the constrained state and the deployed state, a catheter 120 may be slid backward toward the non-coiled segment 104, thereby exposing the first expandable segment 108 to the vasculature and allowing the first expandable segment 108 to expand and coil thereby exerting an outward force on the walls 118 of the target vessel or lumen 119. In an alternate implementation, the guide wire 102 may be pushed through the catheter 120 to advance and expose the first expandable segment 108 in the same way. Likewise, in order to transition from the deployed state to the constrained state, the catheter 120 may be pushed

back over the first expandable segment 108; or, alternatively, the first expandable segment 108 pulled back through the catheter 120. In yet another example, the first expandable segment 108 is configured to transition between the constrained state and the deployed state by simultaneously sliding the first expandable segment 108 out of the catheter 120 and sliding the catheter 120 over the first expandable segment 108.

[37] In some embodiments, the catheter 120 comprises a delivery catheter portion 132 and an interface catheter portion 134. The delivery catheter portion 132 may be shaped or constructed in such a way as to mitigate inadvertent injury to portions of the lumen 118 with which the delivery catheter portion 132 comes into contact. For instance, the tip of the delivery catheter portion 132 may be rounded or smoothed, as shown in Figure 5. Additionally or alternatively, the delivery catheter portion 132 may be constructed of a conformable material that is less stiff than other portions of the apparatus 100, or less stiff than other, traditional *in vivo* materials. The first expandable segment 108 and the leading segment 106 may be disposed within the interface catheter portion 134.

[38] Before use, the non-coiled segment 104 may be positioned within a housing 136. The housing 136 may be a plastic material, for example. The housing 136 may be coupled to the interface catheter 134 via a locking/unlocking hub 138. In operation, the interface catheter 134 may be coupled to the delivery catheter 132 via complementary luer-lock connectors 140A, 140B, as an example. Other example connectors are possible as well, such as a threaded connector, or some other type of connector. Once the interface catheter 134 is coupled to the delivery catheter 132, the housing 136 may be decoupled from the locking/unlocking hub 138 and removed from surrounding the non-coiled segment 104 of the guide wire 102. Once the interface catheter 134 is connected to the delivery catheter 132 and the housing 136 is removed, a valve 142 on the leading edge of the interface catheter 134 can be opened allowing the operator to manipulate the non-coiled segment 104 of the guide wire

102 to thereby advance the guide wire 102 through the interface catheter 134 and into the delivery catheter 132.

[39] In accordance with one embodiment, in order to introduce the apparatus 100 into the lumen 119, first a standard guide wire may be introduced into the lumen 119 via arterial access. Then, the delivery catheter 132 may be advanced into the lumen 119 over the standard guide wire until the delivery catheter 132 is in a desired location. At this point, the standard guide wire may be removed. Next, the interface catheter 134 may be coupled to an *ex vivo* end of the delivery catheter 132 (however, in some embodiments, the interface catheter 134 may already be coupled to the delivery catheter 132 at this point). The first expandable segment 108 and the leading segment 106 of the guide wire 102 are then advanced through the interface catheter 134 and the delivery catheter 132, thereby deploying the first expandable segment 108 in a desired location in the lumen 119. The delivery catheter 132 is removed from the lumen 119 leaving the guide wire 102 in position. A therapeutic and/or implantable device, such as a stent along with its delivery catheter, is then advanced over the non-coiled segment 104 of the guide wire to a desired treatment location. It will be appreciated that other arrangements are possible as well, including some arrangements that involve more or fewer steps than those described above, or steps in a different order than those described above.

[40] Figure 6 is a simplified flow chart illustrating a method 200 according to an exemplary embodiment. Although the blocks are illustrated in a sequential order, these blocks may also be performed in parallel, and/or in a different order than those described herein. Also, the various blocks may be combined into fewer blocks, divided into additional blocks, and/or removed based upon the desired implementation.

