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(54) Title: ADJUSTABLE TUBULAR MEDICAL DEVICE INCLUDING A CATHETER

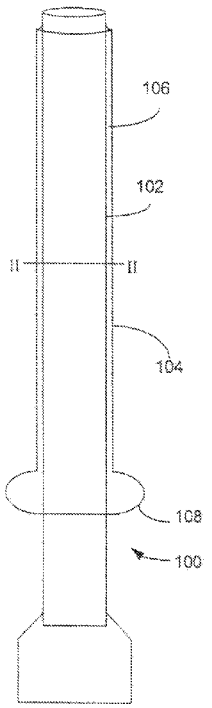

FIG. 1

(57) Abstract: The present invention provides an adjustable medical tubular device that includes a cylindrical catheter and a tubular element in continuity with the catheter. The tubular element extends at least a portion of the catheter and is composed of a material that allows for changing the properties of the tubular element. The adjustable medical tubular device further includes a cavity defined between the cylindrical catheter and the tubular element. The cavity fully extends concurrent with the length of the tubular element. The adjustable medical tubular device further includes a cavity filling device operative to dispose a filler within the cavity. The filling device may be a pneumatic and/or hydraulic device for insertion of the filler within the cavity. The filler may also be liquid, gas and/or gel. The filler, within the cavity, changes at least one of the properties of the tubular element.

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ADJUSTABLE TUBULAR MEDICAL DEVICE INCLUDING A CATHETER

CLAIM OF PRIORITY

The present application claims priority to U.S. Provisional Application No. 61/085,239, entitled "ADJUSTABLE TUBULAR MEDICAL DEVICE INCLUDING A CATHETER," filed on July 31, 2008, the disclosure of which is hereby incorporated by reference herein in its entirety.

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FIELD OF THE INVENTION

[0002] The present invention relates generally to a medical-based tubular device and more specifically to a tubular device including a catheter therein and corresponding members providing for the adjustment of the properties of the tubular device itself.

BACKGROUND

[0003] Generally speaking, catheters are used in medical treatment to access cavities and to navigate through tubular structures such as arteries and veins. A minimal axial profile is utilized to insert the catheter into a patient. During navigation of the catheter within the patient, axial strength as well as the ability to have an adjustable profile is desired. The axial strength provides for the integrity of the catheter within the passageway and the adjustable profile allows for the navigation in the non-straight pathways.

[0004] During therapeutic aspects, axial strength, increased size and insulation may be

required. In existing catheter systems, these characteristics, including stiffness, thickness and shape, have been controlled with the use of wires, syringes and catheter construction features.

[0005] One existing catheter system uses an inflatable balloon and requires syringes that provides fluids for insertion within the interior of the catheter. This technique provides elasticity of the balloon solely at the location on the catheter where the balloon is disposed, providing limited contact area in the event of balloon enlargement. For example, one purpose is to stretch the vessel containing the catheter, commonly referred to as angioplasty. Another purpose of the fluids has been to secure the catheter in place, such as a Foley catheter. Other purposes include obtaining hemostatis from the surrounding tissue, centering the catheter within the vessel, delivering cold or heat, delivering medications through associated holes in the catheter and reversing flow in vessels or maintaining it during stretching.

[0006] Limitations of the available contact area of the inflatable balloon have been addressed in further refinements of catheter technology, including the inclusion of two or more balloons. Inflation and deflation of the balloons at different times and locations can be manipulated to provide therapeutic activities to a patient. For example, different balloons can be utilized to address different arterial blockages in the same procedure. An existing limitation of the multiple balloon techniques is that each balloon is separately controlled, requiring additional elements and operational skills for the doctor using the catheter.

[0007] Another development with catheters is the inclusion of a secondary chamber having a lumen extending therethrough. The lumen-specific chamber may be on the exterior of the catheter and when expandable, provides an outer chamber, generating a veritable figure eight design, allowing for a single operator exchange mode of operation.

[0008] One type of catheter is a balloon dilation catheter that has an outer braided shaft, where the balloon and the catheter are both fixed at the same length. Through the inclusion of a

fluid between an inner shaft and the outer shaft, the balloon is inflated and the catheter is then deformed to offset the change in length because the expansion of the balloon causes the total length to decrease.

[0009] Issues arise in the comfort to the patient for the insertion and removal of catheters. One existing solution is the inclusion of a protective sleeve over the balloon(s) that run along the catheter. The protective sleeve may provide insulative properties as well as facilitate drug dispensing in assisting the catheter insertion / removal operations. The protective sleeve does not provide for the adjustment of any of the physical properties of the catheter, but rather assists in the insertion and/or removal of the catheter.

[00010] Therefore, while there exists many different variations of catheter technology, problems still remain with the limited contact area of a balloon, as well as the problems with multiple balloons and managing the inflation / deflation process with the different balloons. Furthermore, catheter technology does not provide for changing the properties of the catheter or a tubular element including the catheter, but rather focuses on the insertion / removal of the catheter as well as managing distinct balloon segments on various exterior portions of the catheter itself

SUMMARY OF THE INVENTION

[00011] The present invention provides, in one embodiment, an adjustable medical tubular device that includes a cylindrical catheter and a tubular element in continuity with the catheter. The tubular element extends at least a portion of the catheter and is composed of a material that allows for changing the properties of the tubular element. The adjustable medical tubular device further includes a cavity defined between the cylindrical catheter and the tubular element. The cavity fully or partially extends concurrent with the length of the tubular element.

