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Denker et al.

(54) **CATHETER SYSTEM FOR IMPLANTING AN INTRAVASCULAR MEDICAL DEVICE**

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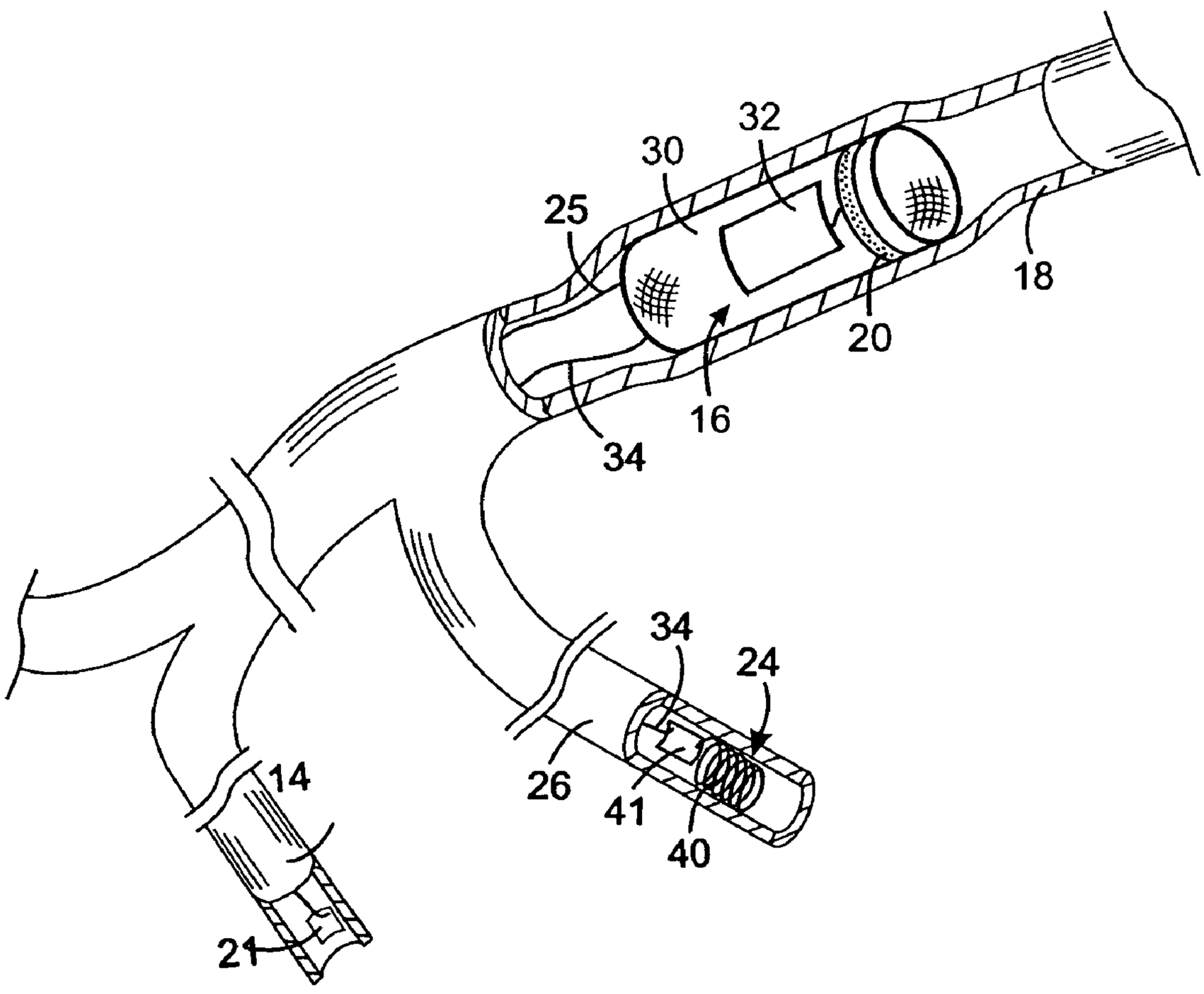
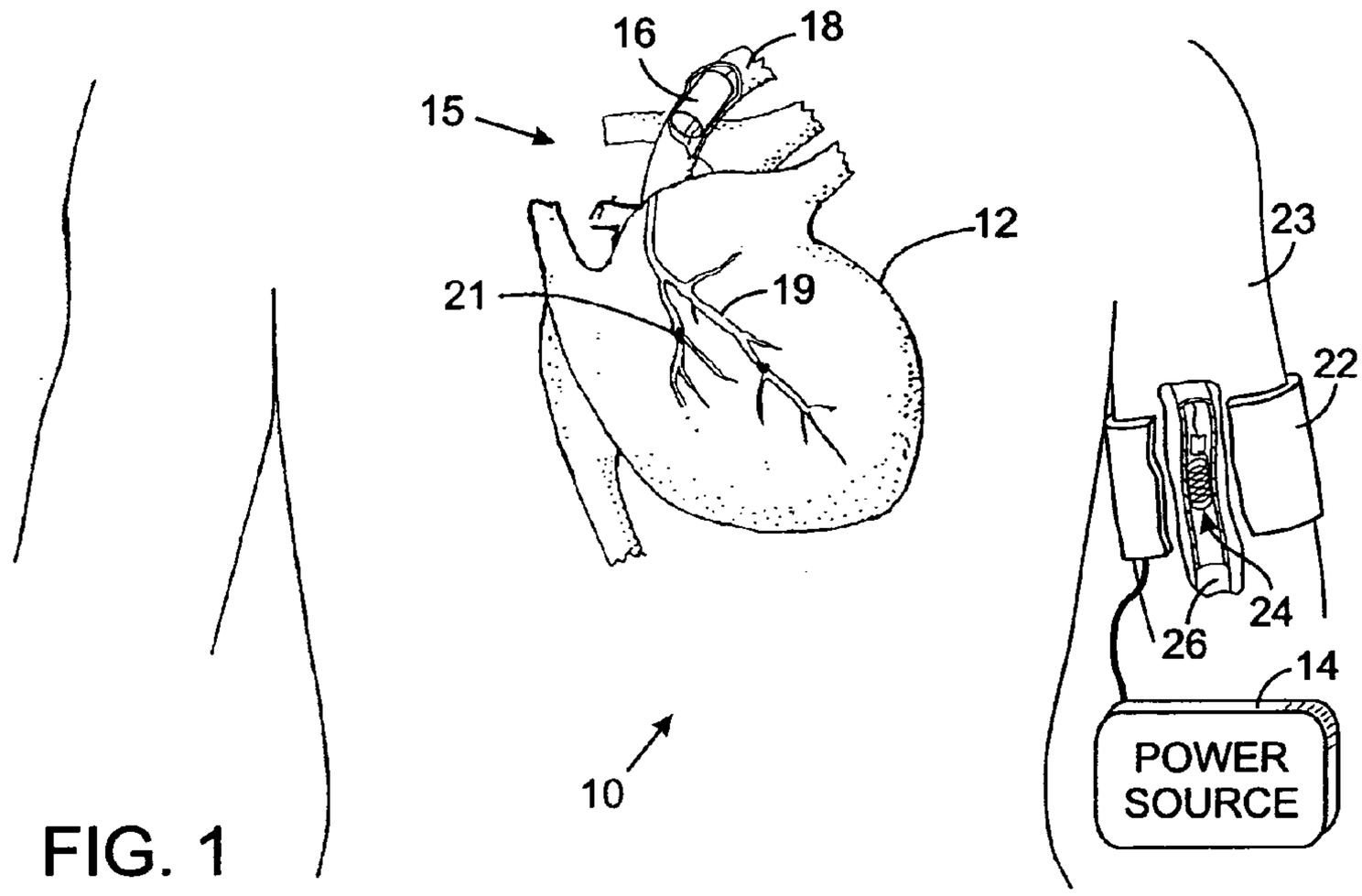
(52) **U.S. Cl.** **607/116**

(57) **ABSTRACT**

A catheter system and method are employed to implant components of a medical device inside an animal. The catheter system includes a plurality of coaxial catheters and sheaths between which electrically interconnected components of the medical device are releasably held. A guide wire is inserted to a desired location inside the animal and the plurality of catheters and sheaths is slid as an assembly along the guide wire to that location. One of the sheaths is moved with respect to the other catheters and sheaths to release one of the components. The guide wire and the remaining catheters and sheaths are repositioned to a second location inside the animal and manipulated to release another component. Additional components can be implanted by further repositioning and manipulating steps. The catheter system is removed from the animal leaving the components in place.

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POWER SOURCE
10

FIG. 1

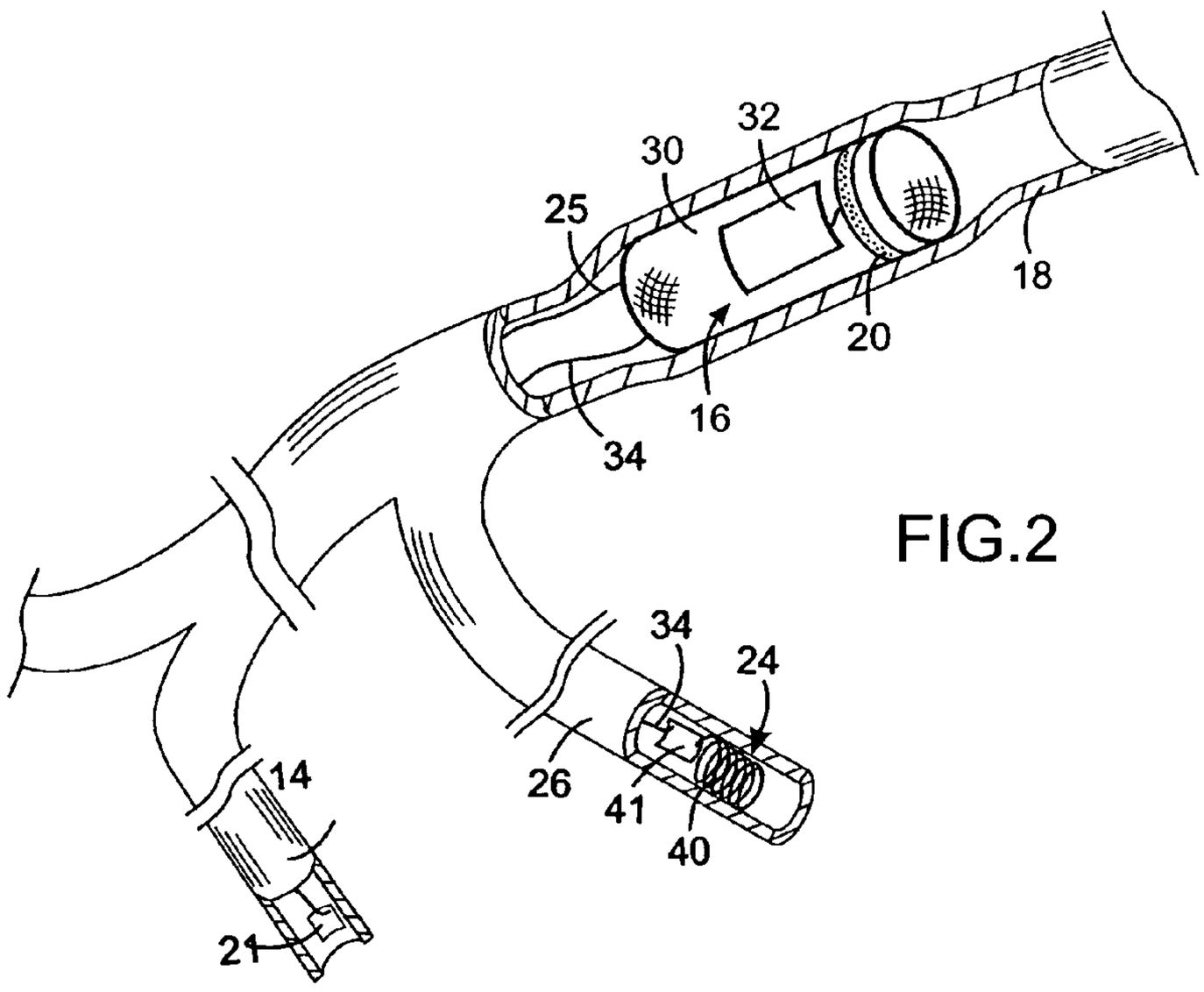
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FIG.2

