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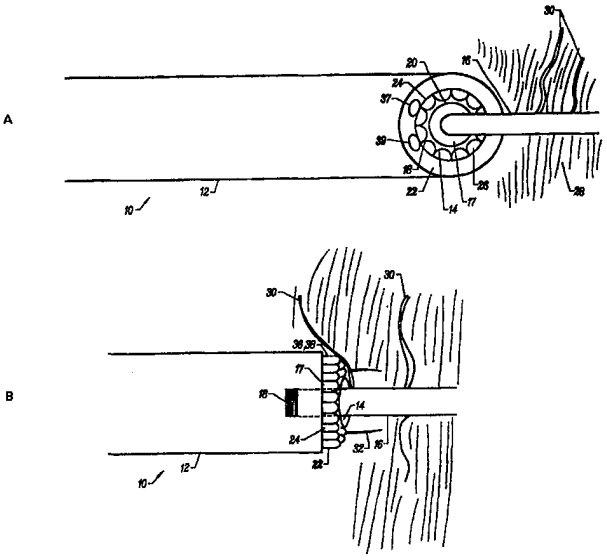

(57) Abstract

A biological vessel harvesting device is provided which separates a segment of a biological vessel from adventitia surrounding the biological vessel while simultaneously cauterizing and sectioning tributaries extending from the separated vessel segment. The biological vessel harvesting device includes an outer catheter and a vessel grasping mechanism positioned within a lumen of the outer catheter for holding an end of a segment of the biological vessel to be harvested, the outer catheter being movable relative to the vessel grasping mechanism such that the vessel grasping mechanism and the vessel segment attached thereto can be drawn into the outer catheter lumen. The biological vessel harvesting device also includes a cautery–sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen. The cautery–sectioning system has a cautery function for cauterizing tributaries extending from the vessel segment about the circumference of the vessel segment and a sectioning function for sectioning the cauterized tributaries.

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BIOLOGICAL VESSEL HARVESTING DEVICE AND METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a device for harvesting a segment of a biological vessel and a method by which the device is used to harvest the biological vessel segment.

Description of Related Art

A variety of surgical applications require the harvesting of a segment of a biological vessel, such as a vein or artery, in one location of a patient's body for use in a surgical application in a second location of the body. The most common example is the harvesting of the saphenous vein for use in multiple vessel coronary artery bypass surgery. For this application, it is necessary to provide a section of vein that is approximately the size of the coronary arteries in a condition in which the intimal lining is in a healthy native condition. At the present time, this is accomplished by making an incision in the skin, identifying the saphenous vein in the leg, separating the vein from adjacent adventitial tissues, ligating or cauterizing tributary veins and delivering the vein. Subsequently, the vein is divided into segments of appropriate length for the purpose of creating anastomotic channels from the aorta to an occluded coronary artery(s) distal to an area of occlusion. This procedure is laborious, time consuming and results in considerable discomfort in the calf region of the leg and is a significant part of the general morbidity following coronary bypass surgery. This effect is not trivial since there are approximately 500,000 such operations annually in the United States alone.

A need currently exists for a minimally invasive biological vessel harvesting device which can be used to harvest segments of biological vessels for later use in surgical procedures while causing a minimal degree of trauma to the patient. A further need exists for a biological vessel harvesting device which can be rapidly and effectively used, thereby reducing the surgeon time and operating room costs associated with harvesting a segment of a biological vessel.

SUMMARY OF THE INVENTION

A biological vessel harvesting device is provided which separates a segment of a biological vessel from adventitial tissue surrounding the biological vessel while simultaneously cauterizing and sectioning tributaries extending from the separated biological vessel segment. A minimally invasive method for using the device is also provided.

The biological vessel harvesting device includes an outer catheter and a vessel grasping mechanism positioned within a lumen of the outer catheter for holding an end of a segment of a biological vessel to be harvested, the outer catheter being movable relative to the vessel grasping mechanism such that the vessel grasping mechanism and the segment of biological vessel attached thereto can be drawn into the outer catheter lumen. The biological vessel harvesting device also includes a cautery-sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen. The cautery-sectioning system has a cautery function for cauterizing tributaries extending from the vessel segment about the circumference of the vessel segment and a sectioning function for sectioning the cauterized tributaries. The cautery-sectioning system preferably extends circumferentially about the catheter.

In a preferred embodiment, the biological vessel harvesting device also includes a hydrodissection system for delivering fluid under pressure to tissue surrounding the vessel segment to be harvested. The pressurized fluid delivery serves to separate tissue surrounding the vessel segment to be harvested.

The outer catheter preferably further includes a blunt nose distal end for initially separating the biological vessel from tissue surrounding the vessel segment being harvested. In one embodiment, the blunt nose distal end is formed by the cautery-sectioning system. The outer catheter also preferably further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end.

In a particularly preferred embodiment, the vessel grasping mechanism includes an inner fluid delivery catheter having a lumen for delivering fluid

through the inner catheter lumen into a lumen of the vessel segment being harvested.

The cautery-sectioning system preferably includes a plurality of guide members for guiding tributaries into contact with the cautery and sectioning functions. In particular, the plurality of guide members are preferably positioned and shaped to form valleys between adjacent guide members such that tributaries are channeled into the valleys as the vessel segment is drawn into the outer catheter lumen.

The cautery function is preferably an electrocautery function. In a particularly preferred embodiment, the cautery function is provided by pairs of bipolar electrodes positioned within the valleys, the pairs of bipolar electrodes cauterizing the tributaries when brought between the bipolar electrodes.

The sectioning function is preferably provided by a sharp edge positioned at the base of the valleys, the sharp edge severing the tributaries when brought in contact with the sharp edge.

In a preferred embodiment, the guide members are also preferably positioned and shaped such that the valleys formed by the guide members serve to squeeze the walls of the tributaries together as the tributary reaches the cautery and sectioning functions. By bringing the walls of the tributary into contact with each other before reaching the cautery and sectioning functions, the tributary is more effectively cauterized and severed.

A minimally invasive method for harvesting a segment of a biological vessel is also provided. The method includes accessing the distal end of a segment of a biological vessel to be harvested; attaching an inner fluid delivery catheter to the distal end of the vessel segment; infusing fluid into the vessel under hydrostatic pressure; advancing the vessel segment to be harvested within a lumen of an outer catheter, the outer catheter including a cautery-sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen; contacting tributaries extending from the vessel segment with the cautery-sectioning system as the vessel segment is advanced, the cautery-sectioning system having a cautery function which cauterizes the tributaries and a sectioning function which severs the cauterized tributaries; and ligating the vessel segment proximal end.