[00012] The adjustable medical tubular device further includes a cavity filling device

operative to dispose a filler within the cavity. The filling device may be a pneumatic and/or hydraulic device for insertion of the filler within the cavity. The filler may also be liquid, gas and/or gel.

[00013] The filler, within the cavity, changes at least one of the properties of the tubular element. For example, one exemplary property to be adjusted may be stiffness or rigidity of the tubular element. Another exemplary property to be adjusted may be insulation properties of the tubular element

[00014] The inclusion of the filler may also be regulated to adjust the shape of the medical device allowing for navigation. For example, inflating one side of the cavity can cause the deflection of the tubular device through a non-straight internal cavity, such as for example, a patient's vein. This can be accomplished in a variety of ways, including by inserting filler into different portions of the cavity at different rates, by using channels within the cavity created through the use of spacers or dividers to divide the tubular element into separate elements, or by making the tubular element have different deformability properties at a desired location of the deflection.

BRIEF DESCRIPTION OF THE DRAWINGS

[00015] The invention is illustrated in the figures of the accompanying drawings which are meant to be exemplary and not limiting, in which like references are intended to refer to like or corresponding parts, and in which:

[00016] Fig. 1 illustrates a plan view of one embodiment of a medical tubular device;

[00017] Fig. 2 illustrates a cross sectional view of the device of Fig. 1 via the cross section II-II;

[00018] Fig. 3 illustrates a plan view of one embodiment of the medical tubular device with an inflated tubular element;

[00019] Fig. 4 illustrates a cross sectional view of the device of Fig. 3 via the cross section IV-IV;

[00020] Fig. 5 illustrates a plan view of one embodiment of the medical tubular device with an adjustment of the navigational direction of the catheter;

[00021] Fig. 6a illustrates a cross sectional view of the device of Fig. 5 via the cross section VIa -VIa;

[00022] Fig. 6b illustrates a cross sectional view of the device of Fig. 5 via the cross section VIb -VIb;

[00023] Fig. 7 illustrates a plan view of one embodiment of the medical tubular device;

[00024] Fig. 8a illustrates a cross sectional view of the device of Fig. 7 via the cross section VIIIa -VIIIa;

[00025] Fig. 8b illustrates a cross sectional view of the device of Fig. 7 via the cross section VIIIb -VIIIb;

[00026] Fig. 9 illustrates a plan view of one embodiment of the medical tubular device;

[00027] Fig. 10a illustrates a cross sectional view of the device of Fig. 9 via the cross section Xa -Xa;

[00028] Fig. 10b illustrates a cross sectional view of the device of Fig. 9 via the cross section Xb -Xb;

[00029] Fig. 11 illustrates another embodiment of a medical tubular device; and

[00030] Fig. 12 illustrates a cross sectional view of the device of Fig. 11 via the cross section XII-XII.

DETAILED DESCRIPTION

[00031] In the following description of the embodiments of the invention, reference is

made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration exemplary embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural changes may be made without departing from the scope of the present invention.

[00032] Fig. 1 illustrates one embodiment of a medical tubular device 100 having a cylindrical catheter 102 and a tubular element 104. As would be recognized by those of skill in the art, the catheter need not be cylindrical in shape and need not be circular or elliptical in cross section as shown in the drawings, but may have other cross-sectional shapes, such as rectangular, hexagonal, or octagonal. The tubular element 104 extends at least a portion of the catheter 102 and is composed of a material allowing for the tubular element 104 to change its properties. For example, as described in further detail below, the tubular element may change its properties relating to stiffness, thickness, shape and insulation, among other properties.

[00033] The device 100 further includes a cavity 106 defined between the catheter 102 and the tubular element 104. The cavity 106 extends concurrent for the length of the tubular element 104.

[00034] The device 100 further includes a cavity filling device 108 to dispose filler within the cavity 106. The inclusion of the filler within the cavity 106 thereby adjusts at least one of the properties of the tubular element 104. The filler may be any suitable matter capable of being disposed and placed in the cavity 106, such as for example liquid, gas or gel.

[00035] Fig. 1 illustrates an embodiment without any filler within the cavity 106. Fig. 2 provides a cross sectional view of the medical device 100 across the cross section II-II. Illustrated in the cross section, the device 100 includes the catheter 102, the tubular element 104 and the cavity 106. The simplicity of this figure provides additional illustration with respect to the additional embodiments described below.

[00036] Referring back to Fig. 1, the cavity filling device 108 is illustrated as an

adaptable region capable of being deformed in a bulbous manner for temporarily holding an excess amount of filler prior to be disposed into the cavity 106. The cavity filling device 108 may also include additional elements not expressly illustrated but recognized by one having ordinary skill in the art. For example, a hydraulic device and/or a pneumatic device may be utilized for the inclusion of the filler therein. The utilization of the cavity 106 with the filling device 108 described herein overcomes complicated issues associated with prior techniques of using syringes to insert filler material within the catheter, such as the utilization of the catheter to inflate a balloon located at a defined location of the catheter.

