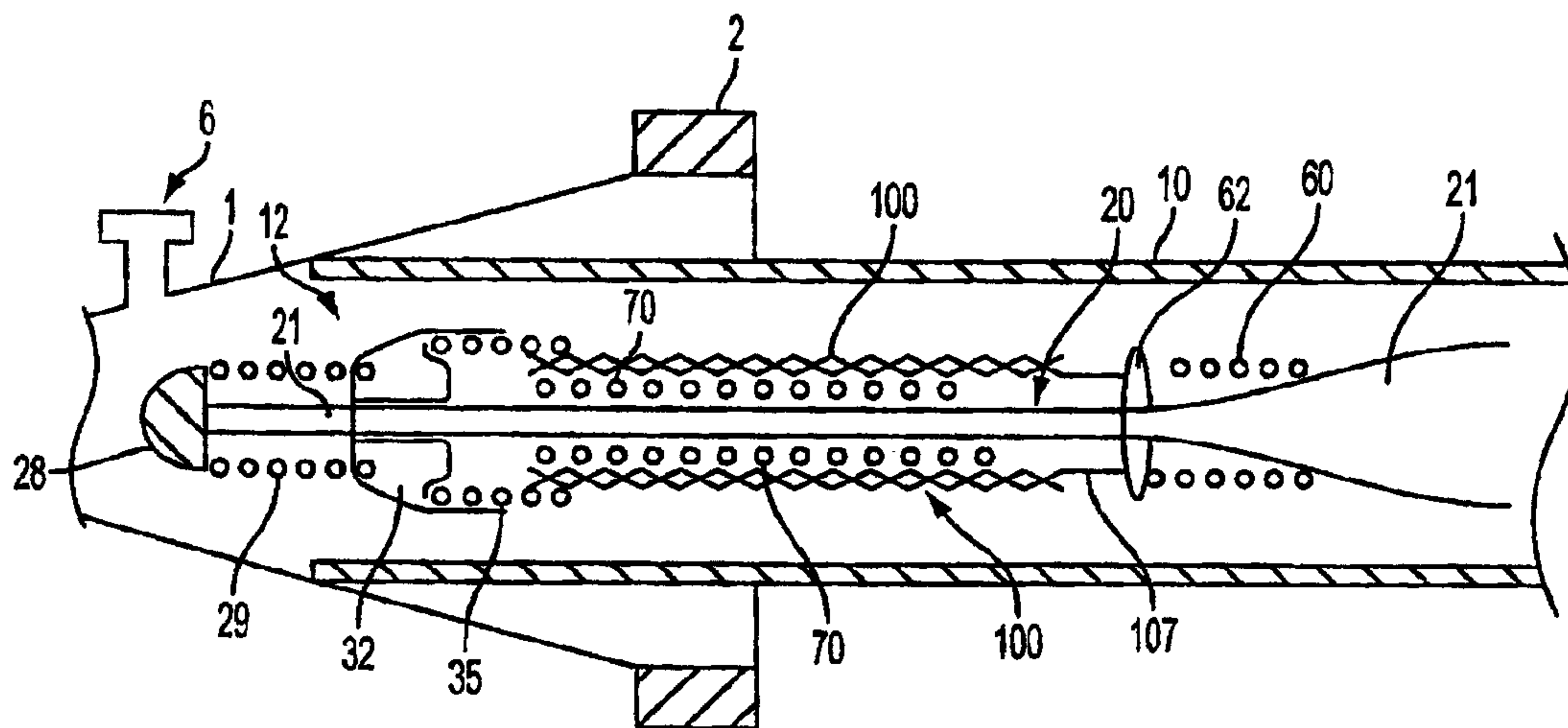




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(57) Abrégé/Abstract:

A system and method for deploying an occluding device that can be used to remodel an aneurysm within the vessel by, for example, neck reconstruction or balloon remodeling. The system comprises an introducer sheath and an assembly for carrying the occluding device. The assembly includes an elongated flexible member having an occluding device retaining member for receiving a first end of the occluding device, a proximally positioned retaining member for engaging a second end of the occluding device and a support surrounding a portion of the elongated flexible member over which the occluding device can be positioned.



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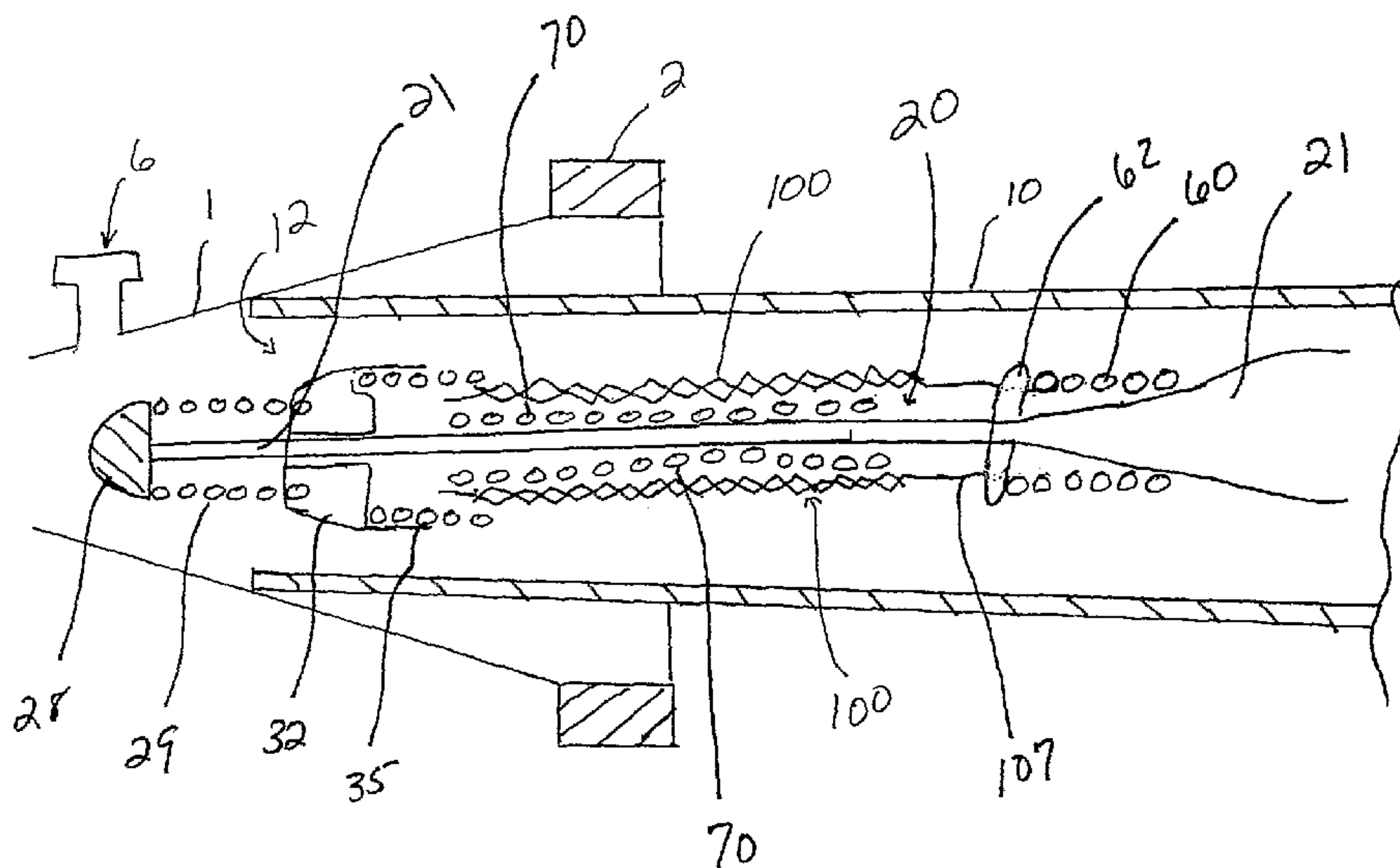
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(54) Title: SYSTEM AND METHOD FOR DELIVERING AND DEPLOYING AND OCCLUDING DEVICE WITHIN A VESSEL



(57) Abstract: A system and method for deploying an occluding device that can be used to remodel an aneurysm within the vessel by, for example, neck reconstruction or balloon remodeling. The system comprises an introducer sheath and an assembly for carrying the occluding device. The assembly includes an elongated flexible member having an occluding device retaining member for receiving a first end of the occluding device, a proximally positioned retaining member for engaging a second end of the occluding device and a support surrounding a portion of the elongated flexible member over which the occluding device can be positioned.