The method preferably also includes the step of delivering fluid under pressure to tissue surrounding the vessel segment to cause the surrounding tissue to separate from the vessel segment.

Other aspects and advantages of the present invention will be understood with reference to the figures, the detailed description and the claims which follows.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1A illustrates an embodiment of a biological vessel harvesting catheter device of the present invention.

Figure 1B illustrates the distal end of the outer catheter having a blunt nose configuration such that the distal end initially separates the peripheral adventitial tissue from the vessel segment.

Figure 2 illustrates the vessel grasping mechanism of the device as including an inner fluid delivery catheter.

Figure 3 illustrates the hydrodissection system delivering fluid under pressure to a tissue area adjacent the distal end of the outer catheter such that peripheral adventitial tissue surrounding the biological vessel is caused to separate from the biological vessel segment being harvested.

Figures 4A-D illustrate alternate embodiments for the hydrodissection system.

Figure 4A illustrate both the hydrodissection fluid delivery and removal channels being positioned within the circumference of the cautery-sectioning system.

Figure 4B illustrate the hydrodissection fluid removal channel being positioned within the circumference of the cautery-sectioning system and the hydrodissection fluid delivery channel being positioned outside the circumference of the cautery-sectioning system.

Figure 4C illustrate both the hydrodissection fluid delivery and removal channels being positioned outside the circumference of the cautery-sectioning system.

Figure 4D illustrate the hydrodissection fluid delivery channel being positioned at the guide members.

Figures 5A-B illustrate the cautery-sectioning system.

Figure 5A illustrates the cautery-sectioning system as including a plurality of guide members surrounding a blunt nosed portion of the outer catheter.

Figure 5B illustrates the cautery-sectioning system as including a plurality of guide members which combine to form a blunt nose portion of the outer catheter.

Figure 6A illustrates the plurality of guide members lining the outer catheter serving to channel the tributaries into the valley formed by adjacent guide members as the outer catheter is moved along the length of the vessel.

Figure 6B illustrates guide members positioned and shaped such that the valleys formed by the guide members squeeze the walls of the tributaries before the tributaries reach the cautery and sectioning mechanisms of the device.

Figures 7-12 illustrate the use of a vessel harvesting device of the present invention to harvest a vein segment.

Figure 7 illustrates accessing the distal end of the vein segment to be harvested.

Figure 8 illustrates an inner fluid delivery catheter being attached to the distal end of the vein segment.

Figure 9 illustrates the blunt nose shape of the outer catheter distal end creating an initial separation of the peripheral adventitial tissues from the vein segment.

Figure 10 illustrates a plurality of almond shaped guide members lining the outer catheter and serving to channel the venous tributaries into the valleys formed by adjacent guide members.

Figure 11 illustrates the proximal end of the harvested vein segment being ligated.

Figure 12 illustrates the device as including a vessel ligation mechanism for ligating the proximal end of the harvested vein segment without a second incision.

DETAILED DESCRIPTION

A biological vessel harvesting device is provided which separates a segment of a biological vessel from adventitia surrounding the biological vessel while simultaneously cauterizing and sectioning tributaries extending from the separated biological vessel segment. The biological vessel harvesting device may be used as part of a rapid, minimally invasive procedure for harvesting a segment of a biological vessel. The minimally invasive nature of the biological vessel harvesting device, combined with its action of cauterizing and sectioning tributaries extending from the vessel being harvested significantly reduces the trauma and risk of morbidity experienced by the patient due to the removal of the segment of the biological vessel. In addition, the time required to remove the vessel segment is significantly reduced, thereby reducing the surgeon time and operating room costs required to harvest a vessel segment.

In general, any biological vessel which includes an internal lumen may be harvested using the device and method of the present invention The device and method are particularly well suited for harvesting vessels which include tributaries extending from the vessel. Examples of types of biological vessels that may be harvested include, but are not limited to veins, arteries and the urethra.

An embodiment of a biological vessel harvesting device of the present invention is illustrated in Figures 1A-B. As illustrated in Figure 1A, the biological vessel harvesting device **10** includes an outer catheter **12** having at least one lumen **14** within which the biological vessel segment **16** to be harvested is drawn. A vessel grasping mechanism **18** is included within the outer catheter lumen to hold a distal end **20** of the vessel segment **16** being harvested. The outer catheter is movable relative to the vessel grasping mechanism such that the vessel grasping mechanism **18** and the vessel segment **16** attached thereto can be drawn into the outer catheter lumen **14**. Also included within the outer catheter lumen **14** near the distal end **22** of the outer catheter **12** is a hydrodissection system **24** and a cautery-sectioning system **26** which act in concert to separate the vein segment **16** from

peripheral adventitial tissue **28** surrounding the vessel while cauterizing and sectioning tributaries **30** extending from the segment **16** of the vessel being harvested.

The outer catheter **12** preferably is a thick walled catheter having a diameter greater than the diameter of the vessel segment being harvested.

As illustrated in Figures 1A-1B, the distal end **22** of the outer catheter **12** is preferably blunt nosed **17** such that the blunt nosed portion **17** of the outer catheter **12** initially separates the peripheral adventitial tissue **28** from the vessel segment **16** as the outer catheter distal end **22** passes along the length of the vessel segment **16**.

In some instances, it is desirable that the surgeon be able to harvest the vessel segment **16** under direct visualization. For such instances as illustrated in Figure **1A**, the outer catheter **12** preferably includes an illumination optic **37** and a viewing optic **39** which provides a field of view adjacent the outer catheter distal end **22**.

The vessel grasping mechanism **18** may be any form of clamp capable of holding the distal end **20** of the vessel segment. In general, the vessel grasping mechanism **18** should be able to hold the vessel segment without damaging the walls of the biological vessel. In a preferred embodiment of the present invention, illustrated in Figure 2, the vessel grasping mechanism **18** includes an inner fluid delivery catheter **40** attached to the end **20** of the vessel segment **16** in order to deliver fluid **42**, e.g. saline or some other physiologically suitable fluid, into the lumen **44** of the vessel segment **16** being harvested. Delivery of fluid into the vessel lumen **44** during harvesting is generally preferred since it renders the vessel more rigid and thus better able to support the hydrodissection, cautery and sectioning of the vessel segment **16**.