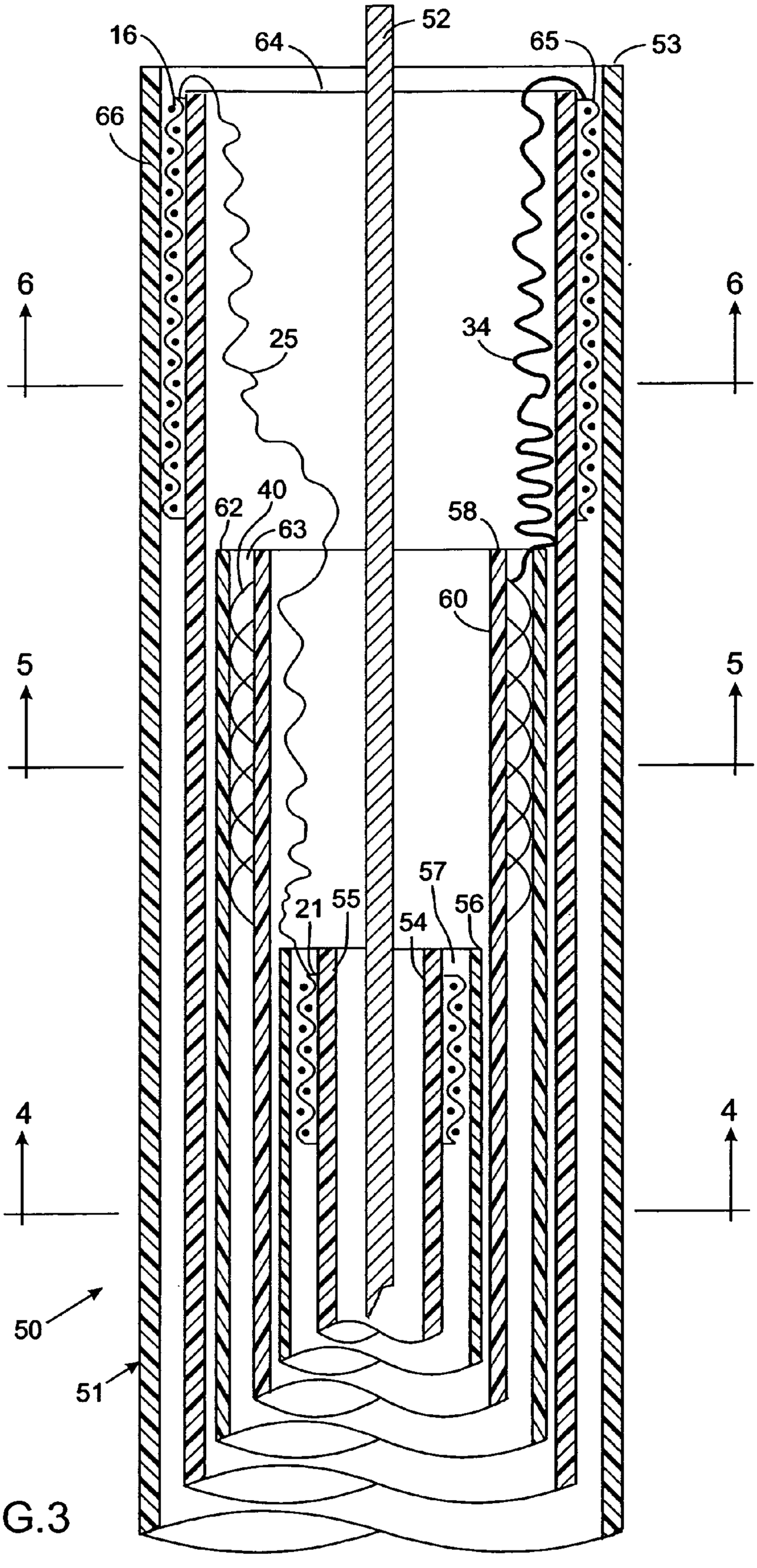

FIG.3

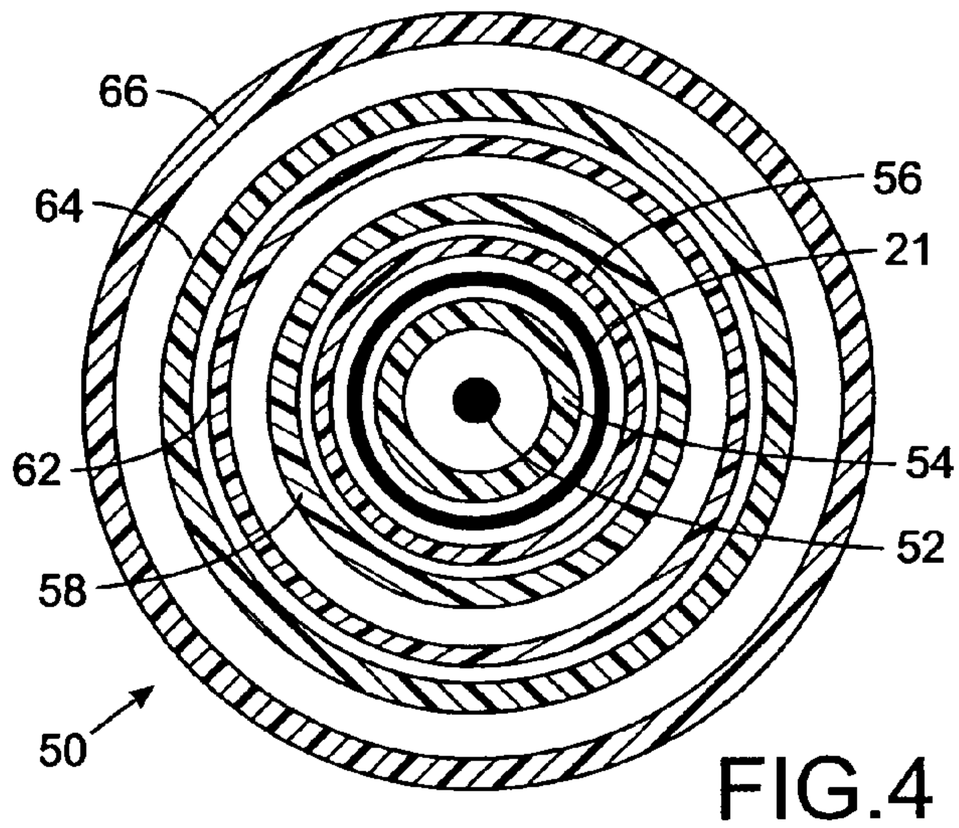

FIG.4

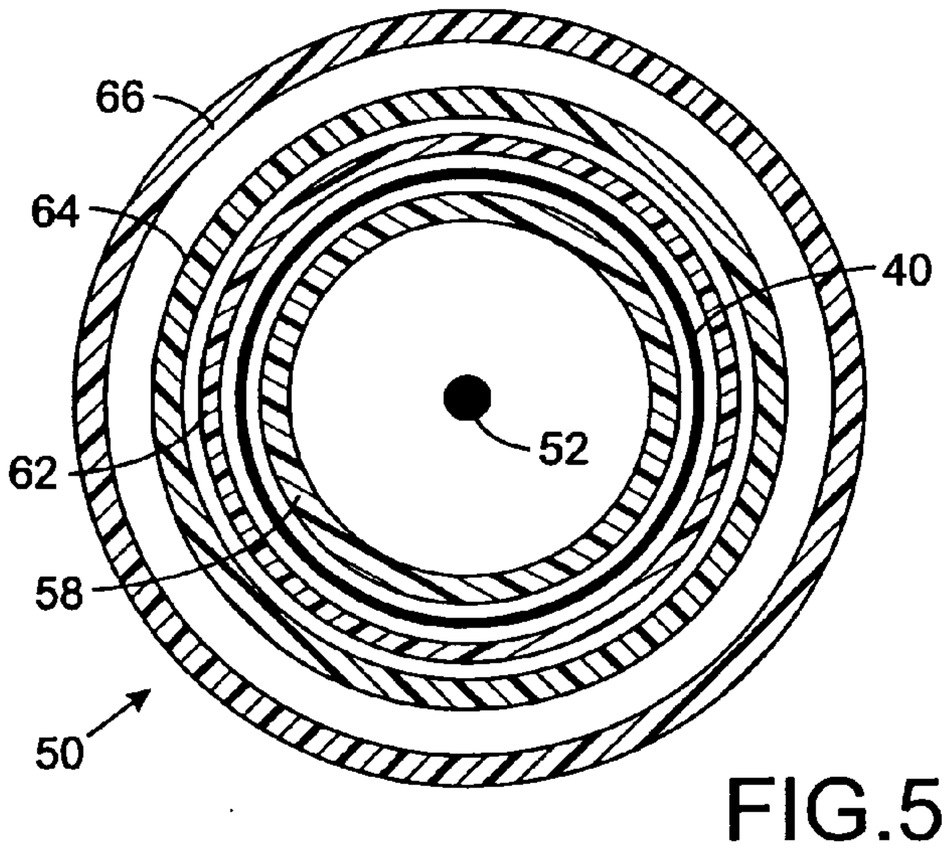

FIG.5

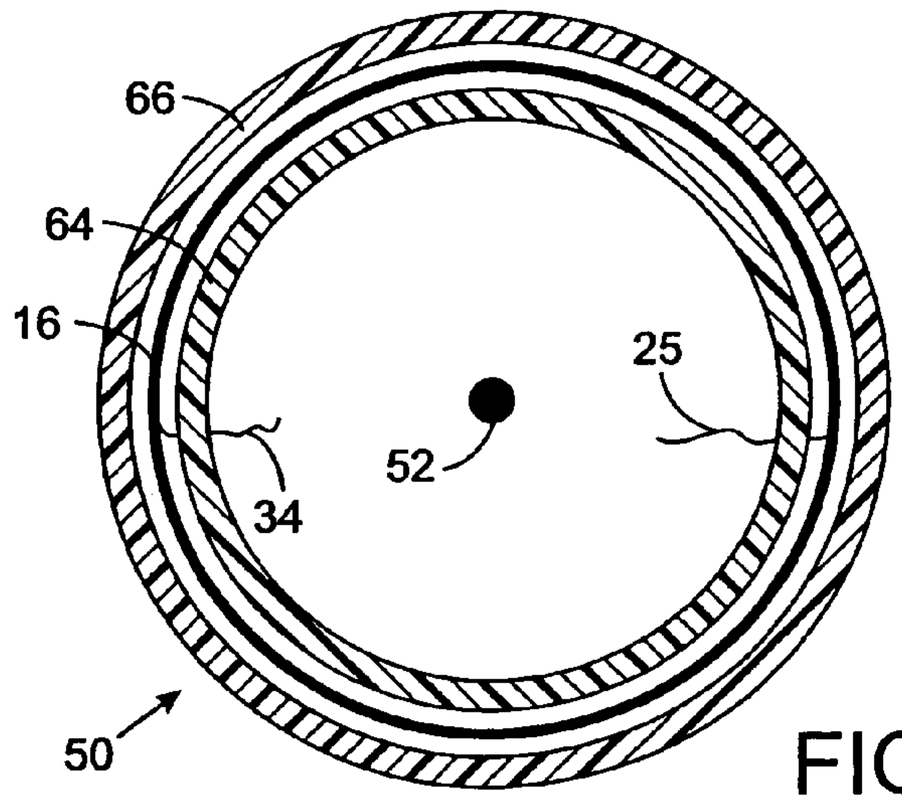

FIG.6

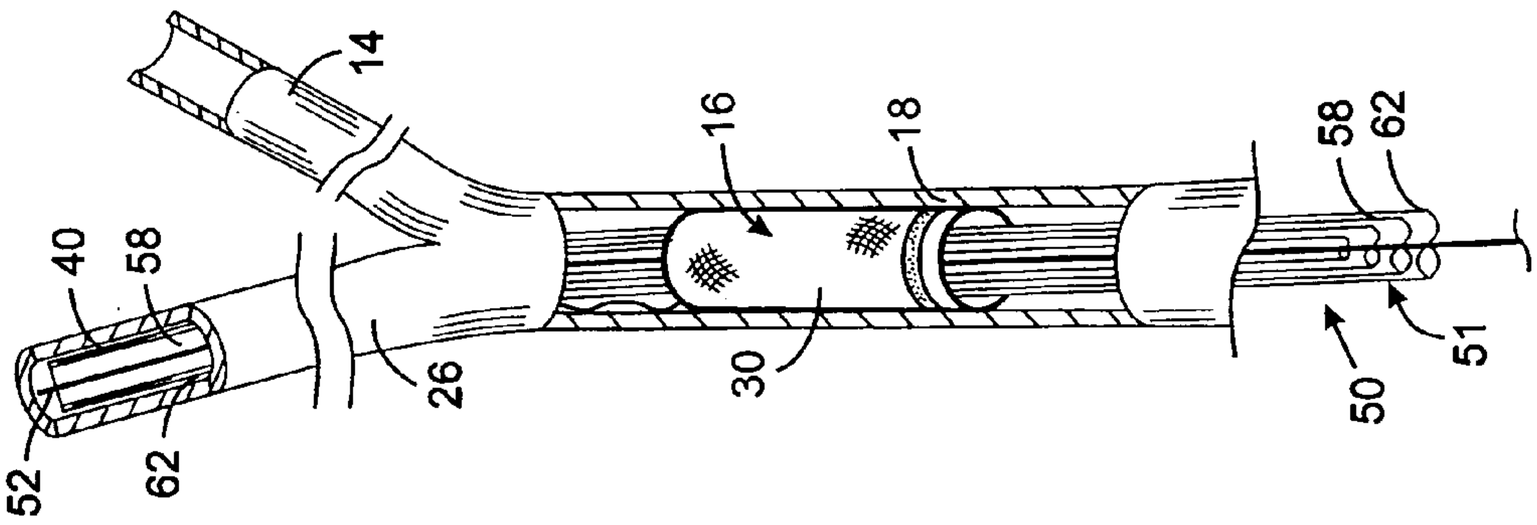

FIG.10

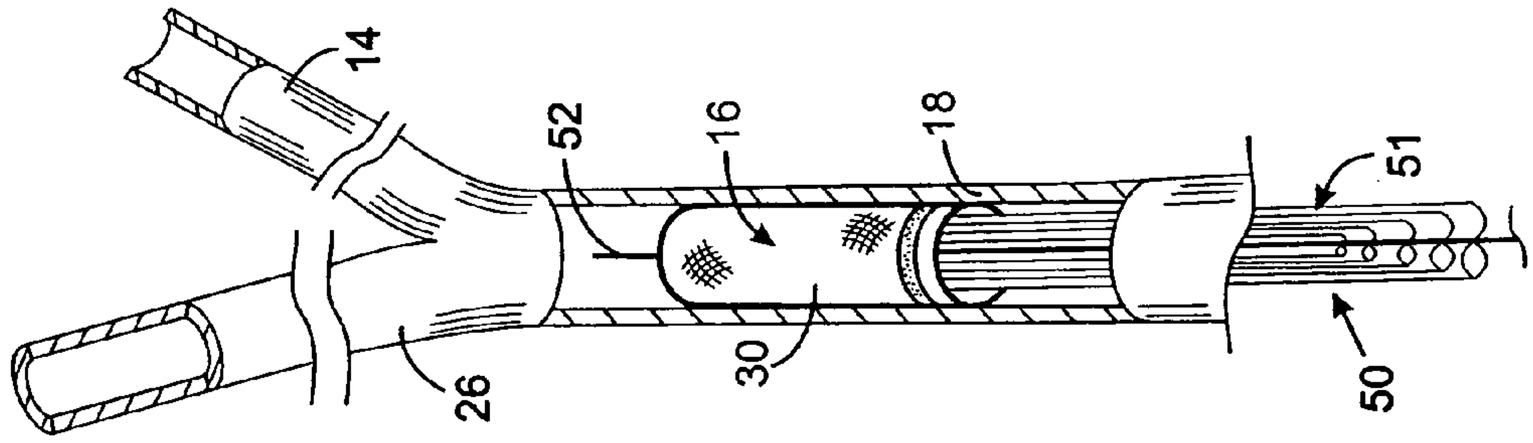

FIG.9

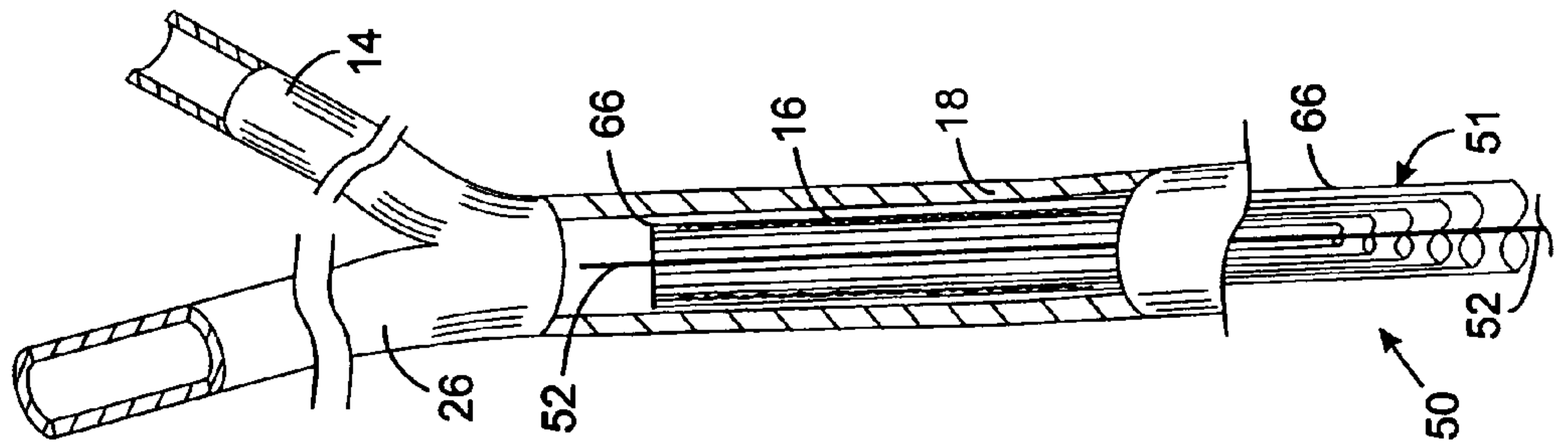

FIG.8

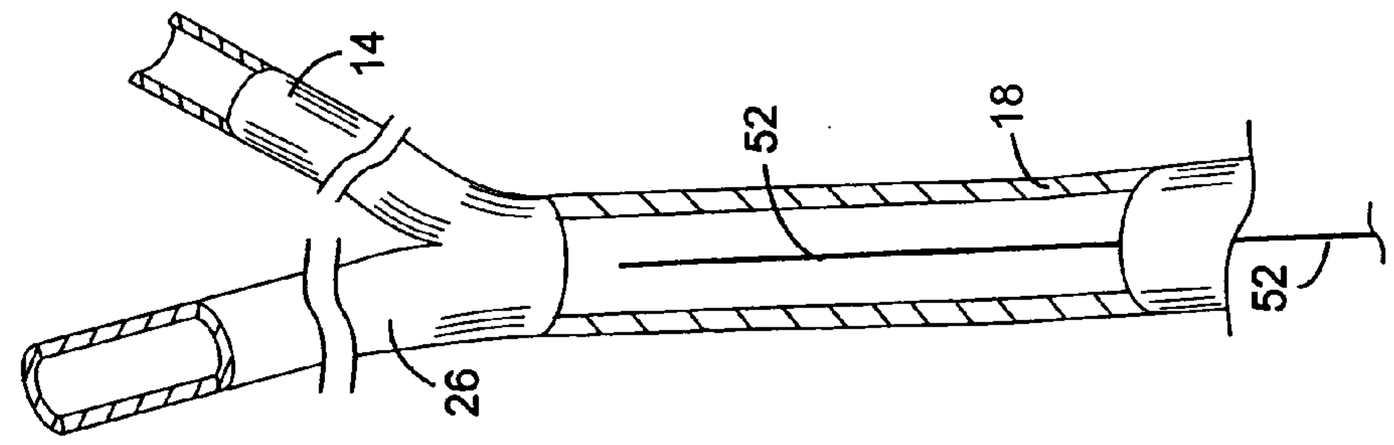

FIG.7

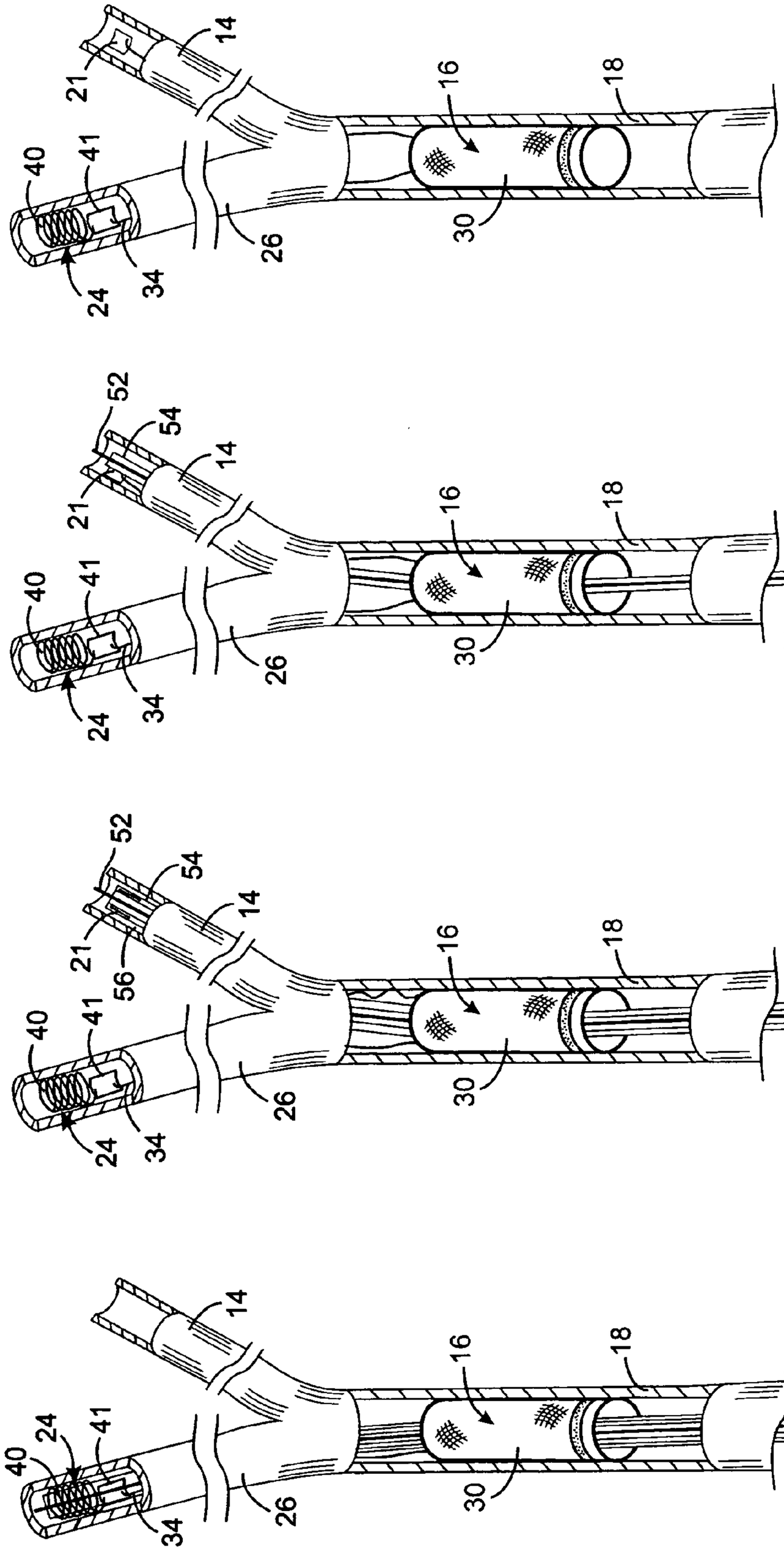

FIG.14

FIG.13

FIG.12

FIG.11

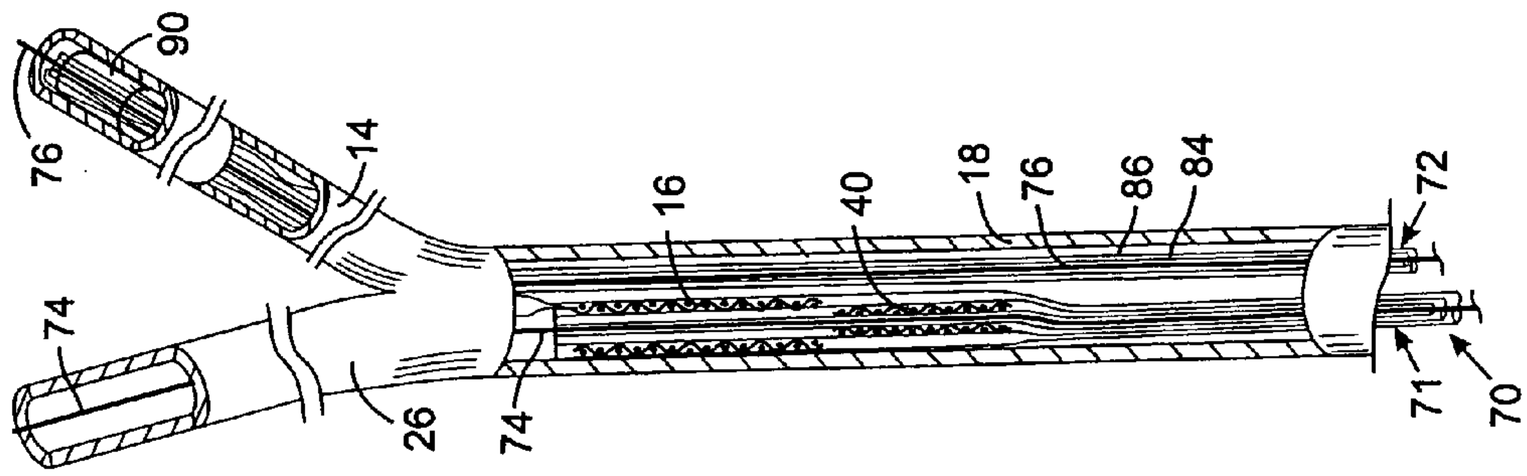

FIG.18

FIG.17

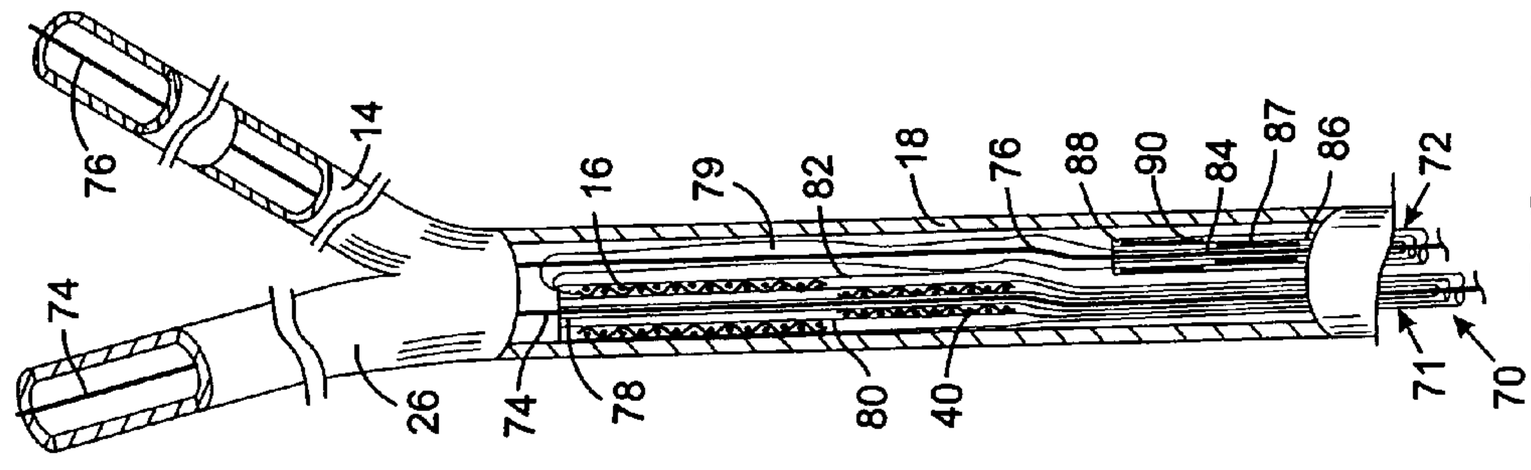

FIG.16

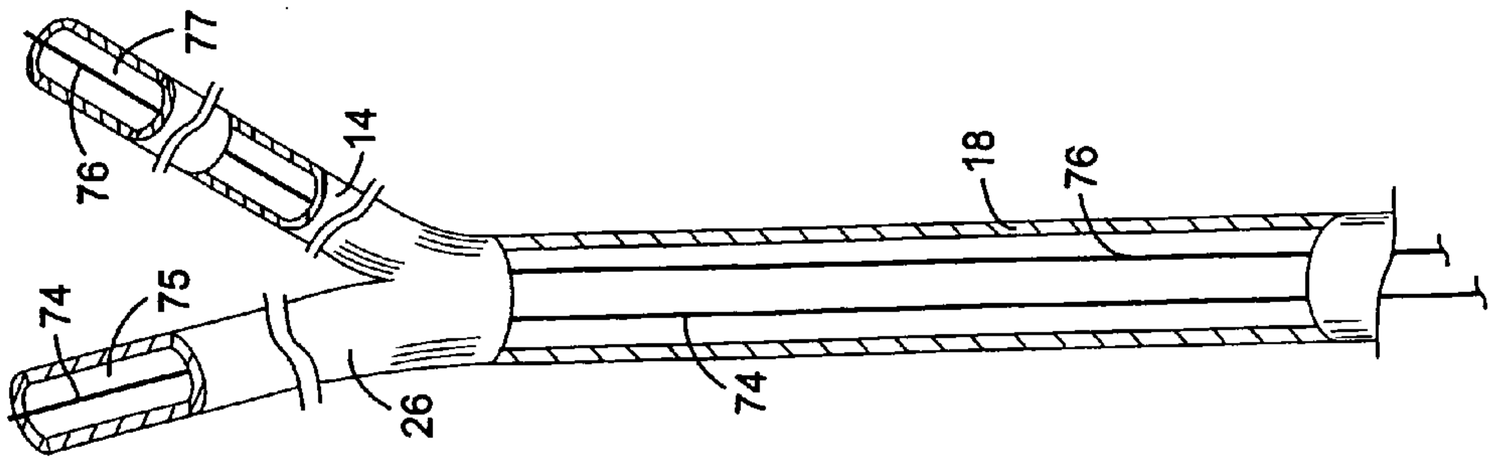

FIG.15

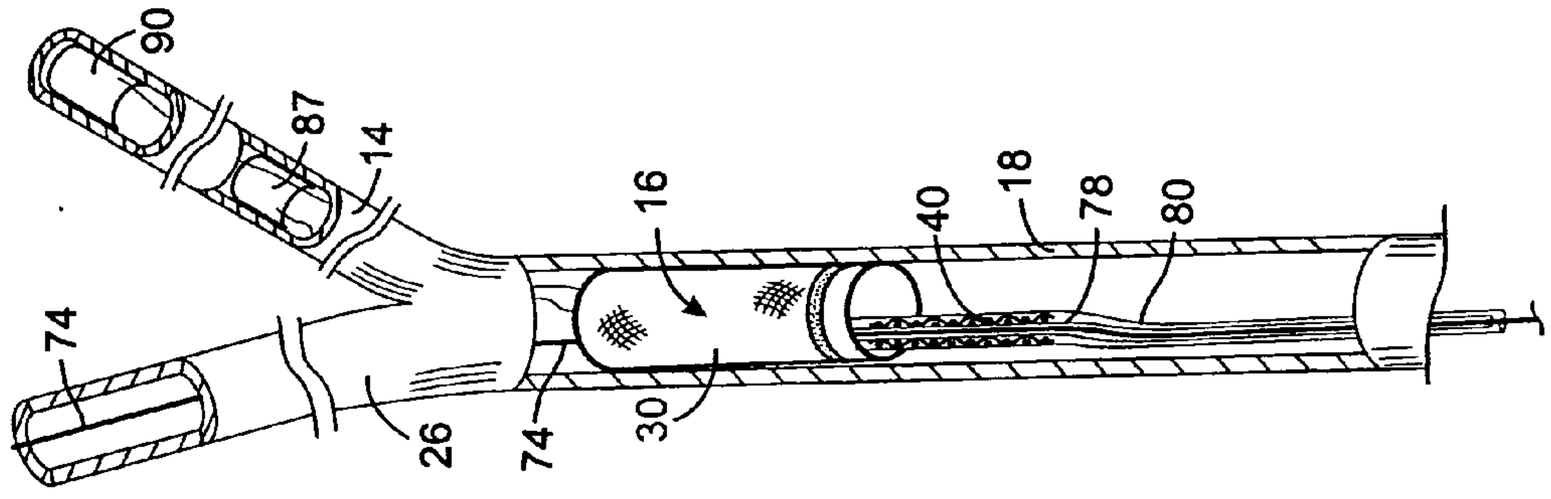

FIG.22

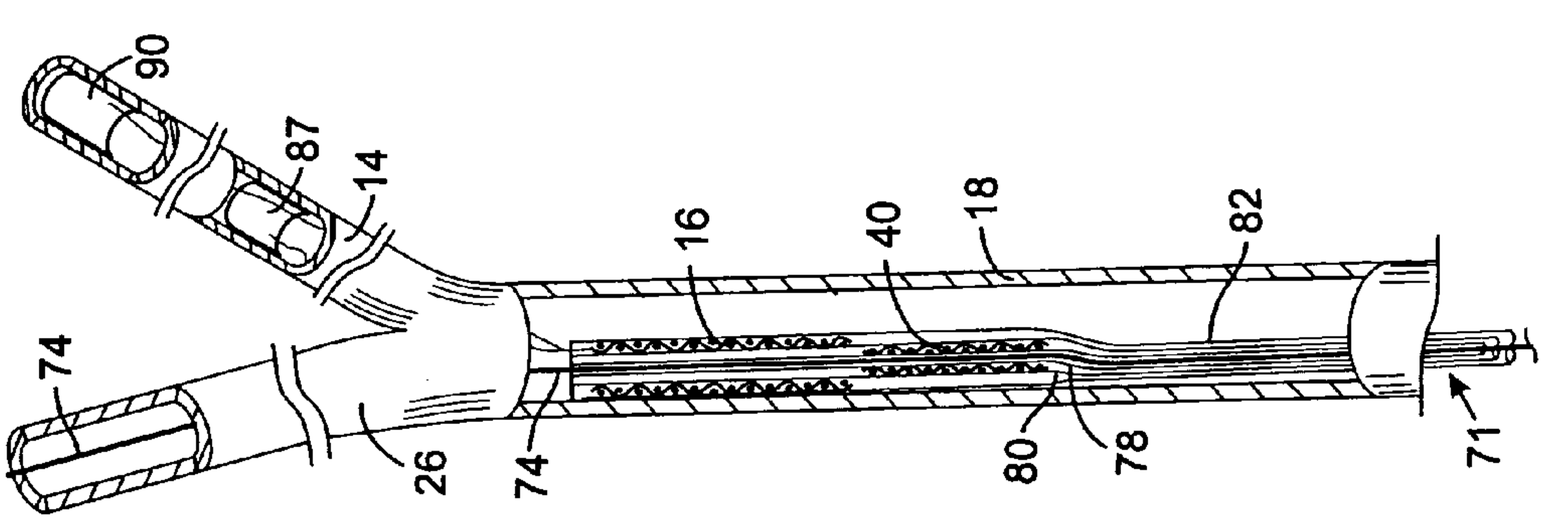

FIG.21

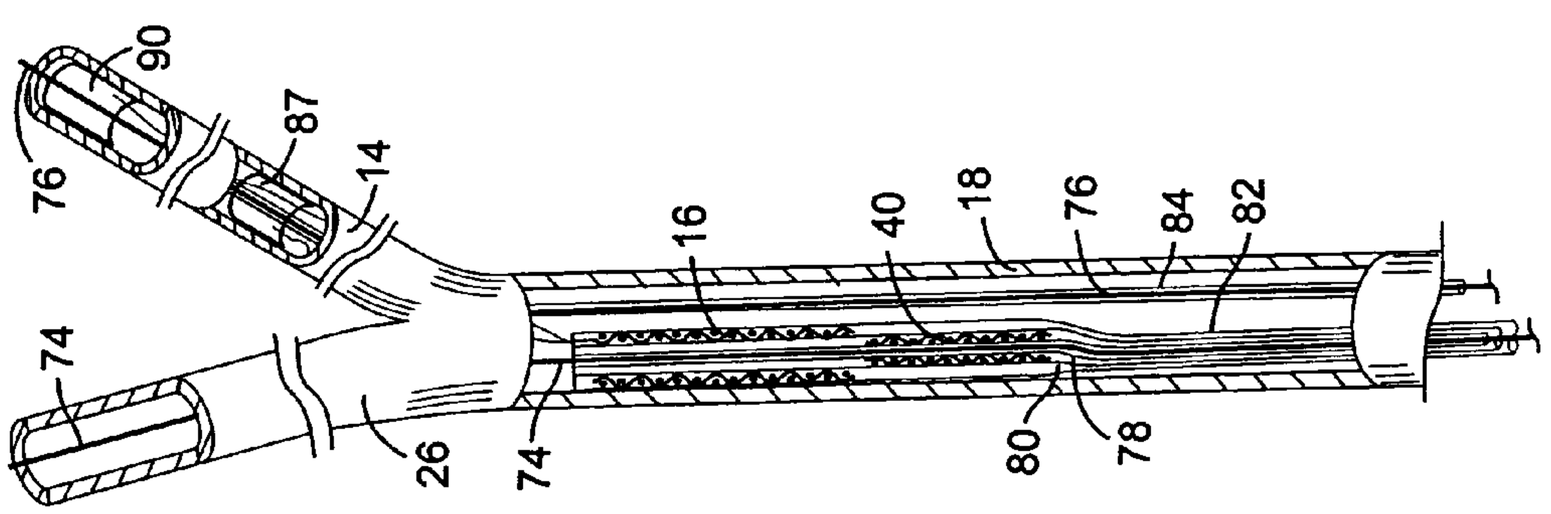

FIG.20

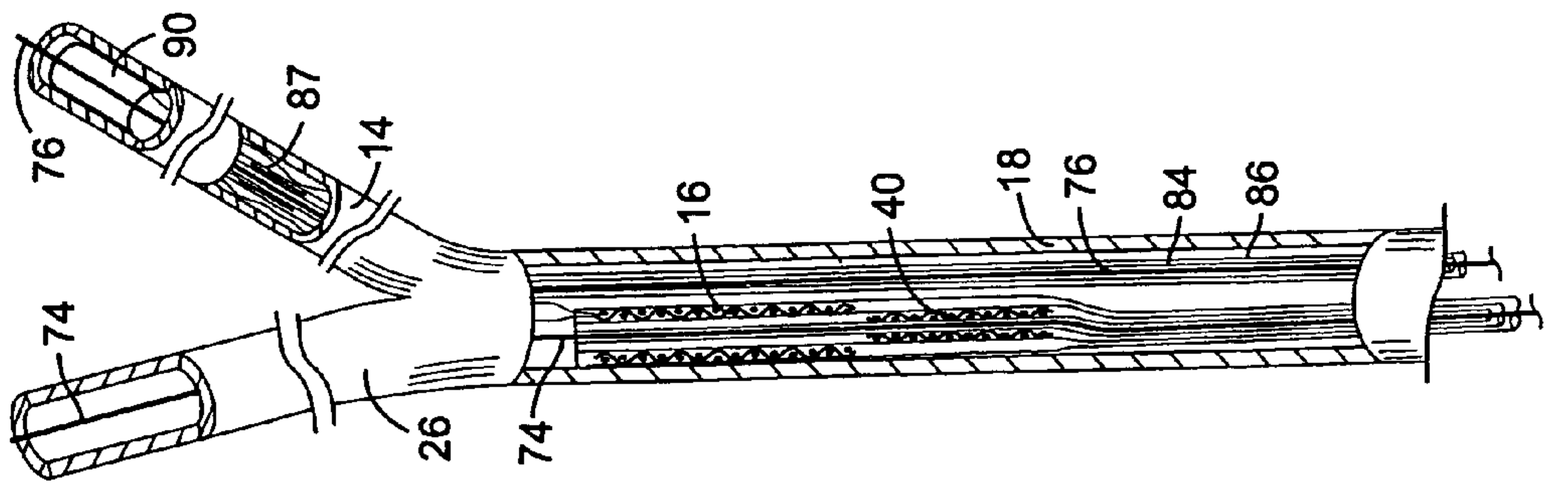

FIG.19

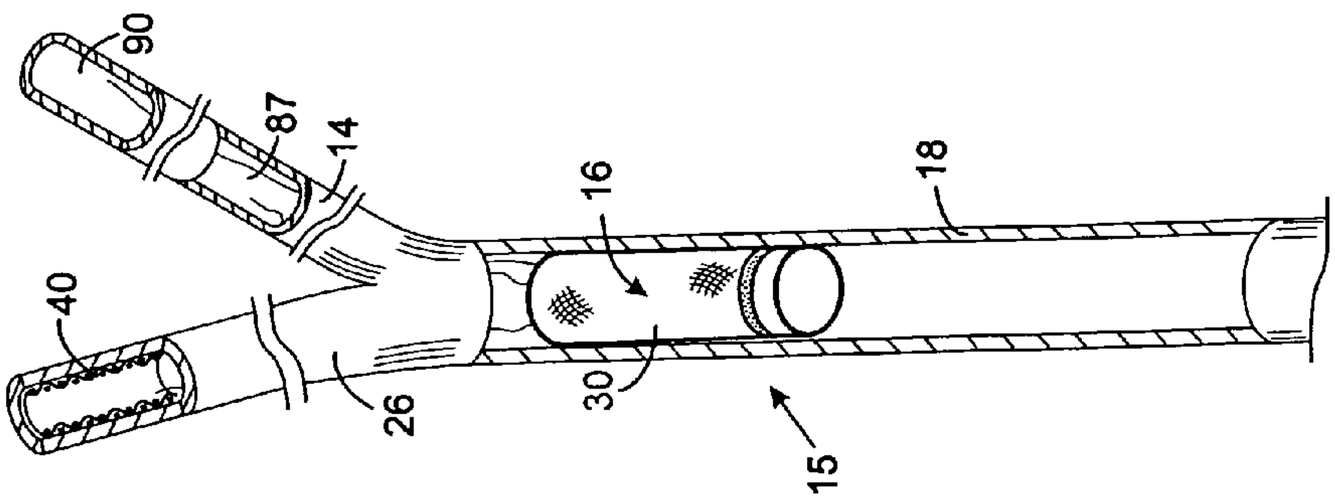

FIG.25

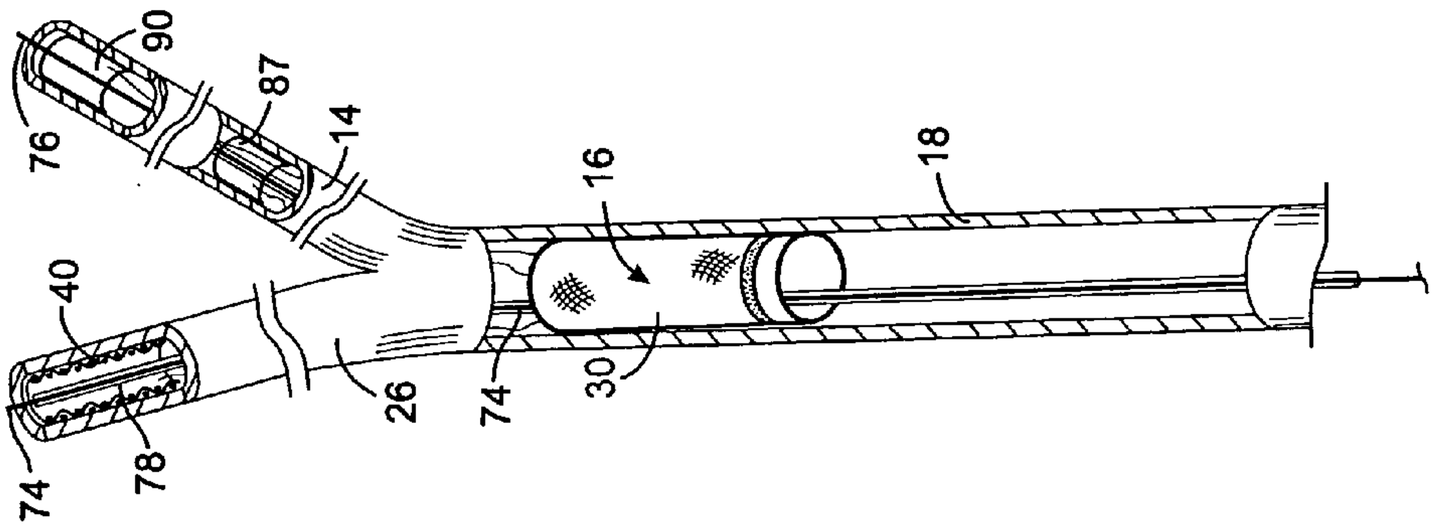

FIG.24

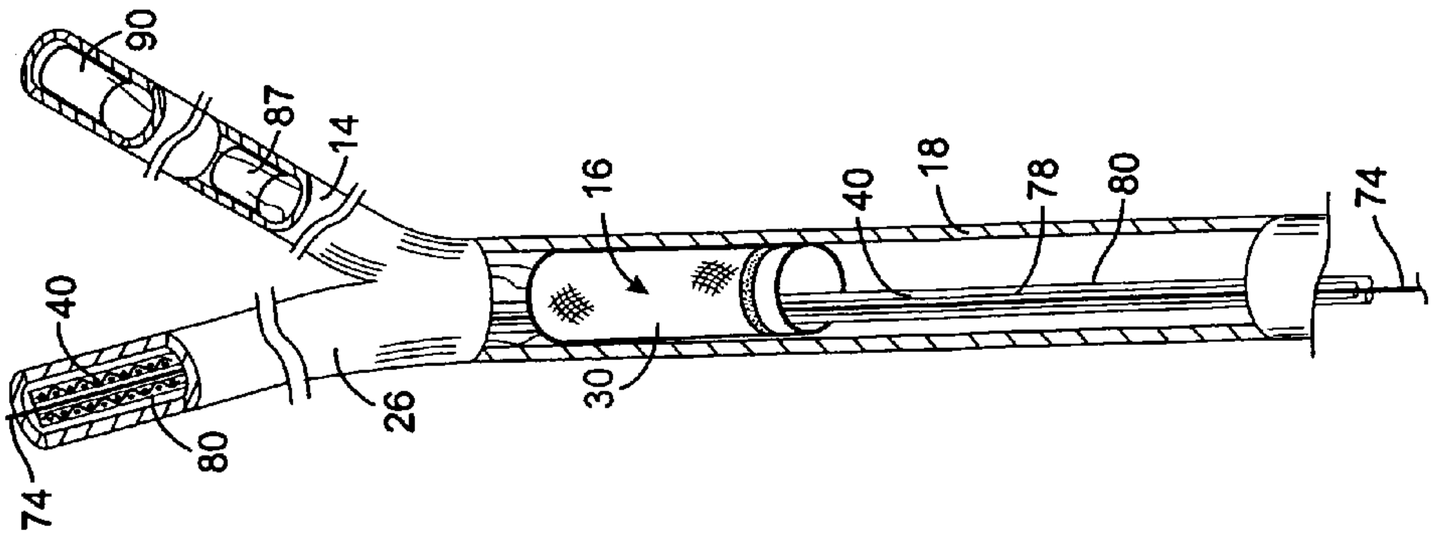

FIG.23

CATHETER SYSTEM FOR IMPLANTING AN INTRAVASCULAR MEDICAL DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This is a continuation in part of U.S. patent application Ser. No. 11/112,181 filed on Apr. 22, 2005.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

[0003] 1. Field of the Invention

[0004] The present invention relates to medical devices that are implanted into the vasculature of an animal, and more particularly to the apparatus for performing the implantation.

[0005] 2. Description of the Related Art

[0006] A remedy for people with slowed or disrupted natural heart activity is to implant a cardiac pacing device which is a small electronic apparatus that stimulates the heart to beat at regular rates.

[0007] Typically the pacing device is implanted in the patient's chest and has sensor electrodes that detect electrical impulses associated with in the heart contractions. These sensed impulses are analyzed to determine when abnormal cardiac activity occurs, in which event a pulse generator is triggered to produce electrical pulses. Wires carry these pulses to electrodes placed adjacent specific cardiac muscles, which when electrically stimulated contract the heart chambers. It is important that the electrodes be properly located to produce contraction of the heart chambers.