## SYSTEM AND METHOD FOR DELIVERING AND DEPLOYING A SELF-EXPANDING DEVICE WITHIN A VESSEL

### Field Of The Invention

[01] The invention generally relates to a system and method for delivering and deploying a medical device within a vessel, more particularly, it relates to a system and method for delivering and deploying an endoluminal therapeutic device within the vasculature of a patient to embolize and occlude aneurysms, particularly cerebral aneurysms.

### Background Art Of The Invention

[02] Walls of the vasculature, particularly arterial walls, may develop areas of pathological dilatation called aneurysms. As is well known, aneurysms have thin, weak walls that are prone to rupturing. Aneurysms can be the result of the vessel wall being weakened by disease, injury or a congenital abnormality. Aneurysms could be found in different parts of the body with the most common being abdominal aortic aneurysms and brain or cerebral aneurysms in the neurovasculature. When the weakened wall of an aneurysm ruptures, it can result in death, especially if it is a cerebral aneurysm that ruptures.

[03] Aneurysms are generally treated by excluding the weakened part of the vessel from the arterial circulation. For treating a cerebral aneurysm, such reinforcement is done in many ways including: (i) surgical clipping, where a metal clip is secured around the base of the aneurysm; (ii) packing the aneurysm with small, flexible wire coils (micro-coils); (iii) using embolic materials to "fill" an aneurysm; (iv) using detachable balloons or coils to occlude the parent vessel that supplies the aneurysm; and (v) intravascular stenting.

[04] Intravascular stents are well known in the medical arts for the treatment of vascular stenoses or aneurysms. Stents are prostheses that expand radially or

otherwise within a vessel or lumen to provide support against the collapse of the vessel. Methods for delivering these intravascular stents are also well known.

- [05] In conventional methods of introducing a compressed stent into a vessel and positioning it within in an area of stenosis or an aneurysm, a guiding catheter having a distal tip is percutaneously introduced into the vascular system of a patient. The guiding catheter is advanced within the vessel until its distal tip is proximate the stenosis or aneurysm. A guidewire positioned within an inner lumen of a second, inner catheter and the inner catheter are advanced through the distal end of the guiding catheter. The guidewire is then advanced out of the distal end of the guiding catheter into the vessel until the distal portion of the guidewire carrying the compressed stent is positioned at the point of the lesion within the vessel. Once the compressed stent is located at the lesion, the stent may be released and expanded so that it supports the vessel.

#### Summary Of The Invention

- [06] A system and method are disclosed of deploying an occluding device within a vessel. The occluding device can be used to remodel an aneurysm within the vessel by, for example, neck reconstruction or balloon remodeling. The occluding device can be used to form a barrier that retains occlusion material such as a well known coil or viscous fluids, such as "ONYX" by Microtherapeutics, within the aneurysm so that introduced material will not escape from within the aneurysm. Also, during deployment, the length of the occluding device can be adjusted in response to friction created between the occluding device and an inner surface of a catheter. When this occurs, the deployed length and circumferential size of the occluding device can be changed as desired by the physician performing the procedure.
- [07] Also disclosed is a system for supporting and deploying an occluding device. The system may comprise an introducer sheath and an assembly for carrying the



occluding device. The assembly may also include an elongated flexible member having an occluding device retaining member for receiving a first end of the occluding device, a proximally positioned retaining member for engaging a second end of the occluding device and a support surrounding a portion of the elongated flexible member over which the occluding device can be positioned.

**[08]** Also disclosed is a system for supporting and deploying an occluding device. The system may comprise an assembly for carrying the occluding device. The assembly may comprise an elongated member including a flexible distal tip portion, a retaining member for receiving a first end of the occluding device, and a support surrounding a portion of the elongated flexible member for supporting the occluding device.

**[09]** Also disclosed is a method of introducing and deploying an occluding device within a vessel. The method may include the steps of introducing an elongated sheath including an introducer sheath carrying a guidewire assembly into a catheter and advancing the guidewire assembly out of the sheath and into the catheter. The method may also include the steps of positioning an end of the catheter proximate an aneurysm, advancing a portion of the guidewire assembly out of the catheter and rotating a portion of the guidewire assembly while deploying the occluding device in the area of the aneurysm.

**[09a]** According to one aspect of the invention, there is provided a system for delivering and deploying a self-expanding device, the system comprising: a self-expanding device; an introducer sheath; and an assembly for moving the self-expanding device within the sheath, the assembly comprising an elongate flexible member, a device retaining member comprising a protective coil receiving a first end of the self-expanding device into a proximalmost opening of, and concentrically within, an interior portion of the protective coil, and a proximally positioned member positioned proximally of a second end of the self-expanding device; wherein rotation of the protective coil results in disengagement of the first end from within

the interior portion, the self-expanding device being movable relative to the flexible member; wherein the proximally positioned member inhibits proximal movement of the self-expanding device along the flexible member when the self-expanding device is carried by the assembly and positioned against the proximally positioned member.

- [09b] According to another aspect of the invention, there is provided a system for delivering and deploying a self-expanding device, the system comprising: a self-expanding device; a sheath; and an assembly for moving the self-expanding device within the sheath, the assembly comprising an elongate member, a retaining member having a portion for receiving and retaining a first end of the self-expanding device, the retaining member rotatably configured to release and permit expansion of the first end of the self-expanding device from within the retaining member and away from the elongate flexible member via a rotary force applied to a proximal end portion of the elongate flexible member so as to rotate the flexible member about its longitudinal axis with respect to the sheath, the retaining member being configured to retain the first end of the self-expanding device when the sheath is retracted to expose at least a portion of the self-expanding device.

#### Brief Description Of The Figures

- [10] Figure 1 is a cross section of an occluding device delivery assembly and occluding device according to an aspect of the invention;
- [11] Figure 2 illustrates a catheter and introducer sheath shown in Figure 1;
- [12] Figure 3 is a partial cut away view of the introducer sheath of Figure 2 carrying a guidewire assembly loaded with an occluding device;
- [13] Figure 4 is a cross section of the guidewire assembly illustrated in Figure 3;

- [14] Figure 5 is a schematic view of the guidewire assembly of Figure 4;
- [15] Figure 6 is a second schematic view of the guidewire assembly of Figure 4;



- [16] Figure 7 illustrates the occluding device and a portion of the guidewire assembly positioned outside the catheter, and how a proximal end of the occluding device begins to deploy within a vessel;
- [17] Figure 8 illustrates a step in the method of deploying the occluding device;
- [18] Figure 9 illustrates the deployment of the occluding device according to an aspect of the present invention;
- [19] Figure 10 is a schematic view of a guidewire assembly according to another embodiment of the present invention; and
- [20] Figure 11 is a schematic view of the deployed occluding device after having been deployed by the guidewire assembly of Figure 10.

#### Detailed Description Of The Invention

- [21] An occluding device delivery assembly having portions with small cross section(s) and which is highly flexible is described herein. FIG. 1 illustrates an introducer sheath 10 according to an aspect of the present invention that receives, contains and delivers an occluding device 100 to a flexible micro-catheter 1 for positioning within the vasculature of an individual. The occluding device 100 can include those embodiments disclosed in copending U.S. Patent Publication No. 2005/0267568, titled "Flexible Vascular Occluding Device", published on December 1, 2005.
- [22] A distal end 12 of the introducer sheath 10 is sized and configured to be received within a hub 2 of the micro-catheter 1, as shown in Figures 1 and 2. The hub 2 can be positioned at the proximal end of the micro-catheter 1 or at another location spaced along the length of the micro-catheter 1. The micro-catheter 1 can be any known micro-catheter that can be introduced and advanced through the vasculature of a patient. In an embodiment, the micro-catheter has an inner diameter of 0.047 inch or less. In another embodiment, the micro-catheter has an



inner diameter of about 0.027 inch to about 0.021 inch. In an alternative embodiment, the micro-catheter could have an inner diameter of about 0.025 inch. However, it is contemplated that the catheter 1 can have an inner diameter that is greater than 0.047 inch or less than 0.021 inch. After the introducer sheath 10 is positioned within the catheter hub 2, the occluding device 100 can be advanced from the introducer sheath 10 into the micro-catheter 1 in preparation for deploying the occluding device 100 within the vasculature of the patient.