The inner fluid delivery catheter **40** is preferably attached to the end **20** of the vessel segment **16** by a circumferential clamp **46** to create a fluid tight seal. In a particular embodiment, illustrated in Figure 2, the circumferential clamp **46** includes a tightening collar **48** which applies pressure to the

adventitial walls **50** of the vessel segment **16**. Fluid **42** is preferably delivered into the vessel lumen **44** under pressure.

A hydrodissection system can be used to separate the vessel segment **16** from peripheral adventitial tissue **28** surrounding the vessel. As illustrated in Figure 3, the hydrodissection system **24** includes a fluid delivery channel **27** which delivers fluid **32** under pressure to a tissue area **34** adjacent the distal end **22** of the outer catheter **12** such that peripheral adventitial tissue **28** surrounding the vessel segment **16** is caused to separate from the vessel segment **16**. The hydrodissection system also includes a second fluid channel **25** for withdrawing the hydrodissection fluid from the tissue site.

Figures 4A-D illustrate alternate embodiments for the hydrodissection system **24**. In general, the hydrodissection system **24** includes a hydrodissection fluid delivery **27** and removal **25** channels for delivering and removing the physiological solution used in the hydrodissection system **24**. As illustrated in Figure 4A, both the hydrodissection fluid delivery **27** and removal **25** channels may be positioned within the circumference of the cautery-sectioning system **26**. As illustrated in Figure 4B, the hydrodissection fluid removal channel **25** may be positioned within the circumference of the cautery-sectioning system **26** while the delivery channel **27** is positioned outside the circumference of the cautery-sectioning system **26**. As illustrated in Figure 4C, both the hydrodissection fluid delivery **27** and removal **25** channels may be positioned outside the circumference of the cautery-sectioning system **26**. As illustrated in Figure 4D, hydrodissection fluid may be delivered through channels **27** positioned within the cautery-sectioning system **26**.

The cautery-sectioning system **26** is illustrated in Figures 5A-5B. As illustrated in Figure 5A, the cautery-sectioning system **26** includes a cautery device **36** for cauterizing exposed tributaries of the vessel segment **16** being harvested. The cautery device **36** is preferably an electrocautery device but may also be a cautery device employing a laser light source. The cautery-sectioning system may also include a sectioning device **38** which cuts the

cauterized tributaries, thereby freeing the vessel segment from the surrounding tissue.

As illustrated in Figure 5A, the cautery-sectioning system **26** preferably includes a plurality of guide members **58** attached to the outer catheter **12** which form a ring around the outer catheter lumen **14**. The width **62** of each guide member **58** preferably increases in the direction of the outer catheter wall **60**. The guide members **58** are preferably almond shaped cones. As illustrated in Figure 5A, the plurality of guide members **58** surround the blunt nosed portion **17** of the outer catheter **12**. As illustrated in Figure 5B, the plurality of guide members **58** may combine to form a blunt nosed portion **17** of the outer catheter **12**. In a preferred embodiment, illustrated in Figures 5A-5B, the cautery device **36** and section device **38** are positioned between the guide members **58** which guide tributaries to the cautery and sectioning devices **36**, **38**.

The action of the guide members **58** to guide the tributaries the cautery and sectioning devices is illustrated in Figures 6A-6B. As illustrated in Figure 6A, the plurality of guide members **58** lining the outer catheter **60** serve to channel tributaries **30** extending from the vessel segment **16** being harvested into valleys **66** formed by adjacent guide members **58** as the outer catheter **12** is moved along the length of the vessel segment **16**.

Positioned in the valleys **66** formed by adjacent guide members **58** is a cautery mechanism **68** for cauterizing the tributaries **30** which are channeled into the valleys **66** formed by adjacent guide members **58**. For example, the cautery mechanism **68** illustrated in Figure 6A is an electrocautery mechanism which includes a pair of bipolar electrodes **70**, **72**. The tributaries **30** are cauterized **74** as they are brought into contact with the pair of bipolar electrodes **70**, **72**.

Also positioned within the valleys **66** formed by adjacent guide members **58** is a sectioning mechanism **76** for severing the cauterized tributaries **74**. The sectioning mechanism **76** may be a sharp edge **78** positioned at the base **80** of each of the valleys **66** formed by adjacent guide

members **58**. The cauterized tributaries **74** are severed as they are brought into contact with the sectioning mechanism **76**.

In a preferred embodiment, illustrated in Figure 6B, the guide members **58** are positioned and shaped such that the shaped valleys **66** formed by the guide members **58** squeeze the walls **61** of tributaries **30** extending from the vessel segment **16** before the tributaries **30** reach the cautery mechanism **68** and sectioning mechanism **74** of the device. By bringing the walls **61** of a tributary **30** into contact before reaching the cautery and sectioning mechanisms, the tributary **30** is effectively cauterized by the cautery mechanism **68** and effectively sectioned by the sectioning mechanism **74**.

Figures 7-11 illustrate the use of the biological vessel harvesting device of the present invention to harvest a segment of a vein. As illustrated in Figure 7, a small distal incision **100** is made in the patient's skin **102** in order access the distal end **104** of a segment **106** of a vein **103** to be harvested. As illustrated, the vein **103** includes tributaries **128** extending from the vein **103**. The vein **103** is isolated, for example, using a mosquito clamp dissection, and delivered to the surface of the patient's skin **102**. The vein **103** is then clamped, cut and ligated at the distal end **104**.

As illustrated in Figure 8, an inner fluid delivery catheter **112** of the biological vessel harvesting device **112** is attached to the distal end **104** of the vein **103** by a circumferential clamp **114** which creates a fluid tight seal between the inner fluid delivery catheter **112** and the lumen **116** of the vein segment **106** being harvested. Saline **120** is then infused into the vein **103** under slight hydrostatic pressure.

The outer catheter **118** of the biological vessel harvesting device **112** is then advanced along the vein segment **106** from the distal end **104** to the proximal end **108** of the vein segment **106**.

As illustrated in Figure 9, as the outer catheter **118** is advanced along the vein segment **106**, the slight blunt nose shape **115** of the outer catheter distal end **118** creates an initial separation **120** of the peripheral adventitial tissues **122** from the vein segment **106**. At the same time, physiological solution **124** is emitted under pressure by the hydrodissection system **126** to

further displace the peripheral adventitial tissues **122** from the vein segment **106**. Displacement of the peripheral adventitial tissues **122** exposes multiple smaller venous tributaries **128** of various sizes which are positioned at irregular intervals and locations along the vein segment **106**.