[0008] Modem cardiac pacing devices vary the stimulation to adapt the heart rate to the patient's level of activity, thereby mimicking the heart's natural activity. The pulse generator modifies that rate by tracking the activity of the sinus node of the heart or by responding to other sensor signals that indicate body motion or respiration rate.

[0009] U.S. Pat. No. 6,445,953 describes a cardiac pacemaker that has a pacing device, which can be located outside the patient, to detect abnormal electrical cardiac activity. In that event, the pacing device emits a radio frequency signal, that is received by a stimulator implanted in a vein or artery of the patient's heart. Specifically, the radio frequency signal induces a voltage pulse in an antenna on the stimulator and that pulse is applied across a pair of electrodes, thereby stimulating adjacent muscles and contracting the heart.

[0010] The stimulator in that wireless system is powered by the energy of the received signal thus requiring that the pacing device transmit a relatively strong radio frequency signal in order to provide adequate energy to the stimulator implanted deep in the patient's chest. It is desirable to place the stimulator, or at least the antenna for the stimulator, in a blood vessel located closer to the skin of the patient with electrodes implanted in one or more cardiac blood vessels and connected to the stimulator by wires extending through the electronic circuit circulatory system. This would enable more of the energy from the frequency signal to reach the stimulator, however, the blood vessels close to the skin are not sufficiently large to accommodate the size of the stimulator.

[0011] The antenna, usually in the form of a coil, must possess several characteristics in order to function within the blood vessel. The coil must retain its shape in order to remain tuned to the particular radio frequency being used. The conductors of the antenna have to be insulated so that the blood and other substances flowing through the vascular system do not provide a short circuit or otherwise detune the antenna. In addition the antenna must be biologically compatible with the blood vessel walls and with the blood.

[0012] Therefore, it is desirable to provide an apparatus for positioning each of the components of the medical device in the patient.

SUMMARY OF THE INVENTION

[0013] A catheter system is provided to implant a medical device in an animal, wherein the medical device has a plurality of components that are to be placed at different locations. The system is particular adapted to implant a medical device in which the components are electrically interconnected by wires.