- [23] The micro-catheter 1 may have at least one fluid introduction port 6 located adjacent the hub 2 or at another position along its length. The port 6 is preferably in fluid communication with the distal end of the micro-catheter 1 so that a fluid, e.g., saline, may be passed through the micro-catheter 1 prior to insertion into the vasculature for flushing out air or debris trapped within the micro-catheter 1 and any instruments, such as guidewires, positioned within the micro-catheter 1. The port 6 may also be used to deliver drugs or fluids within the vasculature as desired.
- [24] Figure 3 illustrates the introducer sheath 10, an elongated flexible delivery guidewire assembly 20 that is movable within the introducer sheath 10 and the occluding device 100. As shown, the guidewire assembly 20 and the occluding device 100, carried by the guidewire assembly 20, have not been introduced into the micro-catheter 1. Instead, as illustrated, they are positioned within the introducer sheath 10. The introducer sheath 10 may be made from various thermoplastics, e.g., PTFE, FEP, HDPE, PEEK, etc., which may optionally be lined on the inner surface of the sheath or an adjacent surface with a hydrophilic material such as PVP or some other plastic coating. Additionally, either surface may be coated with various combinations of different materials, depending upon the desired results.
- [25] The introducer sheath 10 may include drainage ports or purge holes (not shown) formed into the wall near the area covering the occluding device 100. There may be a single hole or multiple holes, e.g., three holes, formed into introducer sheath

10. These purge holes allow for fluids, e.g., saline, to readily escape from in between the introducer sheath 10 and the guidewire assembly 20 when purging the sheath prior to positioning the introducer sheath 10 in contact with the catheter hub 2, e.g., to remove trapped air or debris.

- [26] As shown in Figure 4, the guidewire assembly 20 includes an elongated flexible guidewire 21. The flexibility of the guidewire 21 allows the guidewire assembly 20 to bend and conform to the curvature of the vasculature as needed for positional movement of the occluding device 100 within the vasculature. The guidewire 21 may be made of a conventional guidewire material and have a solid cross section. Alternatively, the guidewire 21 can be formed from a hypotube. In either embodiment, the guidewire 21 has a diameter  $D_5$  ranging from about 0.010 inch to about 0.020 inch. In an embodiment, the largest diameter of the guidewire 21 is about 0.016 inch. The material used for the guidewire 21 can be any of the known guidewire materials including superelastic metals, e.g., Nitinol. Alternatively, the guidewire 21 can be formed of metals such as stainless steel. Length  $L_4$  of the guidewire can be from about 125 to about 190 cm. In an embodiment, the length  $L_4$  is about 175 cm.
- [27] The guidewire assembly 20 can have the same degree of flexion along its entire length. In an alternative embodiment, the guidewire assembly 20 can have longitudinal sections, each with differing degrees of flexion/stiffness. The different degrees of flexions for the guidewire assembly 20 can be created using different materials and/or thicknesses within different longitudinal sections of the guidewire 21. In another embodiment, the flexion of the guidewire 21 can be controlled by spaced cuts (not shown) formed within the delivery guidewire 21. These cuts can be longitudinally and/or circumferentially spaced from each other. The cuts can be formed with precision within the delivery guidewire 21. Different sections of the delivery guidewire 21 can include cuts formed with different spacing and different depths to provide these distinct sections with different amounts of flexion and stiffness. In any of the above embodiments, the guidewire assembly 20 and the guidewire 21 are responsive to torque applied to



the guidewire assembly 20 by the operator. As discussed below, the torque applied to the guidewire assembly 20 via the guidewire 21 can be used to release the occluding device 100 from the guidewire assembly 20.

- [28] The size and shape of the cuts formed within the delivery guidewire 21 may be controlled so as to provide greater or lesser amounts of flexibility. Because the cuts can be varied in width without changing the depth or overall shape of the cut, the flexibility of the delivery guidewire 21 may be selectively altered without affecting the torsional strength of the delivery guidewire 21. Thus, the flexibility and torsional strength of the delivery guidewire 21 may be selectively and independently altered.
- [29] Advantageously, longitudinally adjacent pairs of cuts may be rotated about 90 degrees around the circumference of the delivery guidewire 21 from one another to provide flexure laterally and vertically. However, the cuts may be located at predetermined locations to provide preferential flexure in one or more desired directions. Of course, the cuts could be randomly formed to allow bending (flexion) equally, non-preferentially in all directions or planes. In one embodiment, this could be achieved by circumferentially spacing the cuts.
- [30] The flexible delivery guidewire 21 can include any number of sections having the same or differing degrees of flexion. For example, the flexible delivery guidewire 21 could include two or more sections. In the embodiment illustrated in Figure 4, the flexible delivery guidewire 21 includes three sections, each having a different diameter. Each section can have a diameter of about 0.005 inch to about 0.025 inch. In an embodiment, the diameter of one or more sections can be about 0.010 inch to about 0.020 inch. A first section 22 includes a proximal end 23 that is located opposite the position of the occluding device 100. The first section 22 can have a constant thickness along its length. Alternatively, the first section 22 can have a thickness (diameter) that tapers along its entire length or only a portion of its length. In the tapered embodiment, the thickness (diameter) of the first section 22 decreases in the direction of a second, transition section 24. For those



embodiments in which the guidewire 21 has a circular cross section, the thickness is the diameter of the section.

- [31] The second, transition section 24 extends between the first section 22 and a third, distal section 26. The second section 24 tapers in thickness from the large diameter of the first section 22 to the smaller diameter of the third section 26. As with the first section 22, the second section 24 can taper along its entire length or only a portion of its length.
- [32] The third section 26 has a smaller thickness compared to the other sections 22, 24 of the delivery guidewire 21. The third section 26 extends away from the tapered second section 24 that carries the occluding device 100. The third section 26 can taper along its entire length from the second section 24 to the distal end 27 of the delivery guidewire 21. Alternatively, the third section 26 can have a constant diameter or taper along only a portion of its length. In such an embodiment, the tapering portion of the third section 26 can extend from the second section 24 or a point spaced from the second section 24 to a point spaced from distal end 27 of the delivery guidewire 21. Although three sections of the delivery guidewire 21 are discussed and illustrated, the delivery guidewire 21 can include more than three sections. Additionally, each of these sections can taper in their thickness (diameter) along all or only a portion of their length. In any of the disclosed embodiments, the delivery guidewire 21 can be formed of a shape memory alloy such as Nitinol.
- [33] A tip 28 and flexible tip coil 29 are secured to the distal end 27 of the delivery guidewire 21 as shown in Figures 4 and 5. The tip 28 can include a continuous end cap or cover as shown in the figures, which securely receives a distal end of the tip coil 29. Flexion control is provided to the distal end portion of the delivery guidewire 21 by the tip coil 29. However, in an embodiment, the tip 28 can be free of the coil 29. The tip 28 has a non-percutaneous, atraumatic end face. In the illustrated embodiment, the tip 28 has a rounded face. In alternative embodiments, the tip 28 can have other non-percutaneous shapes that will not

injure the vessel in which it is introduced. As illustrated in Figure 4, the tip 28 includes a housing 45 that securely receives the distal end of the guidewire 21 within an opening 46 in the interior surface of the housing 45. The guidewire 21 can be secured within the opening by any known means.