As the biological vessel harvesting device **112** is advanced along the vein segment **106**, the multiple exposed venous tributaries **128** are placed in contact with the cauterizing system **130**. As illustrated in Figure 10, a plurality of almond shaped guide members **132** of the cauterizing system **130** line the outer catheter **133** and serve to channel the venous tributaries **128** into valleys **134** formed by adjacent guide members **132** as the vessel harvesting device **112** is advanced along the vein segment **106**.

Positioned in the valleys **134** formed by the adjacent guide members **132** are pairs of bipolar electrodes **136**, **138**. The venous tributaries **128** are cauterized **140** as they are brought into contact with the pair of bipolar electrodes **136**, **138**.

Also positioned within the valleys **134** formed by adjacent guide members **132** are sectioning mechanisms **142** for severing the cauterized the venous tributaries **140**. The sectioning mechanisms **142** are preferably sharp edges positioned at the base of each of the valleys **134**. The venous tributaries **128**, already cauterized by the cauterizing mechanism, are severed as they are brought into contact with the sectioning mechanism **142** as the biological vessel harvesting device **112** is advanced along the vein segment **106**.

In a preferred embodiment, described above with regard to Figure 6B, the guide members **132** are shaped and positioned so that the walls of the tributaries are squeezed together within the valleys prior to contacting the cauterizing and sectioning mechanisms.

When the biological vessel harvesting device **112** has been advanced the desired distance along the vein segment **106**, a second, proximal incision **150** is made in the skin overlying the vein segment **106** to be harvested. As illustrated in Figure 11, the vein **103** is clamped **151** and ligated at the

proximal end **108** of the desired vein segment **106**. The flow of physiological fluid through the vein **103** is then terminated.

Once ligated at the proximal end **108** of the vein segment, the vein segment **106** is harvested by withdrawing the vein segment **106** from the patient through the distal incision **100** by removal of the outer catheter **118** within which the vein segment **106** is held.

As an alternative approach to the removal of the vein segment **106** through the use of a second, proximal incision **150**, as described above with regard to Figure 11, the biological vessel harvesting catheter device may include a vessel ligation mechanism for ligating the vessel once the harvesting catheter device has been advanced the desired distance along the vein segment. The vessel ligation mechanism enables the vessel to be cauterized and ligated without the need to create a second, proximal incision.

As illustrated in Figure 12, the vessel ligation mechanism may include a cauterization clamp **153** which is used to clamp the proximal end **108** of the segment **106** of the vein **103** being harvested. The two forks **154**, **155** forming the cauterization clamp **153** may be moved together **154**, **155**, to clamp the vein. The forks may also form a pair of bipolar electrodes. Once the proximal end **108** of the vein segment **106** has been clamped by the cauterization clamp **153**, an electrical potential is applied across the pair of bipolar electrodes **154**, **155** to cauterize the vein. Also included in the vessel ligation mechanism is a cutting blade **156** which can be activated after cauterization of the vein **103** to ligate the proximal end **108** of the vein segment **106** to be harvested. As a result, the proximal end **108** of the vein segment **106** to be harvested may be cauterized and ligated without the need for the second incision into the patient.

The foregoing description of preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in this art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application, thereby enabling others skilled in the art to understand the

invention for various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. A biological vessel harvesting device comprising:

an outer catheter having a distal end, a circumference and at least one lumen;

a vessel grasping mechanism positioned within the outer catheter lumen for holding an end of a segment of a biological vessel to be harvested, the outer catheter being movable relative to the vessel grasping mechanism such that the vessel grasping mechanism and the vessel segment attached thereto can be drawn into the outer catheter lumen; and

a cautery-sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen, the cautery-sectioning system having a cautery function for cauterizing tributaries extending from the vessel segment about the circumference of the vessel segment and a sectioning function for sectioning the cauterized tributaries.

2. The biological vessel harvesting device according to claim 1 wherein the cautery function is an electrocautery function.

3. The biological vessel harvesting device according to claim 1 wherein the outer catheter further includes a blunt nose distal end for initially separating the biological vessel from the tissue surrounding the vessel segment being harvested.

4. The biological vessel harvesting device according to claim 3 wherein the blunt nose distal end is formed by the cautery-sectioning system.

5. The biological vessel harvesting device according to claim 1 wherein the outer catheter further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end.

6. The biological vessel harvesting device according to claim 1 wherein the vessel grasping mechanism includes an inner fluid delivery catheter

having a lumen for delivering fluid through the inner catheter lumen into a lumen of the vessel grasping segment being harvested.

7. The biological vessel harvesting device according to claim 6 wherein the vessel segment lumen is defined by a vessel lumen wall, the inner fluid delivery catheter including a circumferential clamp which binds the vessel lumen wall to create a fluid tight seal between the inner fluid delivery catheter and the vessel segment lumen.

8. The biological vessel harvesting device according to claim 7 wherein the circumferential clamp is a tightening collar which applies pressure to the vessel lumen wall.

9. The biological vessel harvesting device according to claim 1 wherein the cautery-sectioning system includes a plurality of guide members for guiding tributaries into contact with the cautery and sectioning functions.

10. The biological vessel harvesting device according to claim 9 wherein the plurality of guide members are positioned and shaped to form valleys between adjacent guide members such that tributaries are channeled into the valleys as the vessel segment is drawn into the outer catheter lumen.

11. The biological vessel harvesting device according to claim 9 wherein the guide members are almond shaped cones.

12. The biological vessel harvesting device according to claim 10 wherein the cautery-sectioning system includes a pair of bipolar electrodes positioned within the valleys, the pairs of bipolar electrodes serving as the cautery function to cauterize tributaries when brought between the bipolar electrodes.

13. The biological vessel harvesting device according to claim 10 wherein the cautery-sectioning system includes a sharp edge positioned within the

valleys, the sharp edge serving as the sectioning function to section the tributaries when brought in contact with the sharp edge.

14. The biological vessel harvesting device according to claim 12 wherein the valleys have opposing walls and a base, the pairs of bipolar electrodes being positioned on the opposing walls of the valleys, the cautery-sectioning system including a sharp edge positioned at the base of the valleys and serving as the sectioning function to section the tributaries when brought in contact with the sharp edge.