[41] At block 202, the method 200 includes introducing the apparatus 100 according to any of the embodiments described above into a lumen 119 via arterial access, where the guide

wire 102 is disposed in a catheter 120 such that the first expandable segment 108 is in the constrained state. At block 204, the method 200 includes transitioning the first expandable segment 108 from the constrained state to the deployed state, thereby anchoring the guide wire 102 in the lumen 119. As described above, transitioning the first expandable segment 108 from the constrained state to the deployed state may include sliding the first expandable segment 108 out of the catheter 120; or, alternatively or simultaneously, sliding the catheter 120 back over the first expandable segment 108. As the first expandable segment 108 becomes exposed in the deployed state, the first expandable segment 108 may coil and expand due to shape memory, thereby exerting pressure on the lumen 119. The pressure exerted on the lumen 119 in the expanded state where the first expandable segment 108 comes into contact with the lumen 119 may range from about 0.25 ATM to about 3.0 ATM. As further described above, the first expandable segment 108 may exert a graduated pressure on the lumen 119 such that a first portion 109 of the first expandable segment 108 exerts a different pressure than a second portion 111 of the first expandable segment 108. In an alternate embodiment, each portion of the first expandable segment 108 may exert substantially the same pressure on the lumen 119.

[42] In one example, transitioning the first expandable segment 108 from the constrained state to the deployed state comprises sliding the first expandable segment 108 out of the catheter 120 and expanding the first expandable segment 108 due to shape memory. In one example, the method further comprises transitioning the first expandable segment 108 from the deployed state to the constrained state. In such an embodiment, transitioning the first expandable segment 108 from the deployed state to the constrained state may comprise sliding the catheter 120 back over the first expandable segment 108 and returning the first expandable segment 108 to a substantially non-coiled arrangement.

[43] In another example, the guide wire 102 further comprises a second expandable segment 126 positioned between the non-coiled segment 104 and the first expandable segment 106, the second expandable segment 126 being configured to transition between a constrained state and a deployed state, where in the deployed state the second expandable segment 126 is arranged as a second coiled wire. In such an example, the method 200 may further comprise exerting a graduated pressure on the walls 118 of the target vessel or lumen 119 via coils of the second expandable segment 126 in the deployed state such that a first portion 127 of the second expandable segment 126 exerts a different pressure than a second portion 129 of the second expandable segment 126.

[44] In one example, introducing the apparatus 100 into the lumen 119 comprises introducing a delivery catheter 132 into a lumen 119 via arterial access, the delivery catheter 132 being coupled to an interface catheter 134 having disposed therein the guide wire 102 comprising a non-coiled segment 104, a first expandable segment 108, and a leading segment 106. In such an example, the interface catheter 134 may be coupled to the delivery catheter 132 via a luer-lock connector 140A, 140B, a threaded connector, or some other type of connector. Once the interface catheter 134 is connected to the delivery catheter 132, a valve 142 on the leading edge of the interface catheter 134 can be opened allowing the guide wire 102 to be advanced through the interface catheter 134 and into the delivery catheter 132.

[45] The method 200 may further include removing the catheter 120 from the lumen 119 while leaving the guide wire 102 behind, and introducing a therapeutic and/or implantable device, such as a stent, over the non-coiled segment 104 of the guide wire 102 to a desired treatment location.

[46] In the above description, numerous specific details are set forth to provide a thorough understanding of the disclosed concepts, which may be practiced without some or all of these particulars. In other instances, details of known devices and/or processes have

been omitted to avoid unnecessarily obscuring the disclosure. While some concepts were described in conjunction with specific examples, it will be understood that these examples are not intended to be limiting.

Claims

1. An apparatus comprising:

a guide wire having a non-coiled segment, a leading segment, and a first expandable segment positioned between the non-coiled segment and the leading segment, wherein the leading segment includes a first end and a second end, wherein the first expandable segment has a first end and a second end and is configured to transition between a constrained state and a deployed state, wherein the first expandable segment is straight and extends between the first end of the first expandable segment and the second end of the first expandable segment in the constrained state, wherein the first expandable segment has a coiled arrangement configured to exert pressure on walls of a lumen in the deployed state, wherein the first end of the first expandable segment is closer to the first end of the leading segment than the second end of the first expandable segment in the constrained state, and wherein the second end of the first expandable segment is closer to the first end of the leading segment than the first end of the first expandable segment in the deployed state.