- [34] As shown in Figure 4, the tip coil 29 surrounds a portion of the guidewire 21. The tip coil 29 is flexible so that it will conform to and follow the path of a vessel within the patient as the tip 28 is advanced along the vessel and the guidewire 21 bends to follow the tortuous path of the vasculature. The tip coil 29 extends rearward from the tip 28 in the direction of the proximal end 23, as shown.
- [35] The tip 28 and coil 29 have an outer diameter  $D_1$  of about 0.010 inch to about 0.018 inch. In an embodiment, their outer diameter  $D_1$  is about 0.014 inch. The tip 28 and coil 29 also have a length  $L_1$  of about 0.1 cm to about 3.0 cm. In an embodiment, they have a total length  $L_1$  of about 1.5 cm.
- [36] A proximal end 30 of the tip coil 29 is received within a housing 32 at a distal end 24 of a protective coil 35, as shown in Figures 1 and 4. The housing 32 and protective coil 35 have an outer diameter  $D_2$  of about 0.018 inch to about 0.038 inch. In an embodiment, their outer diameter  $D_2$  is about 0.024 inch. The housing 32 and protective coil 35 have a length  $L_2$  of about 0.05 cm to about 0.2 cm. In an embodiment, their total length  $L_2$  is about 0.15 cm.
- [37] The housing 32 has a non-percutaneous, atraumatic shape. For example, as shown in Figure 5, the housing 32 has a substantially blunt profile. Also, the housing 32 can be sized to open/support the vessel as it passes through it. Additionally, the housing 32 can include angled sidewalls sized to just be spaced just off the inner surface of the introducer sheath 10.
- [38] The housing 32 and protective coil 35 form a distal retaining member that maintains the position of the occluding device 100 on the flexible guidewire assembly 20 and helps to hold the occluding device 100 in a compressed state prior to its delivery and deployment within a vessel of the vasculature. The



protective coil 35 extends from the housing 32 in the direction of the proximal end 23 of the delivery guidewire 21, as shown in Figure 4. The protective coil 35 is secured to the housing 32 in any known manner. In a first embodiment, the protective coil 35 can be secured to the outer surface of the housing 32. In an alternative embodiment, the protective coil 35 can be secured within an opening of the housing 32 so that the housing 32 surrounds and internally receives the distal end 51 of the protective coil 35 (Figure 4). As shown in Figures 3 and 4, the distal end 102 of the occluding device 100 is retained within the proximal end 52 so that the occluding device 100 cannot deploy while positioned in the sheath 10 or the micro-catheter 1.

- [39] At the proximal end of the occluding device 100, a bumper coil 60 and cap 62 prevent lateral movement of the occluding device 100 along the length of the guidewire 21 in the direction of the proximal end 23, see Figure 3. The bumper coil 60 and cap 62 have an outer diameter  $D_4$  of about 0.018 inch to about 0.038 inch. In an embodiment, their outer diameter  $D_4$  is about 0.024 inch. The cap 62 contacts the proximal end 107 of the occluding device 100 and prevents it from moving along the length of the guidewire 21 away from the protective coil 35. The bumper coil 60 can be in the form of a spring that contacts and pressures the cap 62 in the direction of the protective coil 35, thereby creating a biasing force against the occluding device 100. This biasing force (pressure) aids in maintaining the secured, covered relationship between the distal end 102 of the occluding device 100 and the protective coil 35. As with any of the coils positioned along the delivery guidewire 21, the bumper coil 60 can be secured to the delivery guidewire 21 by soldering, welding, RF welding, glue, and/or other known adhesives.
- [40] In an alternative embodiment illustrated in FIG. 10, the bumper coil 60 is not utilized. Instead, a proximal end 107 of the occluding device 100 is held in position by a set of spring loaded arms (jaws) 104 while positioned within the introducer sheath 10 or the micro-catheter 1. The inner surfaces of the micro-catheter 1 and the introducer sheath 10 limit the radial expansion of the arms 104. When the proximal end of the occluding device passes out of the micro-catheter 1, the arms 104 would spring open and release the occluding device as shown in FIG. 11.



- [41] In an alternative embodiment, the bumper coil 60 and cap 62 can be eliminated and the proximal end of the occluding device 100 can be held in position relative to the protective coil 35 by a tapered section of the guidewire 21. In such an embodiment, the enlarged cross section of this tapered section can be used to retain the occluding device 100 in position along the length of the delivery guidewire 21 and prevent movement of the occluding device 100 in the direction of the proximal end 23.
- [42] As shown in Figure 4, the guidewire assembly 20 includes a support 70 for the occluding device 100. In a first embodiment, the support 70 can include an outer surface of the delivery guidewire 21 that is sized to contact the inner surface of the occluding device 100 when the occluding device 100 is loaded on the guidewire assembly 20. In this embodiment, the outer surface of the delivery guidewire 21 supports the occluding device 100 and maintains it in a ready to deploy state. In another embodiment, illustrated in the Figures, the support 70 comprises a mid-coil 70 that extends from a location proximate the protective coil 35 rearward toward the bumper coil 60. The mid-coil 70 extends under the occluding device 100 and over the delivery guidewire 21, as shown in Figure 1. The mid-coil 70 can be coextensive with one or more sections of the delivery guidewire 21. For example, the mid-coil 70 could be coextensive with only the second section 24 of the delivery guidewire 21 or it could extend along portions of both the third section 26 and the second section 24 of the delivery guidewire 21.
- [43] The mid-coil 70 provides the guidewire assembly 20 with an outwardly extending surface that is sized to contact the inner surface of the occluding device 100 in order to assist in supporting the occluding device and maintaining the occluding device 100 in a ready to deploy state. Like the other coils discussed herein and

illustrated in the figures, the coiled form of the mid-coil 70 permits the mid-coil 70 to flex with the delivery guidewire 21 as the delivery guidewire 21 is advanced through the vasculature of the patient. The mid-coil 70 provides a constant diameter along a length of the delivery guidewire 21 that is covered by the occluding device 100 regardless of the taper of the delivery guidewire 21 beneath the occluding device 100. The mid-coil 70 permits the delivery guidewire 21 to be tapered so it can achieve the needed flexibility to follow the path of the vasculature without compromising the support provided to the occluding device 100. The mid-coil 70 provides the occluding device 100 with constant support regardless of the taper of the delivery guidewire 21 prior to the occluding device 100 being deployed. The smallest diameter of the occluding device 100 when in its compressed state is also controlled by the size of the mid-coil 70. Additionally, the diameter of the mid-coil 70 can be chosen so that the proper spacing, including no spacing, is established between the occluding device 100 and the inner wall of the micro-catheter 1 prior to deployment of the occluding device 100. The mid-coil 70 can also be used to bias the occluding device 100 away from the delivery guidewire 21 during its deployment.

- [44] In either embodiment, the support 70 can have an outer diameter  $D_3$  of about 0.010 inch to about 0.018 inch. In an embodiment, the outer diameter  $D_3$  is about 0.014 inch. The support 70 can also have a length  $L_3$  of about 2.0 cm to about 30 cm. In an embodiment, the length  $L_3$  of the support 70 is about 7 cm.
- [45] The occluding device 100 may also be placed on the mid-coil 70 between an optional pair of radio-opaque marker bands located along the length of the guidewire assembly 20. Alternatively, the protective coil 35, bumper coil 60 and or mid-coil 70 can include radio-opaque markers. In an alternative embodiment, the guidewire assembly 20 may include only a single radio-opaque marker. The use of radio-opaque markers allows for the visualization of the guidewire assembly 20 and the occluding device 100 during placement within the vasculature. Such visualization techniques may include conventional methods



such as fluoroscopy, radiography, ultra-sonography, magnetic resonance imaging, etc.