15. The biological vessel harvesting device according to claim 9 shaped and wherein the guide members are positioned to squeeze walls of the tributary together prior to contacting the cautery and sectioning functions.

16. A biological vessel harvesting device comprising:

an outer catheter having a distal end, a circumference and at least one lumen;

a vessel grasping mechanism positioned within the outer catheter lumen for holding an end of a segment of a biological vessel to be harvested, the outer catheter being movable relative to the vessel grasping mechanism such that the vessel grasping mechanism and the vessel segment attached thereto can be drawn into the outer catheter lumen;

a cautery-sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen, the cautery-sectioning system having a cautery function for cauterizing tributaries extending from the vessel segment about the circumference of the vessel segment and a sectioning function for sectioning the cauterized tributaries; and

a hydrodissection system for delivering fluid under pressure to tissue surrounding the vessel segment to be harvested to separate the biological vessel from tissue surrounding the biological vessel.

17. The biological vessel harvesting device according to claim 17 wherein the outer catheter further includes a blunt nose distal end for initially

separating the biological vessel from the tissue surrounding the vessel segment being harvested.

18. The biological vessel harvesting device according to claim 17 wherein the blunt nose distal end is formed by the circumferential cautery-sectioning system.

19. The biological vessel harvesting device according to claim 16 wherein the outer catheter further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end.

20. The biological vessel harvesting device according to claim 16 wherein the vessel grasping mechanism includes an inner fluid delivery catheter having a lumen for delivering fluid through the inner catheter lumen into a lumen of the vein segment being harvested.

21. The biological vessel harvesting device according to claim 20 wherein the vessel segment lumen is defined by a vein lumen wall, the inner fluid delivery catheter including a circumferential clamp which binds the vessel lumen wall to create a fluid tight seal between the inner fluid delivery catheter and the vein segment lumen.

22. The biological vessel harvesting device according to claim 21 wherein the circumferential clamp is a tightening collar which applies pressure to the vessel lumen wall.

23. The biological vessel harvesting device according to claim 16 wherein the cautery-sectioning system includes a plurality of guide members for guiding tributaries extending from the vessel segment into contact with the cautery and sectioning functions.

24. The biological vessel harvesting device according to claim 23 wherein the plurality of guide members are positioned and shaped to form valleys

between adjacent guide members such that tributaries are channeled into the valley as the vessel segment is drawn into the outer catheter lumen.

25. The biological vessel harvesting device according to claim 23 wherein the guide members are almond shaped cones.

26. The biological vessel harvesting device according to claim 24 wherein the cautery-sectioning system includes a pair of bipolar electrodes positioned within each valley, the pairs of bipolar electrodes serving as the cautery function to cauterize tributaries when brought between the bipolar electrodes.

27. The biological vessel harvesting device according to claim 24 wherein the cautery-sectioning system includes a sharp edge positioned within each valley, the sharp edge serving as the sectioning function to section the tributaries when brought in contact with the sharp edge.

28. The biological vessel harvesting device according to claim 26 wherein each valley has opposing walls and a base, the pairs of bipolar electrodes being positioned on the opposing walls of each valley, the cautery-sectioning system including a sharp edge positioned at the base of each valley and serving as the sectioning function to section the tributaries when brought in contact with the sharp edge.

29. The biological vessel harvesting device according to claim 24 shaped and wherein the guide members are positioned to squeeze walls of the tributary together prior to contacting the cautery and sectioning functions.

30. The biological harvesting device according to claim 16 wherein the hydrodissection system includes a first fluid delivery channel and a second fluid removal channel.

31. The biological vessel harvesting device according to claim 30 wherein

the hydrodissection fluid delivery channel is positioned outside of the ring formed by the cautery-sectioning system and the hydrodissection fluid removal channel is positioned within the ring formed by the cautery-sectioning system.

32. The biological vessel harvesting device according to claim 30 wherein the hydrodissection fluid delivery and removal channels are positioned within the ring formed by the cautery-sectioning system.

33. The biological vessel harvesting catheter device according to claim 30 wherein the hydrodissection fluid delivery and removal channels are positioned outside of the ring formed by the cautery-sectioning system.

34. The biological vessel harvesting device according to claim 30 wherein the fluid delivery channel is positioned within the cautery-sectioning system.

35. A method for harvesting a segment of a biological vessel having a proximal end and a distal end comprising:

accessing the distal end of the vessel segment to be harvested;

attaching an inner fluid delivery catheter to the distal end of the vessel segment;

infusing fluid into the biological vessel under hydrostatic pressure;

advancing the vessel segment to be harvested within a lumen of an outer catheter, the outer catheter including a cautery-sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen;

contacting tributaries extending from the vessel segment with the cautery-sectioning system as the vessel segment is advanced within the outer catheter, the cautery-sectioning system having a cautery function which cauterizes tributaries extending from the vessel segment and a sectioning function which severs the cauterized tributaries; and

ligating the vessel segment proximal end.

36. The method according to claim 35 wherein the outer catheter further includes a blunt nose shaped distal end, the method further including the step of separating tissue surrounding the vessel segment from the vessel segment as the vessel segment is advanced within the outer catheter lumen.

37. The method according to claim 36 wherein the blunt nose distal end is formed by the cautery-sectioning system.

38. The method according to claim 35 wherein the outer catheter further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end, the method further includes the step of visualizing the harvesting of the vessel segment.

39. The method according to claim 35 wherein the vessel grasping mechanism further includes an inner fluid delivery catheter having a lumen, the method further including the steps of attaching the inner fluid delivery catheter to a lumen of the vessel segment and delivering fluid through the inner catheter lumen to the lumen of the vessel segment being harvested.

40. The method according to claim 35 wherein the cautery-sectioning system includes a plurality of guide members positioned and shaped to form valleys between adjacent guide members, the cautery-sectioning system including pairs of bipolar electrodes positioned within the valleys, the method further including the step of advancing the vessel segment to be harvested within the lumen of the outer catheter such that the tributaries are channeled into a valley and into contact with the bipolar electrodes where the tributaries are cauterized.

41. The method according to claim 40 wherein the cautery-sectioning system further includes a sharp edge positioned within the valleys, the method further including the step of advancing the vessel segment to be harvested within the lumen of the outer catheter such that the cauterized vessel

tributaries are contacted with a sharp edge serving as the sectioning function which severs the tributaries.