2. The apparatus of claim 1, wherein the guide wire has a thickness in the range from about 0.254 mm to about 1.016 mm.

3. The apparatus of any of claims 1-2, wherein the leading segment has a length in a range from about 2 mm to about 200 mm.

4. The apparatus of any of claims 1-3, wherein the guide wire has a length in a range from about 100 cm to about 500 cm.

5. The apparatus of any of claims 1-4, wherein a length of the coiled arrangement of the first expandable segment in the deployed state ranges from about 10 mm to about 100 mm.

6. The apparatus of any of claims 1-5, wherein a diameter of the coiled arrangement of the first expandable segment in the deployed state ranges from about 1 mm to about 80 mm.

7. The apparatus of any of claims 1-6, wherein the leading segment is substantially straight in both the constrained state and the deployed state.

8. The apparatus of any of claims 1-7, wherein the leading segment has a stiffness that is less than a stiffness of the non-coiled segment and a stiffness of the first expandable segment.

9. The apparatus of any of claims 1-8, wherein the first end of the leading segment is rounded.

10. The apparatus of any of claims 1-9, wherein, in the deployed state, the coiled arrangement of the first expandable segment exert pressure on the lumen in a range from about 0.25 ATM to about 3.0 ATM.

11. The apparatus of any of claims 1-10, wherein, in the deployed state, a first portion of the coiled arrangement of the first expandable segment has a larger diameter than a second portion of the coiled arrangement of the first expandable segment such that the first

portion of the coiled arrangement of the first expandable segment is configured to exert a different pressure on the walls of the lumen than the second portion the coiled arrangement of of the first expandable segment.

12. The apparatus of any of claims 1-10, wherein a first portion of the first expandable segment has a guide wire diameter that is greater than a guide wire diameter for a second portion of the first expandable segment such that the first portion of the first expandable segment is configured to exert a different pressure on the walls of the lumen than the second portion of the first expandable segment.

13. The apparatus of any of claims 1-10, wherein in the deployed state a first portion of the coiled arrangement of the first expandable segment has a first pitch, and wherein in the deployed state a second portion of the coiled arrangement of the first expandable segment have a second pitch that is different than the first pitch such that the first portion of the first expandable segment is configured to exert a different pressure on the walls of the lumen than the second portion of the first expandable segment.

14. The apparatus of any of claims 1-13, wherein the guide wire further comprises a second expandable segment positioned between the non-coiled segment and the first expandable segment, wherein the second expandable segment has a first end and a second end and is configured to transition between a constrained state and a deployed state, wherein the second expandable segment is straight and extends between the first end of the second expandable segment and the second end of the second expandable segment in the constrained state, wherein the second expandable segment has a coiled arrangement configured to exert pressure on walls of a lumen in the deployed state, wherein the first end of the second

expandable segment is closer to the first end of the leading segment than the second end of the second expandable segment in the constrained state, and wherein the second end of the second expandable segment is closer to the first end of the leading segment than the first end of the second expandable segment in the deployed state.

15. The apparatus of any of claims 1-14, wherein the first expandable segment comprises a shape memory wire.

16. The apparatus of claim 15, wherein the shape memory wire comprises nitinol, titanium, titanium alloys, or copper-aluminum-nickel alloys.

17. The apparatus of any of claims 1-16, wherein the first expandable segment in a constrained state is disposed within a catheter.

18. The apparatus of any of claims 1-17, wherein the first end of the leading segment comprises a distal end of the guide wire, wherein the first end of the first expandable segment is located distal to the second end of the first expandable segment in the constrained state, and wherein the first end of the first expandable segment is located proximal to the second end of the first expandable segment in the deployed state.