[0014] The catheter system comprises a guide wire, a first catheter with a guide wire lumen for slidably receiving the guide wire, and a tubular outer sheath through which the first catheter extends. A first cavity is formed between the first catheter and the outer sheath within which a first component of the medical device is releasably located. A second cavity also is formed between the first catheter and the outer sheath within which a second component of the medical device is releasably located.

[0015] In a preferred embodiment, the catheter system further includes a second catheter with a lumen within which the first catheter is slidably received. Thus, the first and second catheters are both within the outer sheath. The first cavity is located between the first and second catheters and the second cavity is located between the second catheter and the outer sheath. As an option, an inner sheath may be provided between the first and second catheters, with the first cavity between the first catheter and the inner sheath. More catheters and sheaths may be added coaxially on the catheter system to deliver additional components into the animal.

[0016] The catheter system is manipulatable to independently release each of the first and second components at different locations in the animal. Initially the guide wire is inserted into the animal to a first location. Then, the assembly of catheters is slid over the guide wire until reaching the first location. The outer sheath is moved over the second catheter to expose the second component, that is deposited at the first location.

[0017] If a desired second location for implantation of the second first component is along the existing route of the guide wire through the animal, the first and second catheters are slid along the guide wire to place the first component at the second location. Otherwise, the guide wire can be repositioned to the second location before the first and second catheters are slid into place. Thereafter, the first and second catheters are moved with respect to each other to expose the first component, which is deposited at the second location.