42. The method according to claim 40 wherein the guide members are shaped and positioned to squeeze walls of the tributaries together prior to contacting the cautery and sectioning functions.

43. A method for harvesting a segment of a biological vessel having a proximal end and a distal end comprising:

accessing the distal end of the vessel segment to be harvested;

attaching an inner fluid delivery catheter to the distal end of the vessel segment;

infusing fluid into the biological vessel under slight hydrostatic pressure;

delivering fluid under pressure to tissue surrounding the vessel segment to cause tissue surrounding the biological vessel to separate from the vessel segment;

advancing the vessel segment to be harvested within a lumen of an outer catheter, the outer catheter including a cautery-sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen;

contacting tributaries extending from the vessel segment with the cautery-sectioning system as the vessel segment is advanced within the outer catheter lumen, the cautery-sectioning system having a cautery function which cauterizes tributaries about the circumference of the vessel segment and a sectioning function which severs the cauterized tributaries; and

ligating the vessel segment proximal end.

44. The method according to claim 43 wherein the outer catheter further includes a blunt nose shaped distal end, the method further including the step of separating tissue surrounding the vessel segment from the vessel segment as the vessel segment is advanced within the outer catheter lumen.

45. The method according to claim 44 wherein the blunt nose distal end is formed by the cautery-sectioning system.

46. The method according to claim 43 wherein the outer catheter further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end, the method further includes the step of visualizing the harvesting of the vessel segment.

47. The method according to claim 43 wherein the vessel grasping mechanism further includes an inner fluid delivery catheter having a lumen, the method further including the steps of attaching the inner fluid delivery catheter to a lumen of the vessel segment and delivering fluid through the inner catheter lumen to the lumen of the vessel segment being harvested.

48. The method according to claim 43 wherein the cautery-sectioning system includes a plurality of guide members positioned and shaped to form valleys between adjacent guide members, the cautery-sectioning system including pairs of bipolar electrodes positioned within the valleys, the method further including the step of advancing the vessel segment to be harvested within the lumen of the outer catheter such that the tributaries are channeled into the valleys and into contact with the bipolar electrodes where the venous tributaries are cauterized.

49. The method according to claim 48 wherein the cautery-sectioning system further includes a sharp edge positioned within the valleys, the method further including the step of advancing the vessel segment to be harvested within the lumen of the outer catheter such that the cauterized tributaries are contacted with a sharp edge serving as the sectioning function which severs the tributaries.

50. The method according to claim 48 wherein the guide members are shaped and positioned to squeeze walls of the tributaries together prior to contacting the cautery and sectioning functions.

AMENDED CLAIMS

[received by the International Bureau on 29 July 1998 (29.07.98); original claims 1-50 replaced by amended claims 1-63 (10 pages)]

1. A biological vessel harvesting device comprising:

an outer catheter having a distal end and an outer catheter lumen;

a vessel grasping mechanism positioned within the outer catheter lumen for holding an end of a segment of a biological vessel to be harvested, the outer catheter being movable relative to the vessel grasping mechanism such that the vessel grasping mechanism and the vessel segment grasped thereby can be drawn into the outer catheter lumen; and

a cautery-sectioning system positioned on a wall of the outer catheter adjacent the outer catheter distal end, the cautery-sectioning system having a cautery mechanism for cauterizing tributaries extending from the vessel segment and a sectioning mechanism for sectioning the cauterized tributaries.

2. The biological vessel harvesting device according to claim 1 wherein the cautery mechanism is an electrocautery mechanism.

3. The biological vessel harvesting device according to claim 1 wherein the outer catheter further includes a blunt nose distal end for initially separating the biological vessel from the tissue surrounding the vessel segment being harvested.

4. The biological vessel harvesting device according to claim 3 wherein the blunt nose distal end is formed by the cautery-sectioning system.

5. The biological vessel harvesting device according to claim 1 wherein the outer catheter further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end.

6. The biological vessel harvesting device according to claim 1 wherein the vessel grasping mechanism includes an inner fluid delivery catheter having a lumen for delivering fluid through the inner catheter lumen into a lumen of the vessel segment being harvested.

7. The biological vessel harvesting device according to claim 6 wherein the vessel segment lumen is defined by a vessel lumen wall, the inner fluid delivery catheter including a circumferential clamp which binds the vessel lumen wall to create a fluid tight seal between the inner fluid delivery catheter and the vessel segment lumen.

8. The biological vessel harvesting device according to claim 7 wherein the circumferential clamp is a tightening collar which applies pressure to the vessel lumen wall.

9. The biological vessel harvesting device according to claim 1 wherein the cautery-sectioning system includes a plurality of guide members for guiding tributaries into contact with the cautery and sectioning mechanisms.

10. The biological vessel harvesting device according to claim 9 wherein the plurality of guide members are positioned and shaped to form valleys between adjacent guide members such that tributaries are channeled into the valleys as the vessel segment is drawn into the outer catheter lumen.

11. The biological vessel harvesting device according to claim 9 wherein the guide members are almond shaped cones.

12. The biological vessel harvesting device according to claim 10 wherein the cautery-sectioning system includes a pair of bipolar electrodes positioned within the valleys, the pairs of bipolar electrodes serving as the cautery mechanism to cauterize tributaries when brought between the bipolar electrodes.

13. The biological vessel harvesting device according to claim 10 wherein the cautery-sectioning system includes a sharp edge positioned within the valleys, the sharp edge serving as the sectioning mechanism to section the tributaries when brought in contact with the sharp edge.

14. The biological vessel harvesting device according to claim 12 wherein the valleys have opposing walls and a base, the pairs of bipolar electrodes being positioned on the opposing walls of the valleys, the cautery-sectioning system including a sharp edge positioned at the base of the valleys and serving as the sectioning mechanism to section the tributaries when brought in contact with the sharp edge.

15. The biological vessel harvesting device according to claim 9 shaped and wherein the guide members are positioned to squeeze walls of the tributary together prior to contacting the cautery and sectioning mechanisms.

16. A biological vessel harvesting device comprising:

an outer catheter having a distal end and an outer catheter lumen;

a vessel grasping mechanism positioned within the outer catheter lumen for grasping an end of a segment of a biological vessel to be harvested, the outer catheter being movable relative to the vessel grasping mechanism such that the vessel grasping mechanism and the vessel segment grasped thereby can be drawn into the outer catheter lumen;

a cautery-sectioning system positioned on a wall of the outer catheter adjacent the outer catheter distal end, the cautery-sectioning system having a cautery mechanism for cauterizing tributaries extending from the vessel segment and a sectioning mechanism for sectioning the cauterized tributaries; and

a hydrodissection system for delivering fluid under pressure to tissue surrounding the vessel segment to be harvested to separate the biological vessel from tissue surrounding the biological vessel.