[00037] In this embodiment, the tubular element 104 runs the length of the catheter 102 around the outside. A portion of this outside element 104 may be connected to the catheter 102 in a way that will not allow the cavity 106 to be filled with air, where in one embodiment the cavity 106 may include O-ring (not shown) extending around the exterior of the catheter 102. Therefore, in this embodiment, a series of ridges or grooves on the exterior of the catheter 102 may provide a non-collapsible pathway for the filler. These ridges can be quite small (0.002 in.) when used with a relatively stiff membrane, so as not to become occluded by the outer pathway. For safety considerations, the element 104 may be prevented from extending the entire length, such as to avoid even the potential of inadvertent gas release from a damaged membrane.

[00038] In the embodiment wherein the filler changes the insulation properties, the insulation may provide the delivery of catheter contents at desired temperatures. Heat loss from a catheter is related to radiation, convention and conduction. Heat transfer from the surrounding blood to the catheter contents can be quite high since the catheter 102 is thinned wall, is made of a non-insulating material, is surrounded by flowing fluid, and its long thin shape has a very low volume to surface area ratio. Catheters used for intra- arterial navigation range in size from 3-14 French (diameter in mm), with the most common range being in the 4-8 French range. Since gas is approximately 1000 times more effective as an insulation than water, a small amount of gas

insulation is very effective. In various embodiments, a pneumatic membrane can be placed along the outside or inside of the longitudinal tubular element 104. The cavity 106 could be filled with a gas, where the gas is a non-toxic and stable, with a high solubility, including such gases as, Helium, CO_2, Argon, NO or admixtures. Thereby, using these gases would add a safety feature, since, if the membrane was to inadvertently rupture, spillage of this material at distal emboli would be non-toxic.

[00039] With reference to the filler mechanism, Fig. 3 illustrates another embodiment of the tubular medical device 100 which includes the inclusion of filler within the cavity 106. As illustrated, the bulbous element 108 is now reduced in size relative to its shape in Fig. 1. This size reduction represents the displacement of filler within the cavity 106 as noted by the enlarged circumferential distance between the catheter 102 and the element 104.

[00040] Fig. 4 illustrates a cross section along the line IV-IV. This cross section further illustrates the radial displacement of the tubular element 104 and the enlargement of the cavity 106. As illustrated, the radius of the catheter 102 has not changed, therefore the displacement by the inclusion of the filler is noticeable only relative to the tubular element 104.

[00041] Through the inclusion of this filler, at least one property of the tubular element 104 may be adjusted. The adjustment of the tubular element property further translates to adjustment of a property corresponding to the medical device 100. For example, the inclusion of the filler in the cavity 106 may stretch the tubular element 104 and provide a degree of rigidity or stiffness. This stiffness may then support operations using the catheter 104. In another example, the inclusion of the filler may provide insulation between the catheter and the body cavity that the element 100 is encased therein. This insulation may be useful for delivering contents through the catheter 102 at a desired temperature, for example.

[00042] Fig. 5 illustrates another embodiment of a medical device 120, similar to the

tubular device 100 of Fig. 1, including a catheter 122, a tubular element 124 and a cavity 126 defined between the catheter and the element 124. The device 124 further includes the cavity filling device 128 for inserting filler within the cavity.

[00043] The medical device 120 of Fig. 5 includes providing for the deflection of the tubular element 124 and hence deflection of the catheter 122 by the insertion of the filler material. Through the localized displacement of filler materials, this can change the rigidity property of the tubular element 126 to change the shape and thus allow for navigation within a non-straight canal or cavity. Alternatively, portions of the tubular element 124 at desired locations for displacements or deflection may have different characteristics, such as different deformability or expandability, so that opposing sides of the tubular element 124 expand different amounts to thereby cause more filler to be present on one side than the other, thus pressuring the catheter to deflect as shown. As known to one of ordinary skill in the art, the catheter would of course also need to be deformable or bendable, at least in the region in which the deforming is desired to navigate the vein or artery, at some proportion to the tubular element so that the deforming of the tubular element causes the catheter to bend in the same direction accordingly.

[00044] Figs. 6a and 6b provide cross sectional illustrations of the device 120 at the two exemplary points noted by the cross sections VIa-VIa and Vlb-VIb. These two cross sections illustrate the relationship of the catheter 122, the tubular element 124 and the cavity 126 for each portion of the tubular device 120.

[00045] Fig. 6a illustrates the cross section similar to Fig. 4, where the inclusion of the filler maintains an even circumferential difference of the cavity 126 between the catheter 122 and the tubular element 124. By contrast, Fig. 6b illustrates that with offsetting pressure of the filler quantity, the tubular element 124 therefore bends, in this example, to the right. As such, the cavity 126 is offset with a larger spacing on the left to accommodate the right-direction

displacement of the tubular element 124 and hence the right-direction displacement of the catheter. This larger spacing on the left of the tubular element 124 may also be caused by making that region of the tubular element 124 more expandable or deformable than the region on the right, thus allowing it to expand and retain more filler than the opposing side. The right side of the tubular element 124 in Fig. 6b may alternatively be stiffened prior to use such as by being burned or tacked to the catheter element to prevent or limit its expansion when filler is disposed in the cavity 126.