- [46] The occluding device 100 can be delivered and deployed at the site of an aneurysm A according to the following method and variations thereof. The delivery of the occluding device 100 includes introducing the micro-catheter 1 into the vasculature until it reaches a site that requires treatment. The micro-catheter 1 is introduced into the vasculature using a conventional technique such as being advanced over or simultaneously with a conventional vascular guidewire (not shown). The positioning of the micro-catheter 1 can occur before it receives the guidewire assembly 20 or while it contains the guidewire assembly 20. The position of the micro-catheter 1 within the vasculature can be determined by identifying radio-opaque markers positioned on or in the micro-catheter 1.
- [47] After the micro-catheter 1 is positioned at the desired location, the guidewire is removed and the distal end of the introducer sheath 10 is inserted into the proximal end of the micro-catheter 1, as shown in Figure 1. In an embodiment, the distal end of the introducer sheath 10 is introduced through the hub 2 at the proximal end of the micro-catheter 1. The introducer sheath 10 is advanced within the micro-catheter 1 until a distal tip of the introducer sheath 10 is wedged within the micro-catheter 1. At this position, the introducer sheath 10 cannot be advanced further within the micro-catheter 1. The introducer sheath 10 is then securely held while the delivery guidewire assembly 20 carrying the occluding device 100 is advanced through the introducer sheath 10 until the occluding device 100 is advanced out of the introducer sheath 10 and into the micro-catheter 1.
- [48] The guidewire assembly 20 and the occluding device 100 are advanced through the micro-catheter 1 until the tip coil 29 is proximate the distal end of the micro-catheter 1. At this point, the position of the micro-catheter 1 and guidewire assembly 20 can be confirmed. The guidewire assembly 20 is then advanced out of the micro-catheter 1 and into the vasculature of the patient so that the proximal



end 107 of the occluding device 100 is positioned outside the distal end of the micro-catheter 1 and adjacent the area to be treated. At any point during these steps, the position of the occluding device 100 can be checked to determine that it will be deployed correctly and at the desired location. This can be accomplished by using the radio-opaque markers discussed above.

[49] When the distal end 102 of the occluding device 100 is positioned outside the micro-catheter 1, the proximal end 107 will begin to expand, in the direction of the arrows shown in Figure 7, within the vasculature while the distal end 102 remains covered by the protective coil 35. When the occluding device 100 is in the proper position, the delivery guidewire 21 is rotated (See Figure 8) until the distal end 102 of the occluding device 100 moves away from the protective coil 35 and expands within the vasculature at the desired location. The delivery guidewire 21 can be rotated either clockwise or counter clockwise as needed to deploy the occluding device 100. In an embodiment, the delivery guidewire 21 may be rotated, for example, between two and ten turns in either or both directions. In another example, the occluding device may be deployed by rotating the delivery guidewire 21 clockwise for less than five turns, for example, three to five turns. After the occluding device 100 has been deployed, the delivery guidewire 21 can be retracted into the micro-catheter 100 and removed from the body.

[50] In an alternative or additional deployment step shown in Figure 9, friction between the occluding device 100 and inner surface of the micro-catheter 1 cause the distal end of the occluding device 100 to separate from the protective coil 35. The friction can be created by the opening of the occluding device 100 and/or the mid-coil 70 biasing the occluding device 100 toward the inner surface of the micro-catheter 1. The friction between the micro-catheter 1 and the occluding device 100 will assist in the deployment of the occluding device 100. In those instances when the occluding device 100 does not open and separate from the protective coil 35 during deployment, the friction between occluding device 100 and the inner surface of the micro-catheter 1 will cause the occluding device 100

to move away from the protective coil 35 as the delivery guidewire 21 and the micro-catheter 1 move relative to each other. The delivery guidewire 21 can then be rotated and the occluding device 100 deployed within the vessel.

- [51] After the occluding device 100 radially self-expands into gentle, but secure, contact with the walls of the vessel so as to occlude the neck of the aneurysm A, the micro-catheter 1 may be removed entirely from the body of the patient. Alternatively, the micro-catheter 1 may be left in position within vasculature to allow for the insertion of additional tools or the application of drugs near the treatment site.
- [52] Known materials can be used in the present invention. One common material that can be used with the occluding device 100 and the guidewire 21 is Nitinol, a nickel-titanium shape memory alloy, which can be formed and annealed, deformed at a low temperature, and recalled to its original shape with heating, such as when deployed at body temperature in the body. The radio-opaque markers can be formed of radio-opaque materials including metals, such as platinum, or doped plastics including bismuth or tungsten to aid in visualization.
- [53] The apparatus and methods discussed herein are not limited to the deployment and use within the vascular system but may also be applied to any number of further treatment applications. Other treatment sites may include areas or regions of the body such as organ bodies.



What is claimed is:

1. A system for delivering and deploying a self-expanding device, said system comprising:

a self-expanding device;

an introducer sheath; and

an assembly for moving the self-expanding device within the sheath, said assembly comprising an elongate flexible member, a device retaining member comprising a protective coil receiving a first end of the self-expanding device into a proximalmost opening of, and concentrically within, an interior portion of the protective coil, and a proximally positioned member positioned proximally of a second end of the self-expanding device;

wherein rotation of the protective coil results in disengagement of the first end from within the interior portion, said self-expanding device being movable relative to said flexible member;

wherein said proximally positioned member inhibits proximal movement of the self-expanding device along the flexible member when the self-expanding device is carried by said assembly and positioned against said proximally positioned member.

2. The system according to claim 1, wherein said elongate flexible member includes a guidewire having a flexible atraumatic tip.

3. The system according to claim 2, wherein said guidewire is movable relative to said introducer sheath.

4. The system according to claim 3, wherein said guidewire has at least two sections having different diameters.

5. The system according to claim 3, wherein said guidewire has sections of differing flexions.

6. The system according to claim 1, further comprising a support extending along a portion of the elongate flexible member and having an outer surface for engaging an inner surface of said self-expanding device, said self-expanding device being movable relative to said support.



7. The system according to claim 6, wherein said support surrounds a portion of said elongate flexible member.

8. The system according to claim 1, wherein said proximally positioned member includes a biasing member that urges the self-expanding device toward a distal end of the flexible member when the self-expanding device is moved by said assembly and positioned against said proximally positioned member.

9. The system according to claim 1, wherein said proximally positioned member includes a portion of said elongate flexible member.

10. The system according to claim 1, wherein said device retaining member includes a coiled spring.

11. The system according to claim 1, further comprising a catheter into which said assembly and the self-expanding device can be positioned.

12. The system according to claim 1, wherein said elongate member includes a flexible guidewire that is rotatable relative to said introducer sheath and the self-expanding device.

13. The system according to claim 1, wherein said protective coil and proximally positioned member remain substantially axially fixed with respect to each other during release of the self-expanding device from the protective coil.

14. The system according to claim 1, wherein the first end of the self-expanding device engages an inner surface of the protective coil when the first end is received within the interior portion of the protective coil.

15. The system according to claim 6, wherein said support comprises an elongate coil positioned about a portion of said elongate flexible member.

16. The system according to claim 6, wherein the device retaining member has an outer surface that extends farther from an outer surface of said elongate member than an outer surface of said support.

17. A system for delivering and deploying a self-expanding device, said system comprising:

- a self-expanding device;
- a sheath; and

an assembly for moving the self-expanding device within the sheath, said assembly comprising an elongate member, a retaining member having a portion for receiving and retaining a first end of the self-expanding device, the retaining member rotatably configured to release and permit expansion of the first end of the self-expanding device from within the retaining member and away from the elongate flexible member via a rotary force applied to a proximal end portion of the elongate flexible member so as to rotate the flexible member about its longitudinal axis with respect to the sheath, said retaining member being configured to retain said first end of the self-expanding device when said sheath is retracted to expose at least a portion of the self-expanding device.

18. The system according to claim 17, wherein said elongate member includes a flexible guidewire.

19. The system according to claim 18, wherein said guidewire has at least two sections having different diameters.

20. The system according to claim 18, wherein said guidewire has sections of differing flexions.

21. The system according to claim 17, wherein said elongate member includes an atraumatic tip.

22. The system according to claim 17, wherein said retaining member includes an internal recess for receiving and holding the first end of said self-expanding device prior to deployment of said self-expanding device.

23. The system according to claim 17, wherein said retaining member includes a coiled spring.

24. The system according to claim 17, further comprising a proximal member spaced from the first retaining member for engaging a portion of self-expanding device and urging the self-expanding device toward the first retaining member.