17. The biological vessel harvesting device according to claim 16 wherein the outer catheter further includes a blunt nose distal end for initially separating the biological vessel from the tissue surrounding the vessel segment being harvested.

18. The biological vessel harvesting device according to claim 17 wherein the blunt nose distal end is formed by the circumferential cautery-sectioning system.

19. The biological vessel harvesting device according to claim 16 wherein the outer catheter further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end.

20. The biological vessel harvesting device according to claim 16 wherein the vessel grasping mechanism includes an inner fluid delivery catheter having a lumen for delivering fluid through the inner catheter lumen into a lumen of the vessel segment being harvested.

21. The biological vessel harvesting device according to claim 20 wherein the vessel segment lumen is defined by a vein lumen wall, the inner fluid delivery catheter including a circumferential clamp which binds the vessel lumen wall to create a fluid tight seal between the inner fluid delivery catheter and the vein segment lumen.

22. The biological vessel harvesting device according to claim 21 wherein the circumferential clamp is a tightening collar which applies pressure to the vessel lumen wall.

23. The biological vessel harvesting device according to claim 16 wherein the cautery-sectioning system includes a plurality of guide members for guiding tributaries extending from the vessel segment into contact with the cautery and sectioning mechanisms.

24. The biological vessel harvesting device according to claim 23 wherein the plurality of guide members are positioned and shaped to form valleys between adjacent guide members such that tributaries are channeled into the valley as the vessel segment is drawn into the outer catheter lumen.

25. The biological vessel harvesting device according to claim 23 wherein the guide members are almond shaped cones.

26. The biological vessel harvesting device according to claim 24 wherein the cautery-sectioning system includes a pair of bipolar electrodes positioned within each valley, the

pairs of bipolar electrodes serving as the cautery mechanism to cauterize tributaries when brought between the bipolar electrodes.

27. The biological vessel harvesting device according to claim 24 wherein the cautery-sectioning system includes a sharp edge positioned within each valley, the sharp edge serving as the sectioning mechanism to section the tributaries when brought in contact with the sharp edge.

28. The biological vessel harvesting device according to claim 26 wherein each valley has opposing walls and a base, the pairs of bipolar electrodes being positioned on the opposing walls of each valley, the cautery-sectioning system including a sharp edge positioned at the base of each valley and serving as the sectioning mechanism to section the tributaries when brought in contact with the sharp edge.

29. The biological vessel harvesting device according to claim 24 shaped and wherein the guide members are positioned to squeeze walls of the tributary together prior to contacting the cautery and sectioning mechanisms.

30. The biological harvesting device according to claim 16 wherein the hydrodissection system includes a first fluid delivery channel and a second fluid removal channel.

31. The biological vessel harvesting device according to claim 30 wherein the hydrodissection fluid delivery channel is positioned outside of the ring formed by the cautery-sectioning system and the hydrodissection fluid removal channel is positioned within the ring formed by the cautery-sectioning system.

32. The biological vessel harvesting device according to claim 30 wherein the hydrodissection fluid delivery and removal channels are positioned within the ring formed by the cautery-sectioning system.

33. The biological vessel harvesting catheter device according to claim 30 wherein the hydrodissection fluid delivery and removal channels are positioned outside of the ring formed by the cautery-sectioning system.

34. The biological vessel harvesting device according to claim 30 wherein the fluid delivery channel is positioned within the cautery-sectioning system.

35. The biological vessel harvesting device according to claim 1 wherein the cautery mechanism is a laser cautery mechanism.

36. The biological vessel harvesting device according to claim 1 wherein the sectioning mechanism is a mechanical sectioning mechanism.

37. The biological vessel harvesting device according to claim 16 wherein the cautery mechanism is a laser cautery mechanism.

38. The biological vessel harvesting device according to claim 16 wherein the sectioning mechanism is a mechanical sectioning mechanism.

39. A method for harvesting a segment of a biological vessel having a proximal end and a distal end comprising:

accessing the distal end of the vessel segment to be harvested;

attaching an inner fluid delivery catheter to the distal end of the vessel segment;

infusing fluid into the biological vessel under hydrostatic pressure;

advancing the vessel segment to be harvested within a lumen of an outer catheter, the outer catheter including a cautery-sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen;

contacting tributaries extending from the vessel segment with the cautery-sectioning system as the vessel segment is advanced within the outer catheter, the cautery-sectioning system having a cautery function which cauterizes tributaries extending from the vessel segment and a sectioning function which severs the cauterized tributaries; and

ligating the vessel segment proximal end.

40. The method according to claim 35 wherein the outer catheter further includes a blunt nose shaped distal end, the method further including the step of separating tissue surrounding the vessel segment from the vessel segment as the vessel segment is advanced within the outer catheter lumen.

41. The method according to claim 36 wherein the blunt nose distal end is formed by the cautery-sectioning system.

42. The method according to claim 35 wherein the outer catheter further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end, the method further includes the step of visualizing the harvesting of the vessel segment.

43. The method according to claim 35 wherein the cautery-sectioning system includes a plurality of guide members positioned and shaped to form valleys between adjacent guide members, the cautery-sectioning system including pairs of bipolar electrodes positioned within the valleys, the method further including the step of advancing the vessel segment to be harvested within the lumen of the outer catheter such that the tributaries are channeled into a valley and into contact with the bipolar electrodes where the tributaries are cauterized.

44. The method according to claim 43 wherein the cautery-sectioning system further includes a sharp edge positioned within the valleys, the method further including the step of advancing the vessel segment to be harvested within the lumen of the outer catheter such that the cauterized vessel tributaries are contacted with a sharp edge serving as the sectioning function which severs the tributaries.

45. The method according to claim 43 wherein the guide members are shaped and positioned to squeeze walls of the tributaries together prior to contacting the cautery and sectioning functions.