[00046] Fig. 7 illustrates another embodiment of a device 140, similar to the tubular device 100 of Fig. 1, including a catheter 142, a tubular element 144 and a cavity 146 defined between the catheter and the element 144. The device 144 further includes the cavity filling device 148 for inserting filler within the cavity.

[00047] In the embodiment of Fig. 7, the medical device 140 further includes spacers or ridges 150 on the exterior of the catheter 142 to divide the cavity and provide adjustable insertion of filler at defined, divided portions of the cavity 146. Though Fig. 7 shows only one such spacer 150, a plurality of such spacers may be used to create as many divided portions as desired. In addition, though the spacer in Fig. 7 is shown as extending substantially the entire length of the tubular element, it may extend only a portion of such length in order to create localized divided cavity portions at desired locations along the tubular device. Fig. 7 illustrates a first step in one embodiment of adjusting the shape property of the catheter 142, wherein the second step is illustrated in Fig. 9, as discussed further below.

[00048] The cavity filling device 148 includes a plurality of separate membranes where the filler is capable of being inserted into the different chambers of the tubular element 144. The inclusion of filler in these specific chambers allows for ease of deflection of the catheter 142.

[00049] In the exemplary embodiment of Fig. 7, cross sections VIIIa - VIIIa and VIIIb

- VIIIb illustrate the circumferential differences of the cavity. Fig. 8a illustrates the cavity 146 being circumferentially even between the catheter 142 and the tubular element 144. Fig. 8b illustrates the cavity 146 being circumferentially uneven between the catheter 142 and the tubular element 144, where this uneven cavity 146 is controlled by the offsetting chambers defined by the spacers or ridges 150.

[00050] In continuation, Fig. 9 illustrates the further embodiment of the inclusion of filler material to thereby radially displace catheter 142. The device 100 includes the catheter 142 and tubular element 144 being displaced to the right with cavity filling device 148 being deflated from the inclusion of the filler material within the cavity 146.

[00051] The two cross sections of Figs. 10a and 10b, illustrate the management of possible bulging within the tubular element 144. Fig. 10a illustrates the cross section of Xa - Xa of Fig. 9, showing the localized bulging of the different channels 150 within the cavity 146. In this example, four defined channels 150 are illustrated and the volume of filler displacement is essentially equal therebetween. Fig. 10b illustrates the cross section of Xb - Xb of Fig. 9, wherein the channels have a varied filler volume displacement corresponding to the displacement of the catheter 142.

[00052] As illustrated by Figs. 9, 10a and 10b, the tubular device 140 can be directionally displaced at a designated location by the specified insertion of filler material at defined locations. In this embodiment, the inclusion of spacers 150 to create separate, divided channels provides for the controlling of any bulging or other protrusions that can arise from the irregular insertion of filler. In this embodiment, the insertion of the filler adjusts the directional property of the tubular device, as well as having the ability to change additional properties. For example, the filler can also change insulation properties, as well as provide a degree of rigidity to the tubular element 144.

[00053] Figs. 1-10 illustrate embodiments having the tubular element exterior to the

catheter. The adjustable medical tubular device may further include the tubular element being interior to the catheter, as illustrated in Figs. 11 and 12. The medical device 160 includes the catheter 162, tubular element 164 disposed interior to the catheter thereby forming the channel 166 therebetween. In the illustration of Fig. 11, the cavity filling device has been omitted for clarity purposes only, but may operate similar to the device 108 of Fig. 1 or any other suitable filling technique as recognized by one skilled in the art.

[00054] Fig. 12 illustrates a cross sectional view of the device 160 across the cross section XII - XII, illustrating the circumferential disposition of the catheter 162, tubular element 164 and the cavity 166.

[00055] The inclusion of the tubular element 164 within the catheter 162 allows the tubular element 164 to act as a controllable valve. This embodiment allows for the filler to change the shape property of the tubular element 164 and thus the resistance of flow of contents through the cavity 166 within the catheter 162, thereby acting as a control valve. Moreover, the inclusion of the filler material can also add directionality to the resistance within the cavity 166 and thereby the tubular element 164 can act as a check valve.

[00056] In this embodiment, the tubular element may be a deformable, non-distensible, non-porous membrane that is attached at both ends so as to have a sealed potential space in between the catheter and the thin membrane. Materials such as medical grade shrink tubing, such as, but not limited to, Polytetrafluoroethylene (PTFE), Fluorinatedethylenepropylene (FEP), Perfluoroalkoxy (PFA), Ethylenetetrafluoroethylene, (ETFE) or Polyetheretherketone (PEEK).