19. A method comprising:

introducing an apparatus according to any of claims 1-18 into a lumen via arterial access, wherein the guide wire is disposed in a catheter such that a first expandable segment is in the constrained state; and

transitioning the first expandable segment from the constrained state to the deployed state, thereby anchoring the guide wire in the lumen.

20. The method of claim 19, wherein, in the deployed state, the first expandable segment exerts pressure on walls of the lumen.

21. The method of any of claims 19-20, wherein transitioning the first expandable segment from the constrained state to the deployed state comprises sliding the first expandable segment out of the catheter and expanding the first expandable segment due to shape memory.

22. The method of any of claims 19-21, further comprising:

transitioning the first expandable segment from the deployed state to the constrained state.

23. The method of claim 22, wherein transitioning the first expandable segment from the deployed state to the constrained state comprises sliding the catheter over the first expandable segment and returning the first expandable segment to a substantially non-coiled arrangement.

24. The method of any of claims 19-23, wherein introducing the apparatus according to any of claims 1-19 into a lumen via arterial access comprises:

introducing a delivery catheter into a lumen via arterial access, the delivery catheter being coupled to an interface catheter having disposed therein the apparatus according to any of claims 1-19.

25. The method of claim 24, wherein transitioning the first expandable segment from the constrained state to a deployed state comprises at least one of:

sliding the first expandable segment through the interface catheter, through the delivery catheter, and out of the delivery catheter, and

retracting the interface catheter and the delivery catheter over the first expandable segment.

26. The method of any of claims 19-25, further comprising:

exerting pressure on the lumen via the coiled arrangement of the first expandable segment in the deployed state, the pressure being in a range from about 0.25 ATM to about 3.0 ATM.

27. The method of any of claims 19-26, further comprising:

exerting a graduated pressure on the walls of the lumen via the coiled arrangement of the first expandable segment in the deployed state such that a first portion of the first expandable segment exerts a different pressure than a second portion of the first expandable segment.

28. The method of any of claims 19-27, wherein the guide wire further comprises a second expandable segment positioned between the non-coiled segment and the first expandable segment, the second expandable segment being configured to transition between a constrained state and a deployed state, wherein in the deployed state the second expandable segment has a coiled arrangement, the method further comprising:

exerting a graduated pressure on the walls of the lumen via the coiled arrangement of the second expandable segment in the deployed state such that a first portion of the second expandable segment exerts a different pressure than a second portion of the second expandable segment.

29. The method of any of claims 19-28, further comprising:

removing the catheter from the lumen; and

introducing a therapeutic device over the non-coiled segment via the lumen.