[0018] A second embodiment of a catheter system having two guide wires and two catheter assemblies, one for each guide wire, also is described. The two catheter assemblies cooperate to implant a greater plurality of components, that are electrically interconnected by wires.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] **FIG. 1** is a representation of a cardiac pacing system attached to a medical patient;

[0020] **FIG. 2** is an isometric, cut-away view of a patient's blood vessels in which a receiver antenna, a stimulator and an electrode of an intravascular medical device have been implanted at different locations;

[0021] **FIG. 3** is a longitudinal cross sectional view through a distal end of a catheter system for implanting the components of the intravascular medical device;

[0022] **FIG. 4** is a transverse cross sectional view through a catheter system along line **4-4** of **FIG. 3**;

[0023] **FIG. 5** is a transverse cross sectional view through a catheter system along line **5-5** of **FIG. 3**;

[0024] **FIG. 6** is a transverse cross sectional view through a catheter system along line **6-6** of **FIG. 3**;

[0025] **FIGS. 7-14** depict a sequence of steps by which the components of the intravascular medical device are implanted in the patient; and

[0026] **FIGS. 15-25** illustrate an alternative sequence of steps by which the medical device components are implanted in a patient's vascular system.

DETAILED DESCRIPTION OF THE INVENTION

[0027] Although the present invention is being described in the context of implanting components of a cardiac pacing system, it can be used to implant other types of medical devices into a patient's body. Furthermore, the present apparatus and method are not limited to implanting items in an animal's vascular system, but can be employed to implant elements elsewhere in the animal.

[0028] Initially referring to **FIG. 1**, a cardiac pacing system **10** for electrically stimulating a heart **12** to contract comprises an external power source **14** and a medical device **15** implanted in the circulatory system of a human medical patient. The medical device **15** receives a radio frequency (RF) signal from the power source **14** worn outside the patient and the implanted electrical circuitry is electrically powered from the energy of that signal. At appropriate times, the medical device **15** delivers an electrical stimulation pulse into the surrounding tissue of the patient.