[00057] In the proximal end of the catheter 162, multiple holes may be made such that they communicate with the cavity 166, and the holes are made in an area, that will not be inserted into the body. Around the outside of the catheter 162, a second deformable, non-distensible membrane is attached at both its proximal and distal ends (not shown). The

volume of gas placed in the potential space is less than the total potential space minus the volume of the potential space inside the inner potential space. Thus in a 6 Fr, 100cm catheter, the second membrane would have approximately 1 cc of volume of fluid (e.g., 0.1 x 0.1 x 100 = 1 cc), which is the determined maximum amount of filler that can be placed in this potential space. The potential space in the outer reservoir would be approximately less than 1 cc.

[00058] When the catheter is placed in the body, the inner reservoir is deflated. This due to the fact that the inner lumen is subjected to the high arterial pressure (140mm Hg + 25 mmHg) forcing the gas into the outer reservoir that is subjected to a much lower atmospheric pressure, (25 mm Hg) By putting pressure on the outer reservoir, the gas can be moved back into the catheter 162 and can function as insulation.

[00059] In this embodiment, a sleeve adjacent to the outer membrane can be advanced. In another embodiment, for insulation, a small bag can be used to hold the extra gas. In another embodiment, tubing can connect this space to a syringe, although in this embodiment, it needs to be noted that the system if filled with room air, and/or is over inflated, it could lead to rupture of the membrane, damage to the catheter, occlusion of the lumen, and dangerous air emboli. In this embodiment, the syringe mechanism should be sealed, filled with non toxic gas and have a pre determined amount of gas, and have a low friction mechanism so the pressures can equalize when the plunger is released.

[00060] The foregoing description of the specific embodiments so fully reveal the general nature of the invention that others can, by applying knowledge within the skill of the relevant art(s) (including the contents of the documents cited and incorporated by reference herein), readily modify and/or adapt for various applications such specific embodiments, without undue experimentation, without departing from the general concept of the present invention. Such adaptations and modifications are therefore intended to be within the

meaning and range of equivalents of the disclosed embodiments, based on the teaching and guidance presented herein. It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the present specification is to be interpreted by the skilled artisan in light of the teachings and guidance presented herein, in combination with the knowledge of one skilled in the relevant art(s).

[00061] While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example, and not limitation. It would be apparent to one skilled in the relevant aft(s) that various changes in form and detail could be made therein without departing from the spirit and scope of the invention. Thus, the present invention should not be limited by any of the above described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

CLAIMS

What is claimed is:

1. An adjustable medical tubular device comprising:

a catheter;

a tubular element in continuity with the catheter, the tubular element extending at least a portion of the catheter, the tubular element composed of a material allowing for the tubular element to change its properties;

a cavity defined between the catheter and the tubular element, the cavity extending concurrent with the full length of the tubular element; and

a cavity filling device operative to insert a filler within the cavity to adjust at least one of the properties of the tubular element.

2. The device of claim 1, wherein the filler is a gas.

3. The device of claim 1, wherein the filler is a liquid.

4. The device of claim 1, wherein the filler is a gel.

5. The device of claim 1, wherein the insertion of the filler into the cavity adjusts a deformability property providing rigidity to the tubular element.

6. The device of claim 1, wherein the tubular element is circumferentially exterior to the catheter.

7. The device of claim 1, wherein the cavity filling device includes an adaptable region capable of being deformed in a bulbous manner for temporarily holding an excess amount of filler, prior to the filler being inserting into the cavity.

8. The device of claim 1, wherein the tubular element is circumferentially exterior to the catheter and includes a plurality of channels each of which can be separately inserted with the filler.

9. The device of claim 8, wherein a shape property of the tubular device is

adjusted based on irregular disposal of filler material within different channels in the tubular element.

10. The device of claim 1, wherein the filled cavity adjusts an insulation property of the catheter for insulating an element passable through the catheter.

11. The device of claim 1, wherein the tubular element is circumferentially interior to the catheter.

12. The device of claim 11, wherein a shape property of the tubular device is adjusted as the tubular element adjusts the shape of the catheter based on insertion of filler from the cavity filling device.

13. The device of claim 11, wherein the adjustment of a resistance of filler flow acts as a valve.

14. The device of claim 1, wherein the cavity filling device is at least one of: a hydraulic device and a pneumatic device.

15. An adjustable medical tubular device comprising:

a catheter;

a tubular element in continuity with the catheter and circumferentially exterior to the catheter, the tubular element extending at least a portion of the catheter, the tubular element composed of a material allowing for the tubular element to change its properties;

a cavity defined between the catheter and the tubular element, the cavity extending at least partially concurrent with the full length of the tubular element; and

a cavity filling device operative to dispose a filler within the cavity to adjust at least one of the properties of the tubular element to thereby cause deflection of the tubular element and catheter through a patient's internal cavity.

16. The device of claim 15, wherein the filler is at least one of: a gas, liquid and a gel.

17. The device of claim 15, wherein the disposition of the filler into the cavity adjusts a deformability property providing rigidity to the tubular element.

18. The device of claim 17, wherein the tubular element portion adjacent to a region of the deflection comprises different deformability properties on opposing sides of the tubular element.

19. The device of claim 15, wherein the filled cavity adjusts an insulation property of the catheter for insulating an element passable through the catheter.