25. The system according to claim 17, further comprising a catheter into which said assembly and the self-expanding device can be positioned.

26. The system according to claim 17, wherein said retaining member includes a portion for protecting the first end of the self-expanding device.



27. The system according to claim 17, further comprising a support extending along a portion of the elongate flexible member and forming an outer support surface for engaging and supporting the self-expanding device relative to said elongate member such that said self-expanding device is movable relative to said support.

28. The system according to claim 27, wherein the retaining member has an outer surface that extends farther from an outer surface of said elongate member than an outer surface of said support.

29. The system according to claim 27, wherein said support includes a flexible coil that extends over and surrounds a portion of said elongate member.

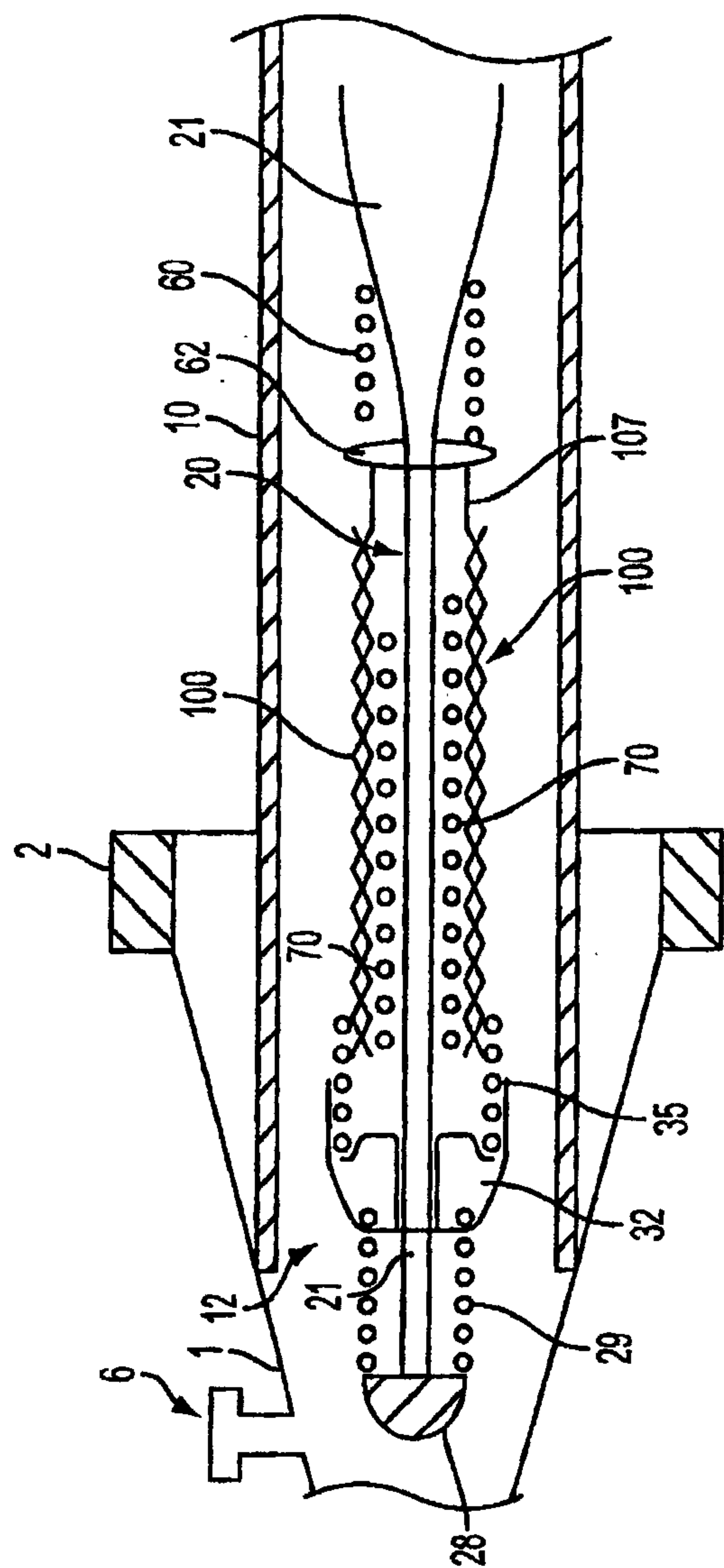


FIG. 1



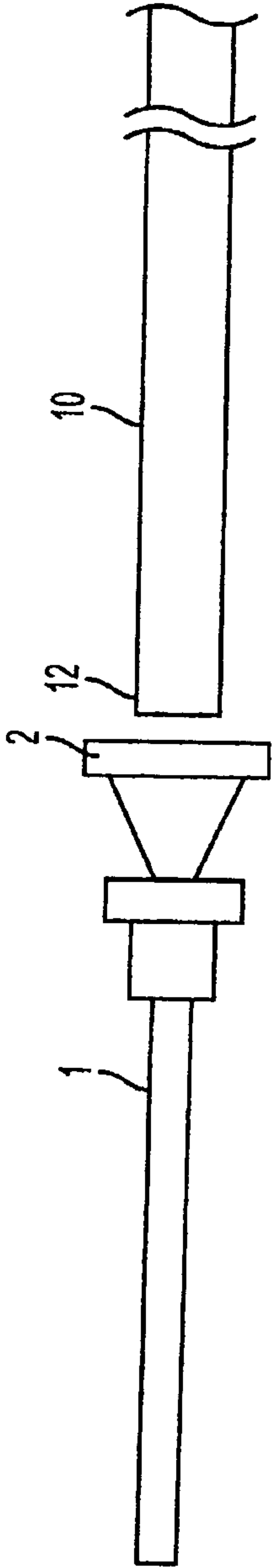


FIG. 2

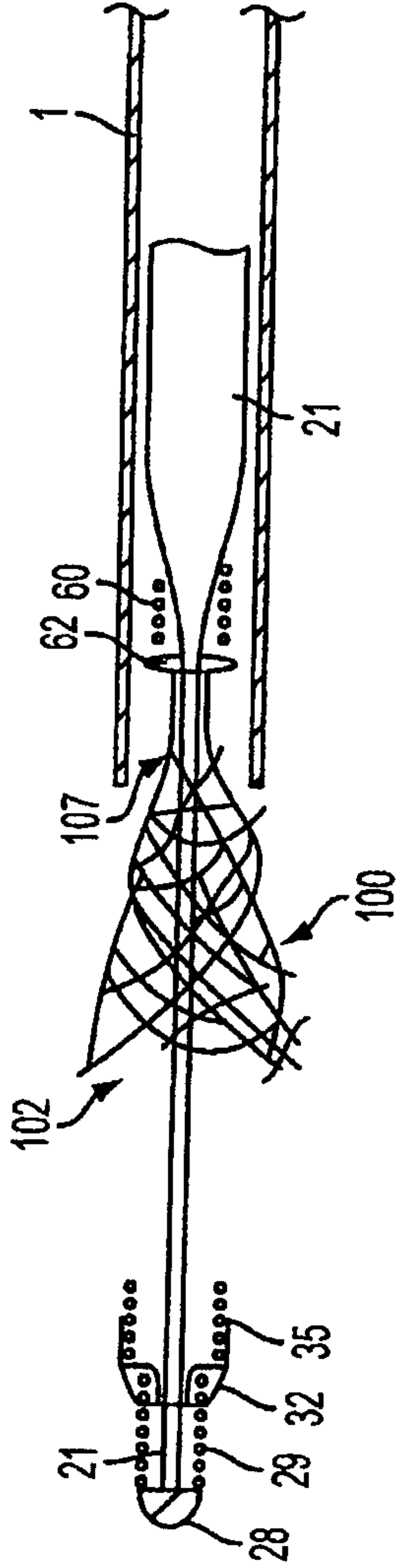


FIG. 9

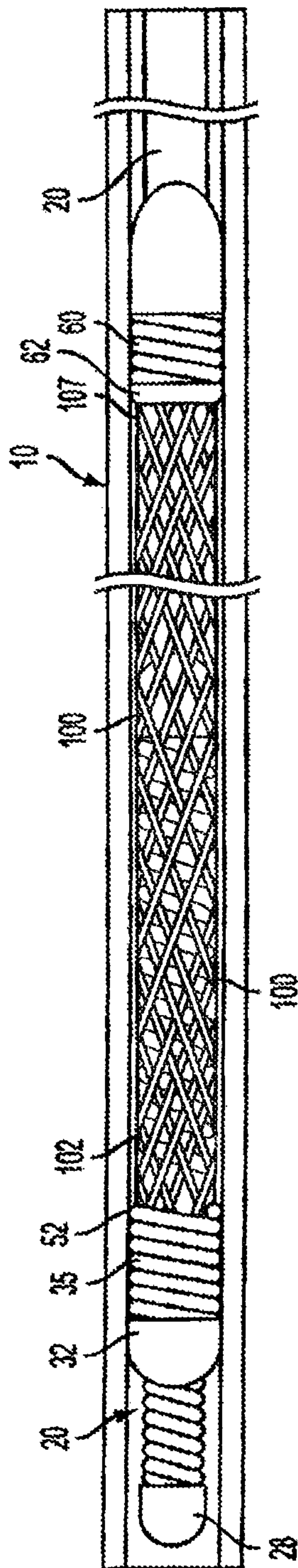


FIG. 3



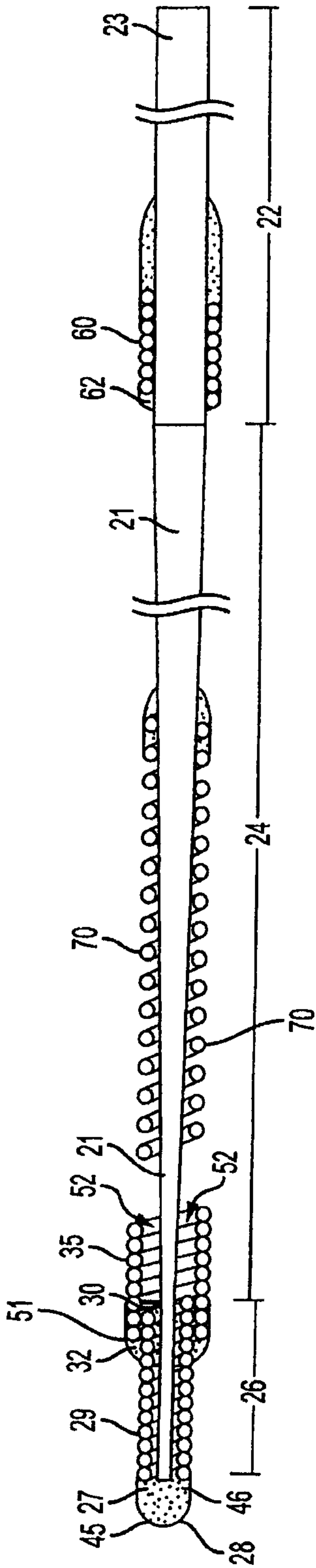


FIG. 4

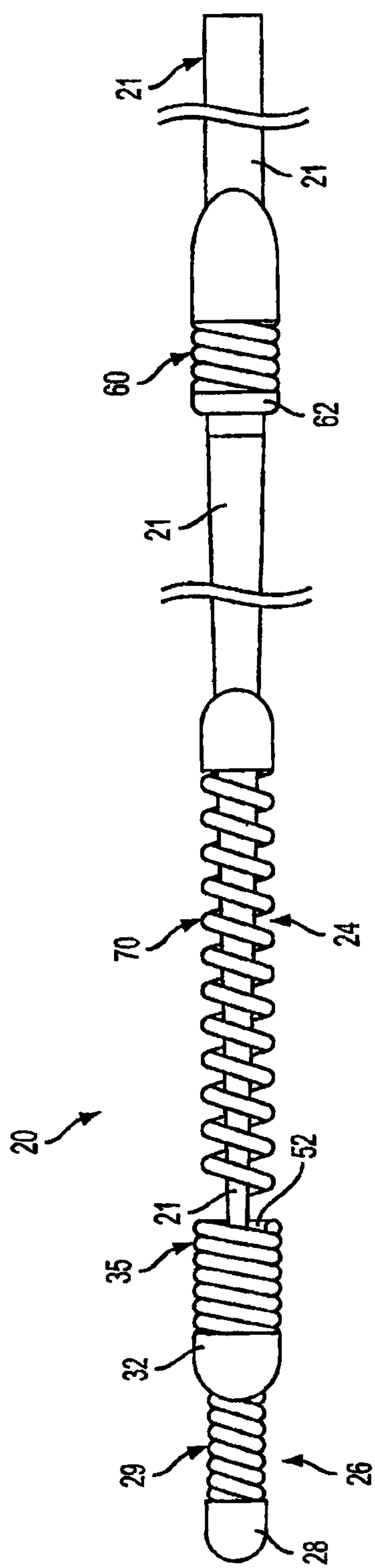
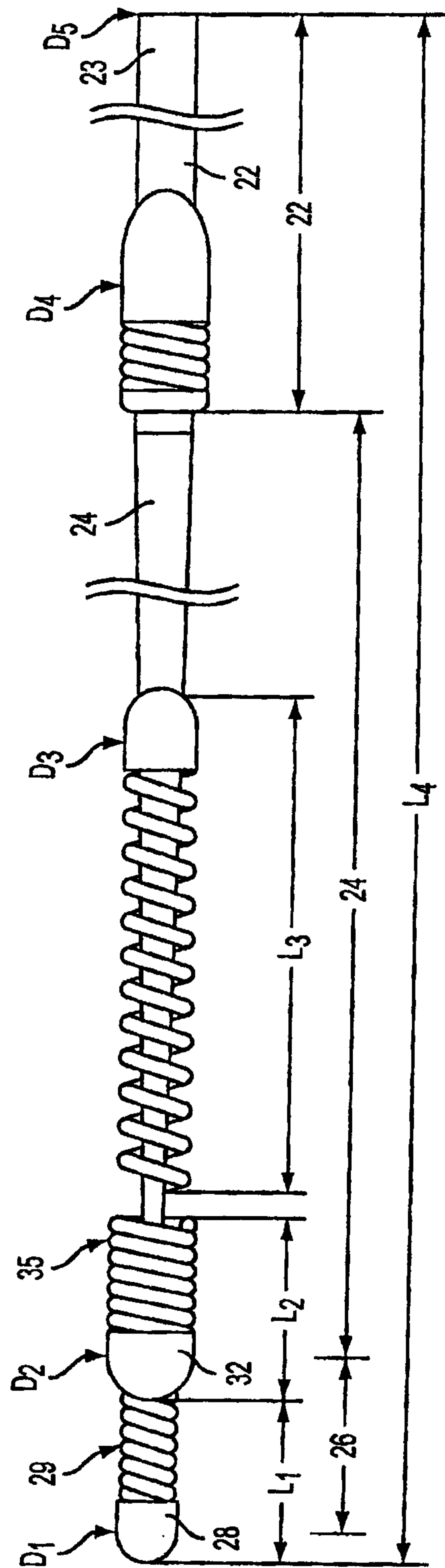