[0029] The power source **14** may be the same type as described in U.S. Pat. Nos. 6,445,953 and 6,907,285 and includes a radio frequency transmitter that is powered by a battery. The transmitter periodically emits a signal at a predefined radio frequency that is applied to a transmitter antenna in the form of a coil of wire within a band **22** that is placed around the patient's upper arm **23**. In a basic version of the cardiac pacing system **10**, the radio frequency signal merely conveys energy for powering the medical device **15** implanted in the patient. In other systems, the transmitter modulates the radio frequency signal with commands received from optional circuits that configure or control the operation of the medical device **15**.

[0030] Referring to **FIGS. 1 and 2**, the exemplary implanted medical device **15** includes an intravascular stimulator **16** located a vein or artery **18** in close proximity to the heart. Because of its electrical circuitry, the stimulator **16** is relatively large requiring a blood vessel that is larger than the arm vein, e.g. the basilic vein, which is approximately five millimeters in diameter. Therefore, the stimulator **16** may be implanted in the superior or inferior vena cava. Electrical wires lead from the stimulator **16** through the cardiac vascular system to one or more locations in smaller blood vessels **19**, e.g. the coronary sinus vein, at which stimulation of the heart is desired. At such locations, the electrical wire **25** are connected to a remote electrode **21** secured to the blood vessel wall.

[0031] Because the stimulator **16** of the medical device **15** is near the heart and relatively deep in the chest of the human medical patient, a receiver antenna **24** for the RF signal is implanted in a vein or artery **26** of the patient's upper right arm **23** at a location surrounded by the transmitter antenna within the arm band **22**. That arm vein or artery **26** is significantly closer to the skin and thus receiver antenna **24** picks up a greater amount of the energy of the radio frequency signal emitted by the power source **14**, than if the receiver antenna was located on the stimulator **16**. Alternatively, another limb, neck or other area of the body with an adequately sized blood vessel close to the skin surface of the patient can be used. The receiver antenna **24** is connected to the stimulator **16** by a micro-coaxial cable **34**.