20. An adjustable medical tubular device comprising:

a catheter;

a tubular element in continuity with the catheter extending at least a portion of the catheter and defining a cavity between the catheter and the tubular element, the cavity including a plurality of channels defined by one or more spacers in the tubular device; and

a cavity filling device operative to dispose a filler within the cavity in different amounts for each of the channels in the cavity.

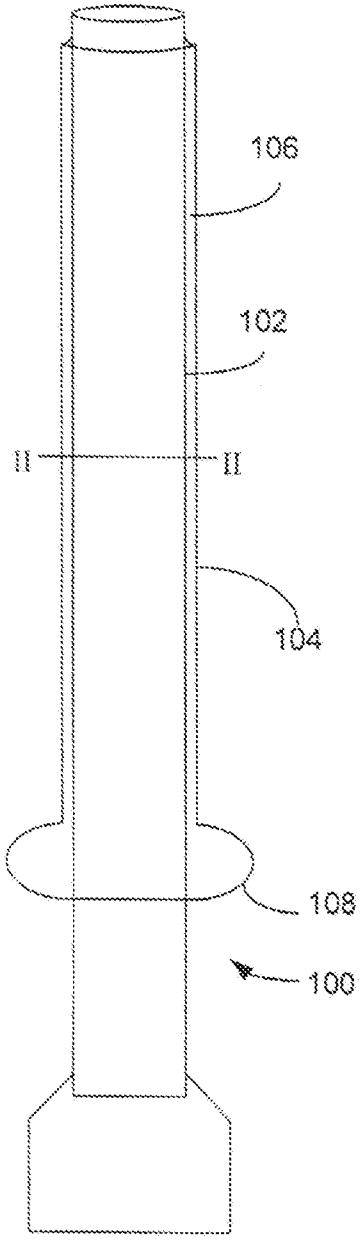

FIG. 1

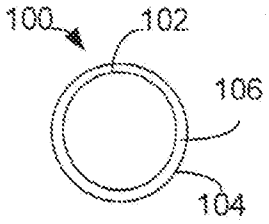

FIG. 2

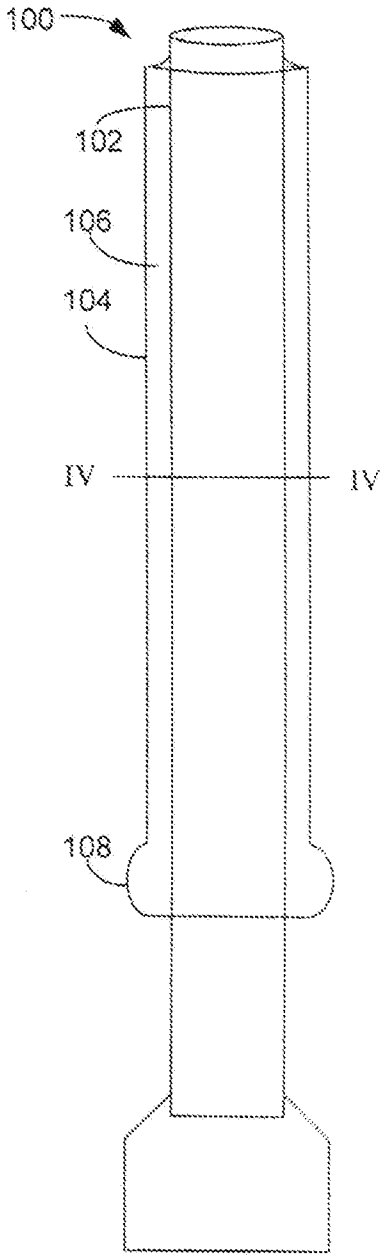

FIG. 3

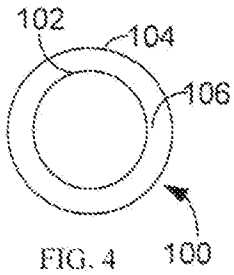

FIG. 4

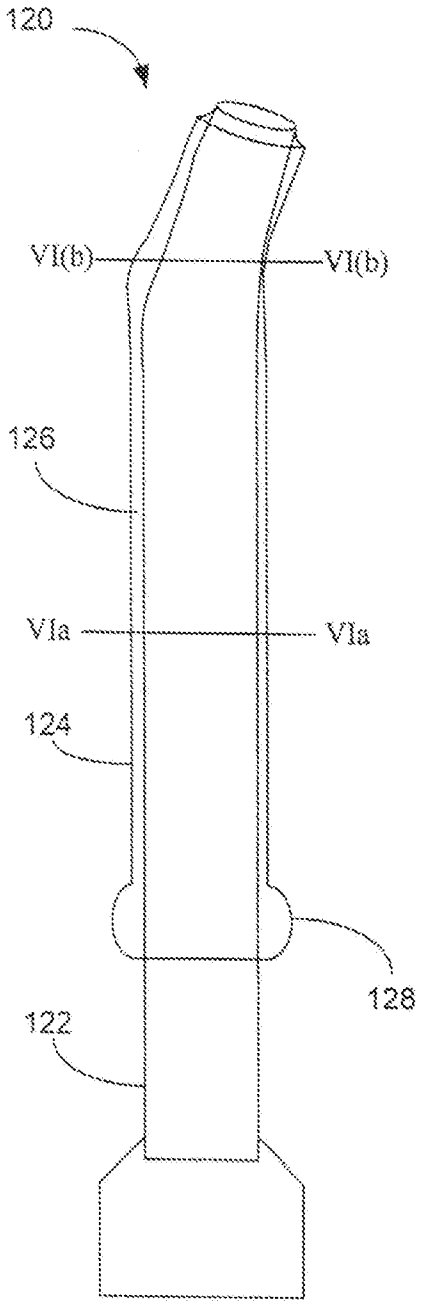

FIG. 5

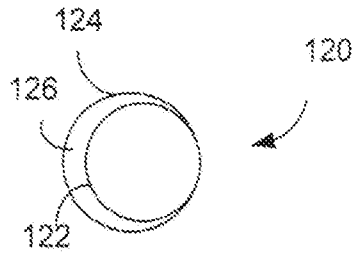

FIG. 6b

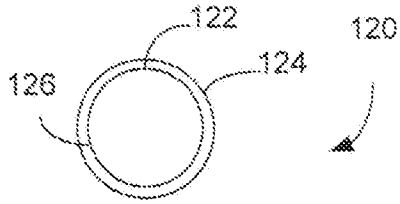

FIG. 6a