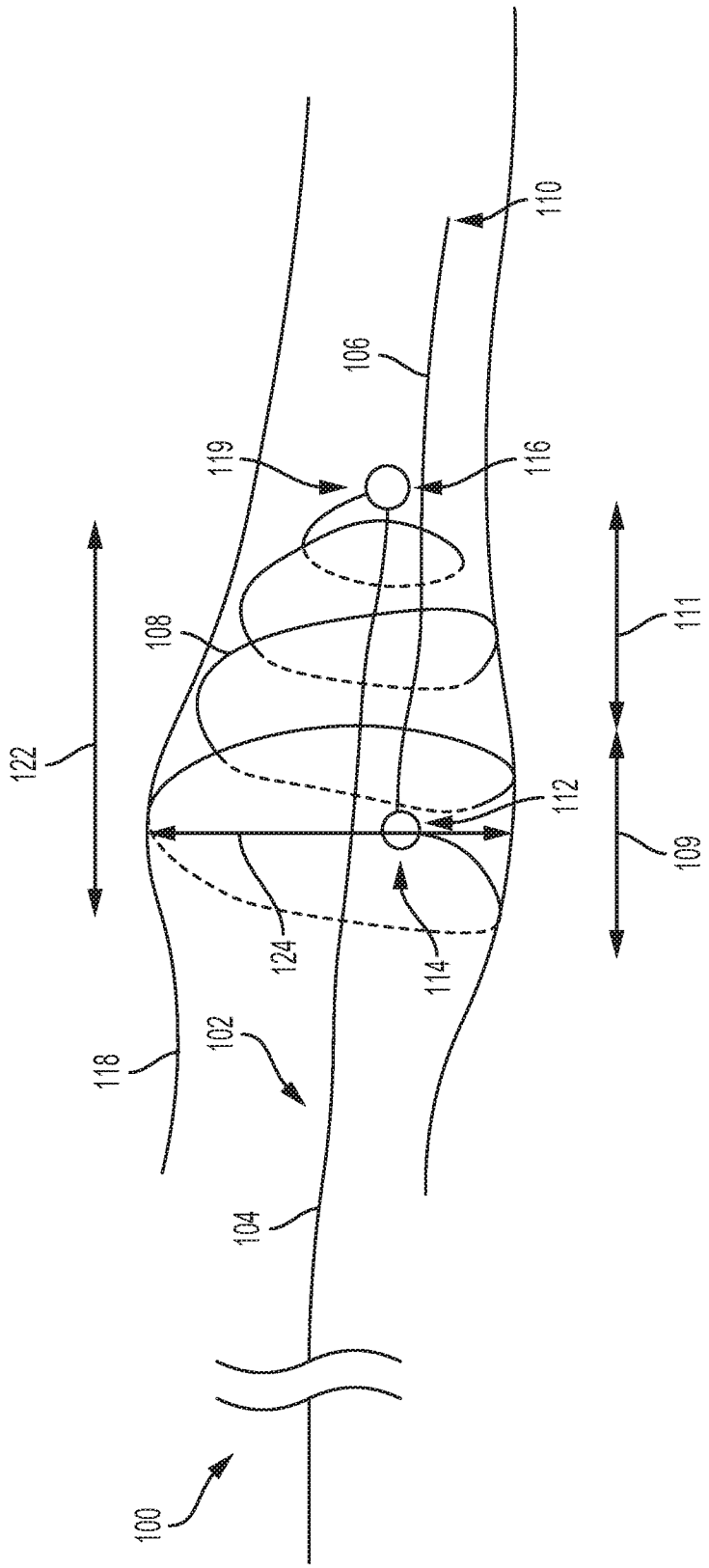
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Fig. 1

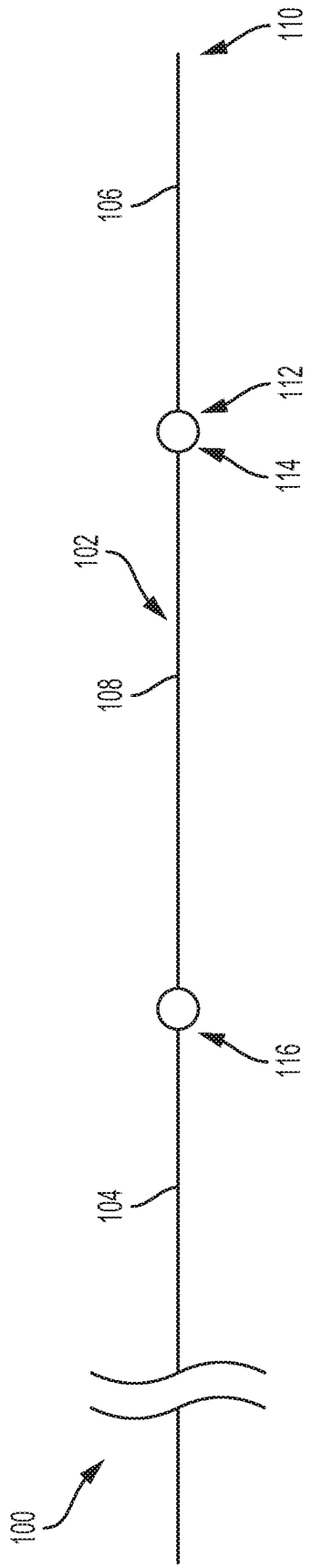
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Fig. 2