[0032] As illustrated in **FIG. 2**, the intravascular stimulator **16** has a body **30** constructed similar to well-known expandable vascular stents. The stimulator body **30** comprises a plurality of wires formed to have a memory defining a tubular shape or envelope. Those wires may be heat-treated platinum, Nitinol, a Nitinol alloy wire, stainless steel, plastic wires or other materials. Plastic or substantially nonmetallic wires may be loaded with a radiopaque substance which provide visibility with conventional fluoroscopy. The stimulator body **30** has a memory so that it normally assumes an expanded configuration when unconfined, but is capable of assuming a collapsed configuration when disposed and confined within a catheter assembly, as will be described. In that collapsed state, the tubular body **30** has a relatively small diameter enabling it to pass freely through the vasculature of a patient. After being properly positioned in the desired blood vessel, the body **30** is released from the catheter and expands to engage the blood vessel wall. The stimulator body **30** and other components of the medical device **15** are implanted in the patient's circulatory system using a novel technique that employs a unique catheter system described hereinafter.

[0033] The body **30** has a stimulation circuit **32** mounted thereon and, depending upon its proximity to the heart **12**, may hold a first electrode **20** in the form of a ring that encircles the body. Alternatively, when the stimulator **16** is relatively far from the heart **12**, the first electrode **20** can be remotely located in a small cardiac blood vessel much the same as a second electrode **21**. The stimulation circuit **32**, which may be the same type as described in the aforementioned U.S. patents, includes a power supply to which the micro-coaxial cable **34** from the receiver antenna **24** is

connected. The power supply utilizes electricity from that antenna to charge a storage capacitor that provides electrical power to the stimulation circuit. A conventional control circuit within the stimulation circuit **32** detects the electrical activity of the heart and determines when electrical pulses need to be applied so that the heart **12** contracts at the proper rate. When stimulation is desired, the stimulation circuit **32** applies electrical voltage from its internal storage capacitor across the electrodes **20** and **21**. The second electrode **21** and the first electrode when located remotely from the stimulator **16**, can be mounted on a collapsible body of the same type as the stimulator body **30**.

[**0034**] With reference to **FIG. 3**, the components of the medical device **15** are inserted into the patient utilizing a catheter system **50** which is a meter or more long as is necessary to extend from an incision in the patient through the vascular system to the various locations where the components of the medical device **15** are to be implanted. The catheter system **50** has a proximal end that remains outside the patient to which the physician has access to manipulate the elements of the catheter system, and has a distal end that is inserted into the patient and which contains the medical device components.

[**0035**] The distal end section of the catheter system **50** is illustrated in **FIG. 3** to which continuing reference is made. The catheter system comprises a conventional guide wire **52** over which an assembly **51** of several catheters and sheaths are coaxially inserted. Those catheters and sheaths are made of a flexible biologically compatible material commonly used for medical catheters. A first, or inner, catheter **54** has a tubular construction with a lumen **55** through which the guide wire **52** extends, see also the cross-section through this region of the catheter system **50** in **FIG. 4**. A first component, such as the second electrode **21**, of the medical device is positioned around the end of the first catheter **54** with a first inner sheath **56** around the first component to maintain it in a collapsed state. A first cavity **57** is formed between the first catheter **54** and the first inner sheath **56** within which the first component is located. The first inner sheath **56** extends longitudinally to the proximal end of the first catheter **54** which is outside the patient. Both the first catheter **54** and the first inner sheath **56** have a distal end that is spaced from the distal end **53** of catheter assembly **51**.

[**0036**] A second, or intermediate, catheter **58** extends longitudinally over the first inner sheath **56** so that the inner components of the catheter system **50** described thus far are located within a lumen **60** of the second catheter **58**, see also the cross-section through this region in **FIG. 5**. The end of the second catheter projects beyond the end of the first catheter, but falls short of the distal end **53** of the catheter assembly **51**. The antenna **40**, which also is referred to herein as a second component of the medical device **15**, is placed around the end section of the second catheter **58** and is held in an elongated, reduced diameter state by a second inner sheath **62** that extends around the antenna **40** and along the second catheter **58** to the proximal end of the catheter system **50**. A second cavity **63** is defined between the second catheter **58** and the second inner sheath **62** within which the second medical device component is located.

[**0037**] With reference to **FIGS. 3 and 6**, a third catheter **64** is located around and extends along the outside of the second inner sheath **62** and projects to substantially the distal end **53** of the catheter assembly **51**. A third component, in this case the stimulator **16**, is located around the third catheter **64** and is held in its collapsed state by a third, or outer, sheath **66** that forms the outermost element of the catheter system **50** extending around all of the other elements. A third cavity **65** is located between the third catheter **64** and the third sheath **66** within which the stimulator **16** is located. The electrical wire **25** extends from the stimulator **16** through the catheter system **50** to the first component, electrode **21**, and the micro-coaxial cable **34** extends from the stimulator **16** to the second component **40**. More coaxially arranged catheters and sheaths can be provided to deliver additional components of a medical device.

[**0038**] The medical device **15** is implanted in the vascular system of the patient by first inserting the guide wire **52** as depicted in **FIG. 7**. An incision is made into large blood vessel in the patient's thigh, for example, using conventional surgical procedures for inserting catheters. The guide wire **52** is then threaded through the vasculature until its distal end reaches the location at which the stimulator **16** is to be implanted. Next, the catheter assembly **51** is inserted over the proximal end of the guide wire **52** and pushed there along to the location selected for the stimulator implantation, as shown in **FIG. 8**. With the stimulator **16** properly positioned within the blood vessel **18**, the outer, or third sheath **66** is pulled out of the patient while maintaining the remainder of the catheter system **50** in place. Once the third sheath **66** clears the stimulator **16**, the stimulator's body **30** expands diametrically against the wall of the blood vessel **18** thereby securing the stimulator **16** in place, as illustrated in **FIG. 9**. This diametric expansion of the stimulator body **30** causes a longitudinal contraction as evident from a comparison of the length of the stimulator **16** in **FIGS. 8 and 9**. It should be noted that before the third sheath **66** fully exposes the stimulator body **30**, that sheath can be pushed back into the patient over the third catheter **64** and the exposed portion of the stimulator **16**. This action re-collapses the stimulator body **30** so that it may be repositioned within the blood vessel **18**.

[**0039**] With reference to **FIG. 10**, after implanting the stimulator **16**, the guide wire **52** is advanced through the vascular system until it reaching a point at which the antenna **40** is desired to be placed in blood vessel **26**. Thereafter, the remainder of the catheter assembly **51** is advanced along the guide wire **52** until the distal end **53** reaches the desired location (as seen as **FIG. 3**). As this advancement occurs, the micro-coaxial cable **34** connecting the antenna **40** to the stimulator **16** is unfurled from catheter assembly. Next, the physician withdraws the second inner sheath **62** from the patient. When the second inner sheath **62** has been withdrawn sufficiently to expose the antenna **40**, that component contracts longitudinally and expands diametrically against the inner surface of the blood vessel **26**. That action secures the antenna **40** in place, as shown in **FIG. 11**. Before the antenna **40** has been fully exposed, the second inner sheath **62** may be pushed back into the patient to re-collapse the partially expanded antenna, if necessary.

[**0040**] With the antenna **40** secured in place, the physician extracts the remainder of the catheter system **50**, including the guide wire **52** from the blood vessel **26** to a junction where the assembly can be directed into the other blood vessel **19** for implantation of the second electrode **21**. From that withdrawn position, the guide wire **52** alone is advanced

through the vascular system until its distal end reaches the location within blood vessel **19** at which the electrode is to be implanted. Then, the remainder of the catheter assembly **51** is advanced along the guide wire **52** until its distal end **53** reaches the distal end of the guide wire, as depicted in **FIG. 12**. At this point, the first, or inner, catheter **54** and its surrounding sheath **56** are located at the distal end of the guide wire along with the second electrode **21**. With that electrode properly positioned within the blood vessel **19**, the first sheath **56** is withdrawn from the patient along the first catheter **54**. Upon being exposed, the second electrode **21** expands to engage the wall of the blood vessel **19**, thereby being secured in place as illustrated in **FIG. 13**. Other techniques for securing the electrode and the other components in the blood vessel wall may be employed. Then, the first catheter **54** and guide wire **52** are withdrawn from the vascular system of the patient leaving the components of the medical device **15** in place, as shown in **FIG. 14**.

[**0041**] The first catheter system **50** employs a single catheter assembly **51** that comprises coaxially located catheters and sheaths to carry the components of the medical device **15**. **FIGS. 15-22** illustrate a second catheter system **70** having first and second catheter assemblies **71** and **72**, which are inserted through the vascular system of the patient. These catheter assemblies **71** and **72** are structurally each similar to the catheter assembly **51** previously described. The first catheter assembly **71** is used to deliver the stimulator **16** and the antenna **40**, and the second catheter assembly **72** delivers a pair of electrodes **87** and **90** to different locations in the patient's vasculature. The implantation procedure commences by inserting a first guide wire **74** into the patient and threading it through the vascular system until reaching a position **75** in blood vessel **26** at which the antenna **40** is to be located as shown in **FIG. 15**. A second guide wire **76** also is inserted through the vascular system to a location **77** in blood vessel **19** for one of the electrodes. Then the first catheter assembly **71** is placed over the first guide wire **74** and the second catheter assembly **72** is placed over the second guide wire **76**. The two catheter assemblies are slid in unison over their respective guide wires until the first catheter assembly **71** reaches the location **79** in blood vessel **18** for the stimulator **16** as illustrated in **FIG. 16**. The two catheter assemblies **71** and **72** have to be inserted simultaneously into the patient because the components carried by them are connected by relatively short electrical wires. Alternatively those interconnecting wires may be long enough to extend outside the patient while only some of the components have been implanted. This eliminates the need to simultaneously insert both catheter assemblies **71** and **72** and also permits testing of each component upon being finally positioned in the vascular system. For example, the antenna **40** can be tested for adequate signal reception before implanting the stimulator **16**.

[**0042**] The first catheter assembly **71** has a first catheter **78** with a second catheter **80** extending coaxially there around. Specifically, the first catheter **78** has a lumen through which the first guide wire **74** passes and the second catheter **80** has another lumen within which the first catheter is received. A first cavity is formed between those catheters within which the antenna **40** is located. In the second catheter system **70**, there is no inner sheath between the antenna and the second catheter **80**, however such a sheath could be provided as in the previously described catheter system **50**. A first outer sheath **82** extends longitudinally along and around the second catheter **80** forming a second cavity there between within which the stimulator **16** is located adjacent the distal end of the first catheter assembly **71**.

[**0043**] The second catheter assembly **72** has a third catheter **84** immediately surrounding the second guide wire **76**. A fourth catheter **86** extends coaxially around and along the third catheter **84** forming a cavity there between within which a first electrode **87** is located. In particular, the third catheter **84** has a lumen through which the second guide wire **76** passes and the fourth catheter **86** has another lumen within which the third catheter is received. A second outer sheath **88** extends coaxially around and along the fourth catheter **86** forming a cavity there between within which a second electrode **90** is held.

[**0044**] With reference to **FIG. 17**, while the first catheter assembly **71** is held in place, the second catheter assembly **72** is advanced along the second guide wire **76** past the end of the first catheter assembly **71** and into the blood vessel **19**. As this advancement occurs, the electrical wires connecting the first and second electrodes **87** and **90** to the stimulator **16** are pulled along and unfurled from the distal end of the second catheter assembly **72**. The second catheter assembly **72** continues slide over the second guide wire **76** until reaching the location desired for implantation of the second electrode **90**. Then the second outer sheath **88** is withdrawn from the patient by sliding it along the remaining components of the second catheter assembly **72**. That action exposes the second electrode **90** which thereby expands diametrically to become imbedded in the inner wall of the blood vessel **19**, as shown in **FIG. 18**. Other techniques for securing the electrode in the blood vessel wall may be employed.