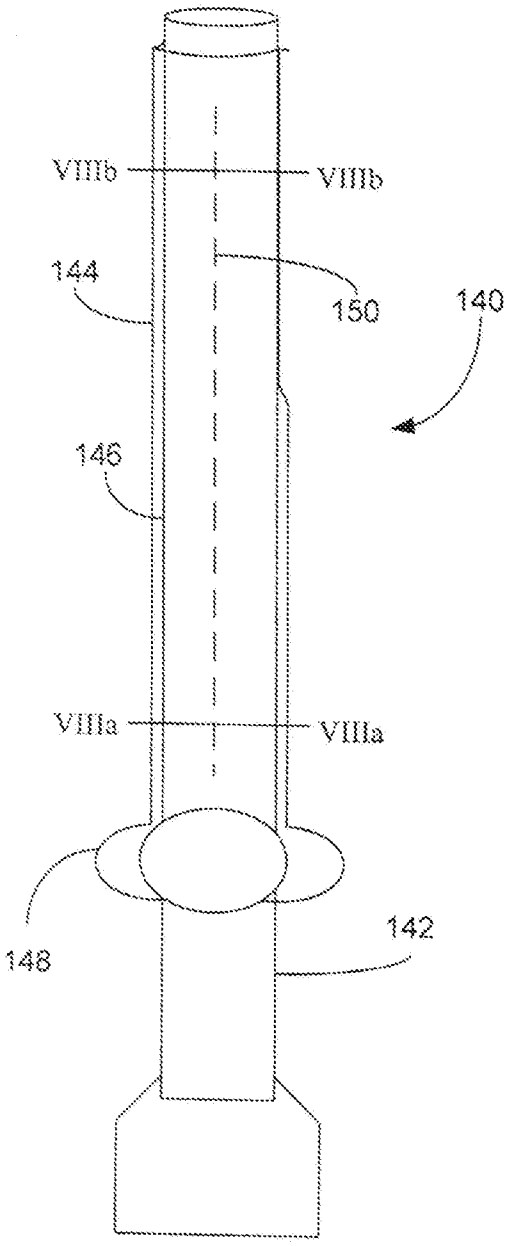

FIG. 7

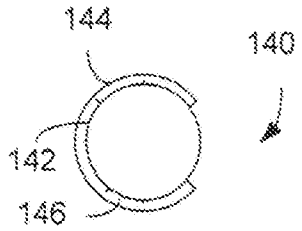

FIG. 8b

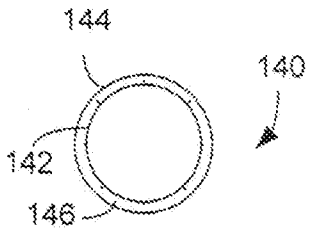

FIG. 8a

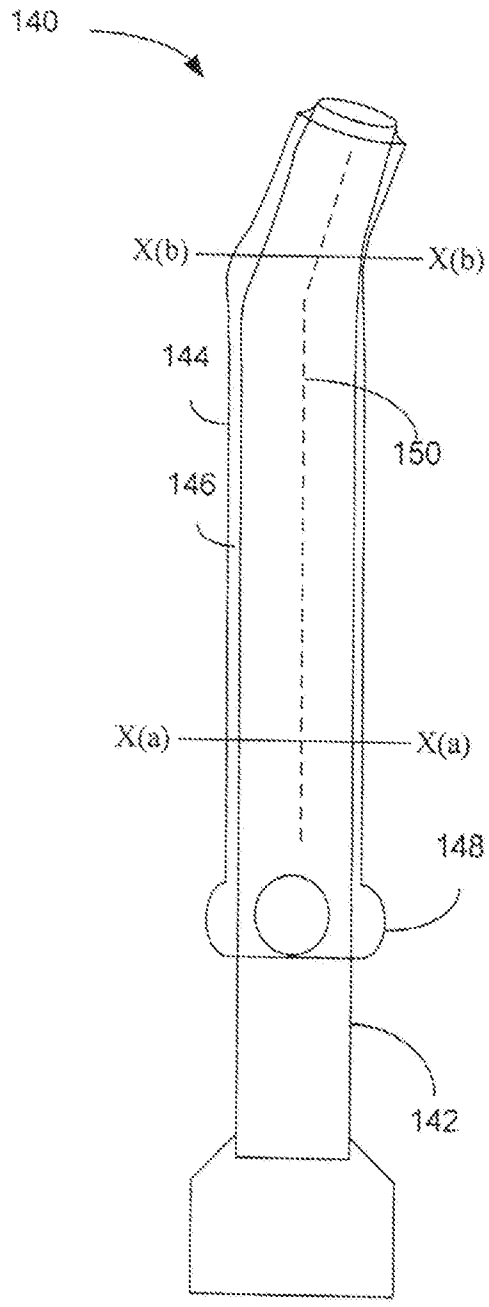

FIG. 9

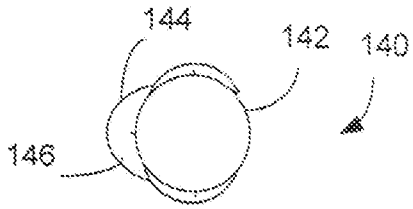

FIG. 10b

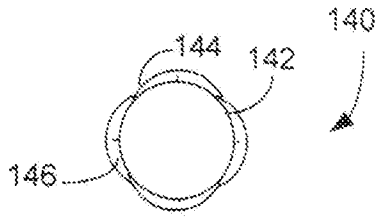

FIG. 10a

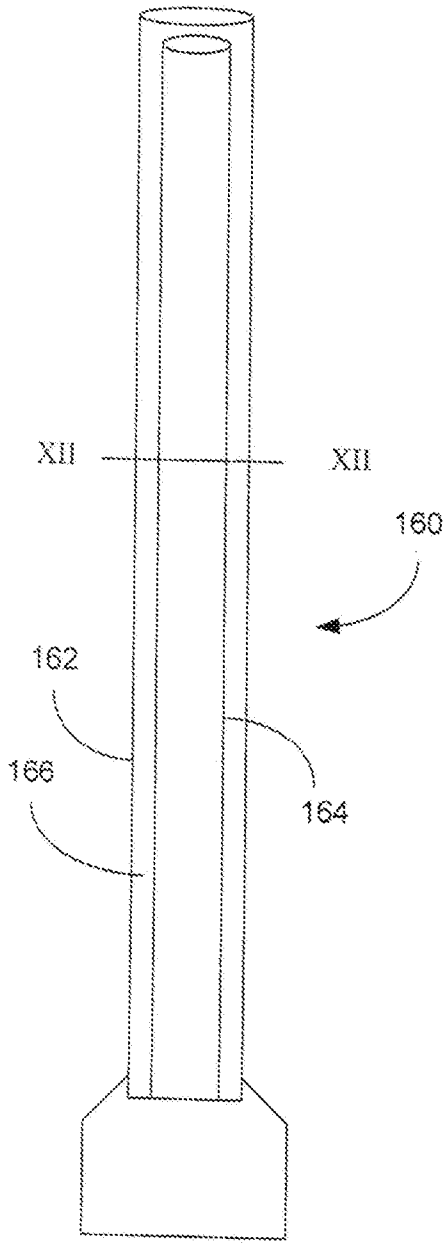

FIG. 11

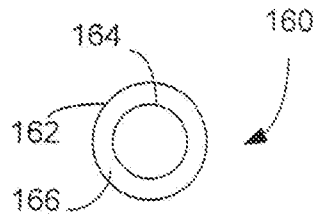

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 09/52375

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61M 25/092 (2009.01)
USPC - 604/528
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)
IPC(8) - A61M 25/092 (2009.01)
USPC - 604/528

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC (8) - A61M 25/00, 25/01, 25/14 (2009.01)
USPC - 604/48, 93.01, 264, 525, 523, 524, 536, 535, 534, 533

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB, USPT, EPAB, JPAB)
Search Terms: cavity, filler, tube, tubular device, catheter, properties, medical device

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,156,620 A (PIGOTT) 20 October 1992 (20.10.1992), Fig. 1, 4, 5, 11, col 2, ln 32-34, ln 54-56, col 4, ln 15-18, ln 48-54, col 5, ln 2-7, col 8, lnln 19-27, 23-28	1-20
Y	US 4,846,791 A (HATTLER et al.) 11 July 1989 (11.07.1989), col 2, ln 36-39, col 4, ln 61-66, col 6, ln 8-11	8, 9, 20
Y	US 6,485,512 B1 (CHENG) 26 November 2002 (26.11.2002), Fig. 1, col 5, ln 36-39, ln 44-56, ln 59-67	1-19

☐ Further documents are listed in the continuation of Box C. ☐

* 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
04 November 2009 (04.11.2009)	16 NOV 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)