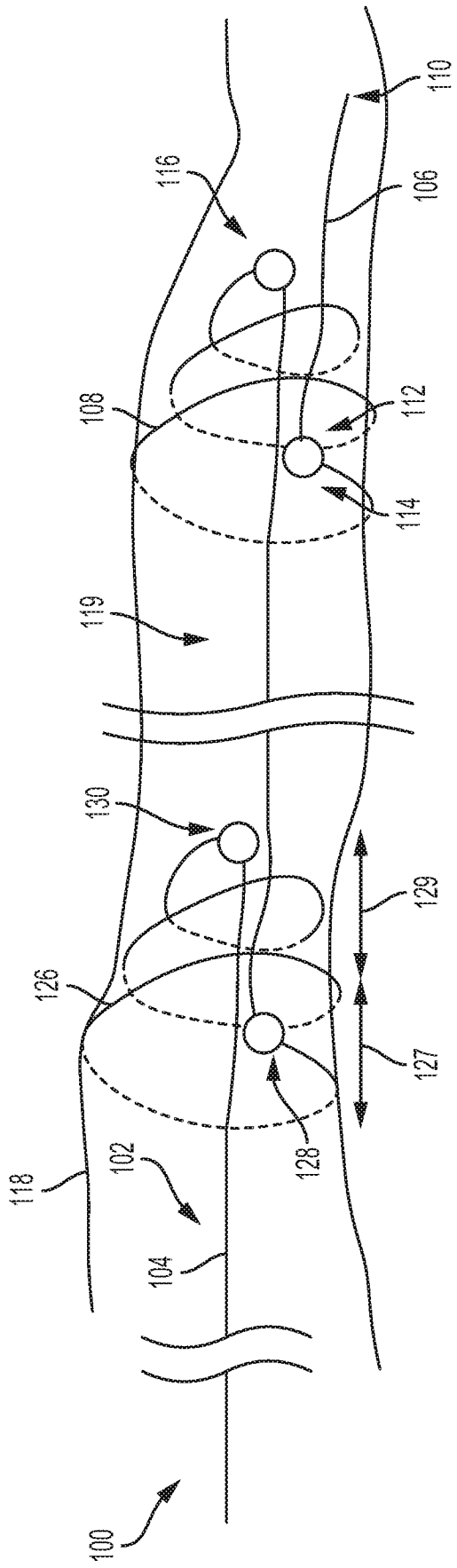
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Fig. 3

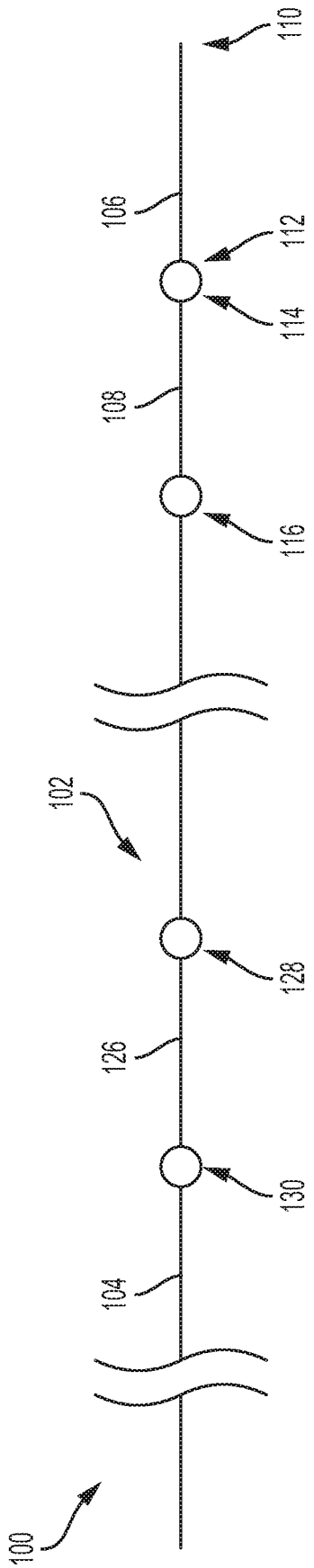
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Fig. 4