[**0045**] Then the third and fourth catheters **84** and **86** are withdrawn partially from the patient carrying the first electrode **87** through the blood vessel **19** until it is located at the desired place for implantation, as depicted in **FIG. 19**. If the desired location for the first electrode **87** is not along the existing route of the second guide wire **76**, that guide wire may also be partially extracted from the patient and reinserted through a different route to the desired implantation point. In that latter case, the two catheters **84** and **86** then are slid along the second guide wire **76** until the first electrode **87** reaches that desired point of implantation. When the first electrode is properly positioned, the third catheter **84** is withdrawn from the patient so its distal end slides over the first electrode **87**. Upon being fully exposed, the first electrode **87** expands diametrically thereby engaging the walls of the blood vessel **19** becoming secured in place as illustrated in **FIG. 20**. Here too, other techniques may be used to secure this electrode in the blood vessel wall. Thereafter, the third catheter **84** and the second guide wire **76** are withdrawn from the patient leaving the two electrodes **87** and **90** in place, as shown in **FIG. 21**.

[**0046**] Then with the first catheter assembly **71** still positioned at the location desired for the stimulator **16**, the first outer sheath **82** of the first catheter assembly **71** is withdrawn from the patient to release the stimulator. When the body **30** of the stimulator is fully exposed, it expands diametrically against the inner wall of the blood vessel **18** to secure the stimulator **16** in place, as depicted in **FIG. 22**. Next, the first and second catheters **78** and **80** are advanced along the first guide wire **74**, through the now expanded

stimulator body **30**, until the collapsed antenna **40** carried by those catheters is located within the blood vessel **26** at the desired position for implantation shown in **FIG. 23**. At this time, the second catheter **80** is pulled at least partially from of the patient to expose the antenna **40** thereby allowing the antenna coil to expand against the inner wall of the blood vessel **26** as exemplified in **FIG. 24**. Then, the first catheter **78** and the first guide wire **74** are removed from the patient, either separately or in unison. This leaves the medical device **15**, comprising the stimulator **16**, antenna **40** and the first and second electrodes **87** and **90**, implanted in the patient's vasculature as shown in **FIG. 25**.

[**0047**] The foregoing description was primarily directed to preferred embodiments of the invention. Even though some attention was given to various alternatives within the scope of the invention, it is anticipated that one skilled in the art will likely realize additional alternatives that are now apparent from disclosure of embodiments of the invention. For example, different quantities of components for the medical device can be implanted by modifying the catheter assembly with more catheters and sheaths, and the position of the components on the catheter assembly can be changed to enable a different order of implantation. Accordingly, the scope of the invention should be determined from the following claims and not limited by the above disclosure.

1. A catheter system for implanting a medical device in an animal, wherein the medical device has a plurality of components for implantation at different locations, said catheter system comprising:

a guide wire;

an inner catheter with a guide wire lumen within which the guide wire is slidably receivable; and

a tubular outer sheath through which the inner catheter extends, wherein a first component and a second component of the medical device being releasably located between the inner catheter and the outer sheath with an electrically conductive wire connected to both the first and second components;

wherein the catheter system is manipulable to independently release each of the first component and the second component at different locations in the animal.

2. The catheter system as recited in claim 1 further comprising:

first cavity formed between the inner catheter and the outer sheath within which a first component of the medical device is releasably located;

and a second cavity formed between the inner catheter and the outer sheath within which a second component of the medical device is releasably located, wherein the electrically conductive wire extends between the first and second cavities;

and a member separating the first and second cavities.

3. The catheter system as recited in claim 1 wherein the tubular outer sheath is slidable with respect to the inner catheter to release the first component into the animal.

4. The catheter system as recited in claim 1 further comprising an intermediate catheter extending within the tubular outer sheath and having a lumen within which the inner catheter extends.

5. The catheter system as recited in claim 4 wherein the intermediate catheter and the inner catheter are slidable with respect to each other to release the second component into the animal.

6. A catheter system for implanting a medical device in an animal, wherein the medical device has a plurality of components that are electrically interconnected, said catheter system comprising:

a first guide wire;

a first catheter with a first lumen extending along a longitudinal axis and within which the first guide wire is slidably receivable;

a second catheter with a second lumen in which the first catheter is slidably received, wherein a first cavity is defined between the first and second catheters;

a first component of the medical device releasably located in the first cavity;

a tubular first outer sheath through which the second catheter slidably extends, wherein a second cavity is defined between the second catheter and the first outer sheath; and

a second component of the medical device releasably located in the second cavity.

7. The catheter system as recited in claim 6 wherein the tubular first outer sheath is slidable with respect to the second catheter to release the second component into the animal.

8. The catheter system as recited in claim 6 wherein the second catheter is slidable with respect to the first catheter to release the first component into the animal.

9. The catheter system as recited in claim 6 further comprising a first inner sheath between the first and second catheters with the first component located between the first inner sheath and the first catheter.

10. The catheter system as recited in claim 6 wherein the first component is one of a stimulation circuit, an antenna, and an electrode, and the second component is another one of a stimulation circuit, an antenna, and an electrode.

11. The catheter system as recited in claim 6 wherein at least one of the first component and the second component comprises an expandable body that is held in a collapsed state in the catheter system and which expands upon being released from the catheter system.

12. The catheter system as recited in claim 6 wherein the first component and the second component are located in tandem along the longitudinal axis.

13. The catheter system as recited in claim 6 further comprising:

a third catheter within the first outer sheath and having a third lumen through which the second catheter is slidably received, wherein the second cavity is formed between the second and third catheters and a third cavity is formed between the third catheter and the first outer sheath; and

a third component of the medical device releasably located in the third cavity.

14. The catheter system as recited in claim 13 further comprising:

a first inner sheath extending between the first and second catheters with the first component located between the first inner sheath and the first catheter; and

a second inner sheath extending between the second and third catheters with the second component located between the second inner sheath and the second catheter.

15. The catheter system as recited in claim 6 further comprising;

a second guide wire;

a third catheter with a third lumen within which the second guide wire is slidably receivable;

a second outer sheath through which the third catheter slidably extends, wherein a third cavity is defined between the third catheter and the second outer sheath; and

a third component of the medical device releasably located in the third cavity and electrically connected by a wire to one of the first and second components.

16. The catheter system as recited in claim 6 further comprising;

a second guide wire;

a third catheter with a third lumen in which the second guide wire is slidably receivable;

a fourth catheter with a fourth lumen in which the third catheter is slidably received, wherein a third cavity is defined between the third and fourth catheters;

a third component of the medical device releasably located in the third cavity;

a tubular second outer sheath through which the fourth catheter slidably extends, wherein a fourth cavity is defined between the fourth catheter and the second outer sheath; and

a fourth component of the medical device releasably located in the second cavity;

wherein at least one of the third component and the fourth component is electrically connected by a wire to one of the first component and the second component.

17. The catheter system as recited in claim 16 further comprising an inner sheath extending between the third and fourth catheters with the third component located between the inner sheath and the third catheter.

18. A method of implanting a medical device in an animal, wherein the medical device has a plurality of components, said method comprising:

inserting a first guide wire to a first location inside the animal;

inserting a first catheter assembly releasably containing a first component and a second component of the medical device over the first guide wire until the first catheter assembly reaches the first location, wherein the first component and the second component are electrically connected;

releasing one of the first component and the second component at the first location inside the animal;

repositioning the first catheter assembly to a second location inside the animal; and

releasing another one of the first component and the second component at the second location inside the animal.

19. The method as recited in claim 18 wherein inserting a first catheter assembly comprises employs a first catheter assembly that comprises a first catheter with a first lumen within which the first guide wire is received, and a tubular first outer sheath through which the first catheter extends, a first cavity defined between the first catheter and the first outer sheath and releasably containing a first component of the medical device, and a second cavity defined between the first catheter and the first outer sheath and releasably containing a second component of the medical device.

20. The method as recited in claim 19 wherein repositioning the first catheter assembly comprises relocating the first guide wire adjacent the second location.

21. The method recited in claim 19 further comprising removing the first catheter assembly from the animal leaving the first and second components inside the animal.

22. The method as recited in claim 19 wherein the first catheter assembly further comprises a second catheter within the first outer sheath and having a second lumen within which the first catheter is slidably received, wherein the first cavity is defined between the first and second catheters and the second cavity is defined between the second catheter and the first outer sheath.

23. The method as recited in claim 22 wherein repositioning the first catheter assembly comprises relocating the first guide wire adjacent the second location.

24. The method as recited in claim 23 wherein repositioning the first catheter assembly further comprises sliding at least one of the first and second catheters along the first guide wire to the second location.

25. The method as recited in claim 22 wherein releasing one of the first component and the second component comprises sliding the first outer sheath and the second catheter with respect to each other.

26. The method as recited in claim 22 wherein releasing another one of the first component and the second component comprises sliding the first catheter and the second catheter with respect to each other.

27. The method as recited in claim 22 wherein the first catheter assembly further comprises an inner sheath extending between the first and second catheters; and wherein releasing another one of the first component and the second component comprises sliding the inner sheath and the first catheter with respect to each other.

28. The method as recited in claim 22 further comprising:

inserting a second guide wire to a third location inside the animal;

inserting a second catheter assembly over the second guide wire until the second catheter assembly reaches the third location, wherein the second catheter assembly comprises a third catheter with a third lumen in which the second guide wire is slidably received, and a tubular second outer sheath through which the third catheter slidably extends, wherein a third cavity is defined between the third catheter and the second outer sheath and releasably contains a third component that is electrically connected by a wire to one of the first and second components; and

releasing the third component inside the animal.

29. The method as recited in claim 28 wherein inserting a first catheter assembly and inserting a second catheter assembly are performed in unison.

30. The method as recited in claim 28 wherein releasing the third component comprises sliding the second outer sheath and the third catheter with respect to each other.

31. The method as recited in claim 28 further comprising removing the second catheter assembly from the animal while leaving the third component inside the animal.

32. The method as recited in claim 22 further comprising:

inserting a second guide wire to a third location inside the animal;

inserting a second catheter assembly over the second guide wire until the second catheter assembly reaches the third location, wherein the second catheter assembly comprises a third catheter with a third lumen in which the second guide wire is slidably received, a fourth catheter with a fourth lumen within which the third catheter is slidably received, a third cavity defined between the third and fourth catheters and releasably containing a third component of the medical device, a tubular second outer sheath through which the fourth catheter slidably extends, and a fourth cavity defined between the fourth catheter and the second outer sheath and releasably containing a fourth component of the medical device, wherein at least one of the third and fourth components is electrically connected by a wire to one of the first and second components;

releasing one of the third component and the fourth component inside the animal;

repositioning the second catheter assembly to a fourth location in the animal; and

releasing another one of the third component and the fourth component inside the animal.

33. The method as recited in claim 32 wherein inserting a first catheter assembly and inserting a second catheter assembly are performed in unison.

34. The method as recited in claim 32 wherein repositioning the second catheter assembly comprises:

moving the second guide wire adjacent the fourth location; and

sliding at least one of the third and fourth catheters along the second guide wire to the fourth location.

35. The method as recited in claim 32 wherein releasing one of the third component and the fourth component comprises sliding the second outer sheath and the fourth catheter with respect to each other.

36. The method as recited in claim 32 wherein releasing another one of the third component and the fourth component comprises sliding the third catheter and the fourth catheter with respect to each other.

37. The method as recited in claim 32 wherein the second catheter assembly further comprises an inner sheath extending between the third and fourth catheters; and wherein releasing another one of the third component and the fourth component comprises sliding the inner sheath and the third catheter with respect to each other.

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