FIG. 5





**FIG. 6**

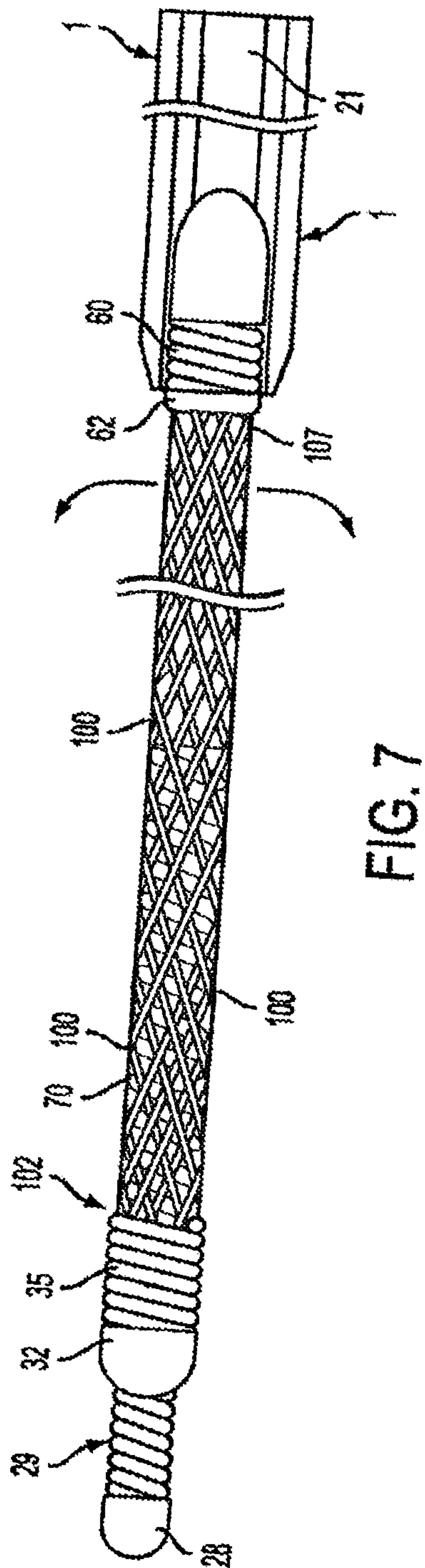


FIG. 7



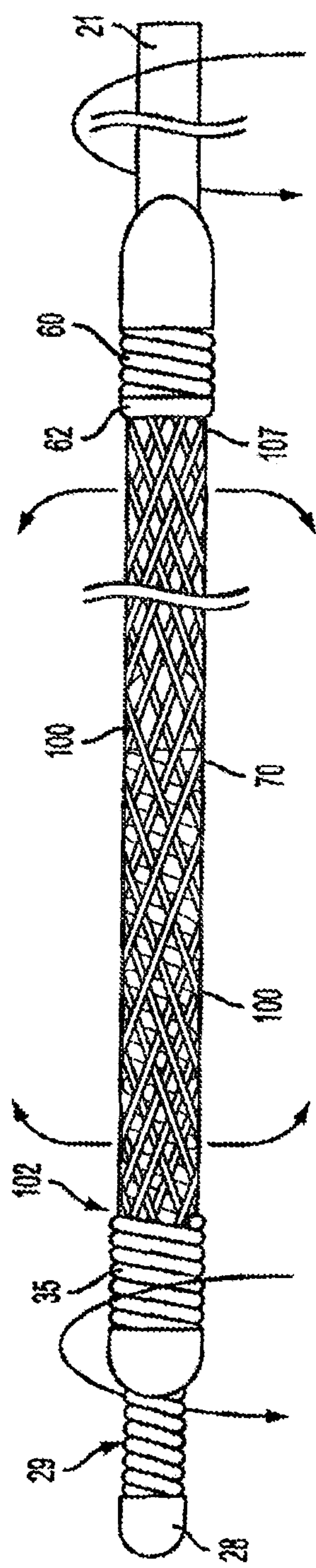


FIG. 8

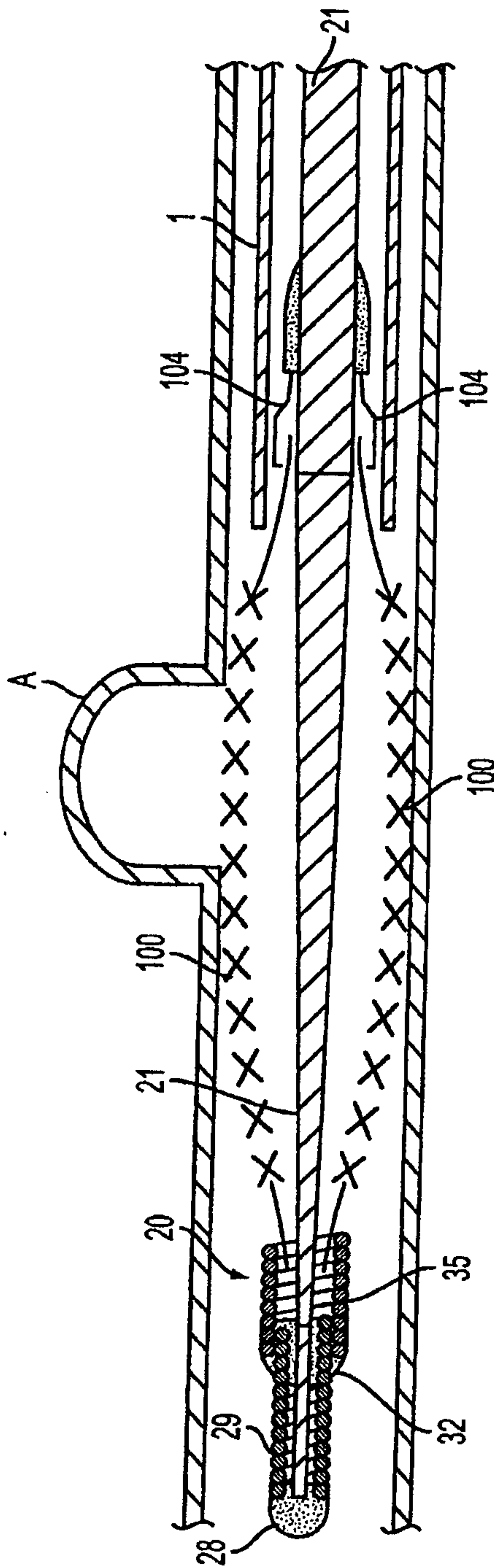


FIG. 10

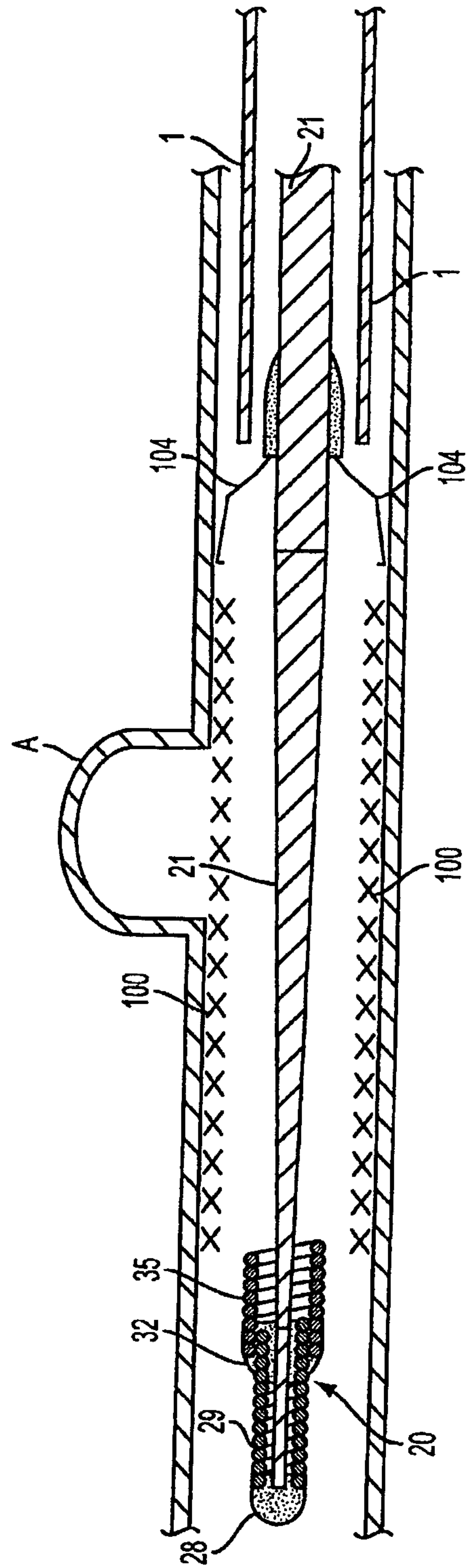


FIG. 11