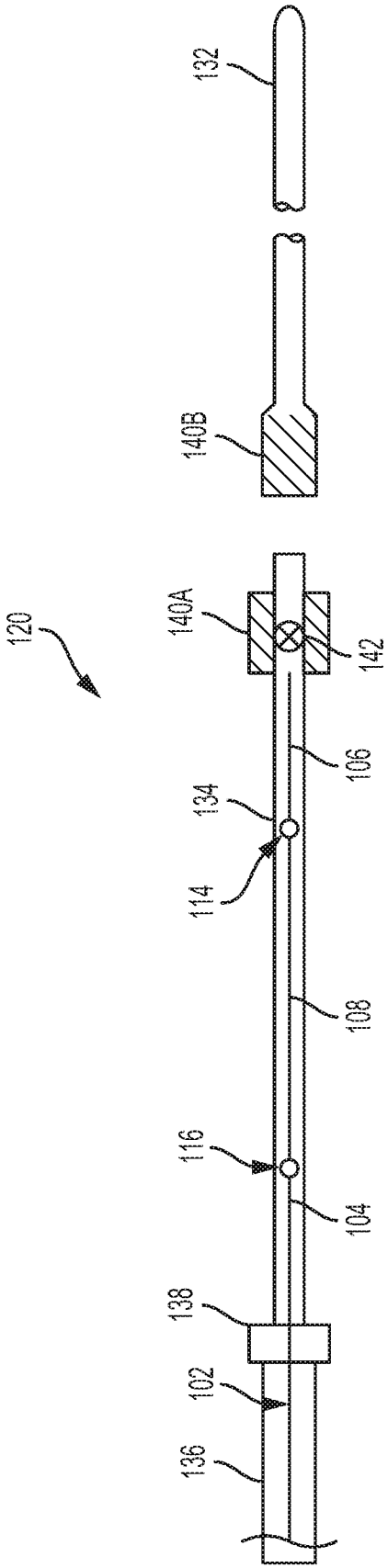
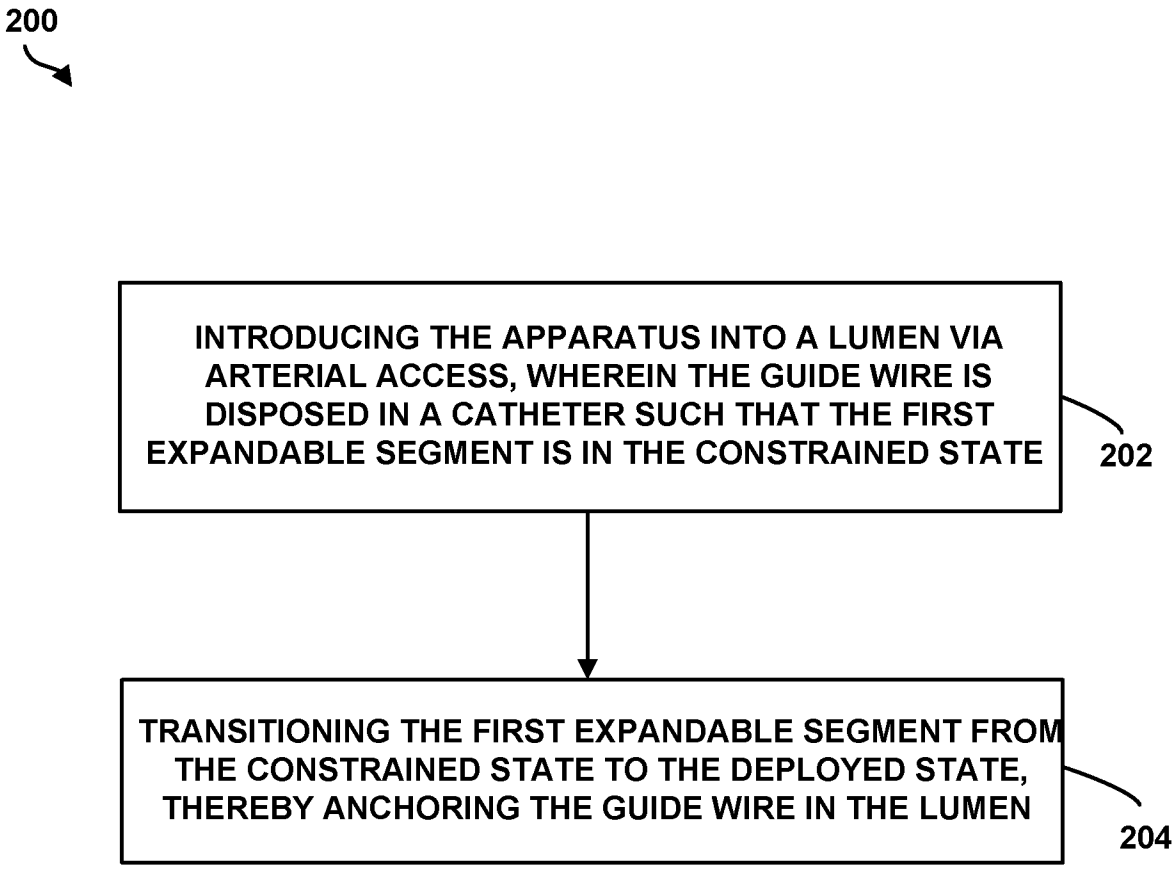


Fig. 5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INTRODUCING THE APPARATUS INTO A LUMEN VIA ARTERIAL ACCESS, WHEREIN THE GUIDE WIRE IS DISPOSED IN A CATHETER SUCH THAT THE FIRST EXPANDABLE SEGMENT IS IN THE CONSTRAINED STATE
202
TRANSITIONING THE FIRST EXPANDABLE SEGMENT FROM THE CONSTRAINED STATE TO THE DEPLOYED STATE, THEREBY ANCHORING THE GUIDE WIRE IN THE LUMEN
204

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/048422

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M25/09
ADD.

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)
A61M

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 516 718 A (QUEEN ELIZABETH HOSPITAL KING S LYNN NHS FOUNDATION TRUST [GB]) 4 February 2015 (2015-02-04) the whole document	1-18
A	US 2016/101267 A1 (KELLY PATRICK W [US]) 14 April 2016 (2016-04-14) the whole document	1-18
E	WO 2018/183191 A1 (BOSTON SCIENT SCIMED INC [US]) 4 October 2018 (2018-10-04) page 6, lines 4-13; figures 2B, 2C	1-18

☐ 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

"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	Date of mailing of the international search report
28 November 2018	10/12/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rodrigues, Elodie

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2018/048422

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2516718 A	04-02-2015	GB 2516718 A	04-02-2015
		WO 2015015203 A1	05-02-2015
US 2016101267 A1	14-04-2016	AU 2015332550 A1	23-03-2017
		CA 2962811 A1	21-04-2016
		EP 3206743 A1	23-08-2017
		JP 2017534314 A	24-11-2017
		US 2016101267 A1	14-04-2016
		WO 2016061213 A1	21-04-2016
WO 2018183191 A1	04-10-2018	US 2018271530 A1	27-09-2018
		WO 2018183191 A1	04-10-2018

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/048422

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. [X] Claims Nos.: 19-29
because they relate to subject matter not required to be searched by this Authority, namely:

see FURTHER INFORMATION sheet PCT/ISA/210

2. [ ] Claims Nos.:
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:

3. [ ] Claims Nos.:
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:

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 an 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.

Continuation of Box II.1

Claims Nos.: 19-29

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery The methods comprising introducing an apparatus according to any of claims 1-18 into a lumen via arterial access claimed in claims 19-29 comprise the step of introducing an apparatus according to any of claims 1-18 into a lumen via arterial access. These methods are thus surgical methods.