46. A method for harvesting a segment of a biological vessel having a proximal end and a distal end comprising:

accessing the distal end of the vessel segment to be harvested;

attaching an inner fluid delivery catheter to the distal end of the vessel segment;

infusing fluid into the biological vessel under slight hydrostatic pressure;

delivering fluid under pressure to tissue surrounding the vessel segment to cause tissue surrounding the biological vessel to separate from the vessel segment;

advancing the vessel segment to be harvested within a lumen of an outer catheter, the outer catheter including a cautery-sectioning system positioned adjacent the outer catheter distal end in a ring around the outer catheter lumen;

contacting tributaries extending from the vessel segment with the cautery-sectioning system as the vessel segment is advanced within the outer catheter lumen, the cautery-sectioning system having a cautery function which cauterizes tributaries about the circumference of the vessel segment and a sectioning function which severs the cauterized tributaries; and

ligating the vessel segment proximal end.

47. The method according to claim 46 wherein the outer catheter further includes a blunt nose shaped distal end, the method further including the step of separating tissue surrounding the vessel segment from the vessel segment as the vessel segment is advanced within the outer catheter lumen.

48. The method according to claim 47 wherein the blunt nose distal end is formed by the cautery-sectioning system.

49. The method according to claim 46 wherein the outer catheter further includes an illumination optic and a viewing optic for providing a field of view distal to the outer catheter distal end, the method further includes the step of visualizing the harvesting of the vessel segment.

50. The method according to claim 46 wherein the cautery-sectioning system includes a plurality of guide members positioned and shaped to form valleys between adjacent

guide members, the cautery-sectioning system including pairs of bipolar electrodes positioned within the valleys, the method further including the step of advancing the vessel segment to be harvested within the lumen of the outer catheter such that the tributaries are channeled into the valleys and into contact with the bipolar electrodes where the venous tributaries are cauterized.

51. The method according to claim 50 wherein the cautery-sectioning system further includes a sharp edge positioned within the valleys, the method further including the step of advancing the vessel segment to be harvested within the lumen of the outer catheter such that the cauterized tributaries are contacted with a sharp edge serving as the sectioning function which severs the tributaries.

52. The method according to claim 48 wherein the guide members are shaped and positioned to squeeze walls of the tributaries together prior to contacting the cautery and sectioning functions.

53. The method according to claim 39 wherein the step of infusing fluid into the biological vessel is performed under hydrostatic pressure.

54. The method according to claims 39 wherein the step of cauterizing the tributaries is performed by electrocautery.

55. The method according to claim 39 wherein the step of cauterizing the tributaries is performed by laser cautery.

56. The method according to claim 39 where the step of sectioning the tributaries is performed by mechanically severing the tributaries.

57. The method according to claim 42 wherein visualization is performed through an optic adjacent the outer catheter distal end.

58. The method according to claim 46 wherein the step of infusing fluid into the biological vessel is performed under hydrostatic pressure.

59. The method according to claim 46 wherein the step of cauterizing the tributaries is performed by electrocautery.

60. The method according to claim 46 wherein the step of cauterizing the tributaries is performed by laser cautery.

61. The method according to claim 46 wherein the step of sectioning the tributaries is performed by mechanically severing the tributaries.

62. The method according to claim 46 wherein the step of separating the vessel segment from tissue surrounding the vessel segment includes delivering fluid to tissue surrounding the vessel segment to cause tissue surrounding the vessel segment to separate from the vessel segment.

63. The method according to claim 49 wherein visualization is performed through an optic adjacent the outer catheter distal end.

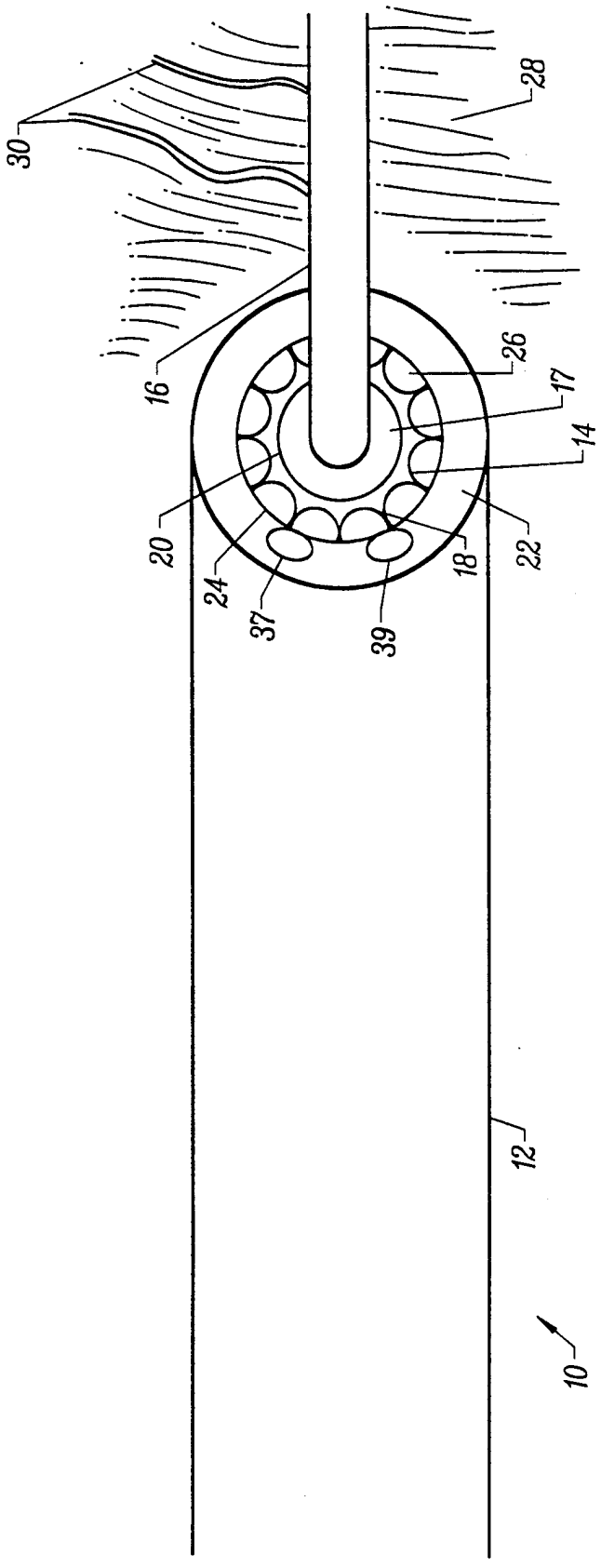


FIG. 1A

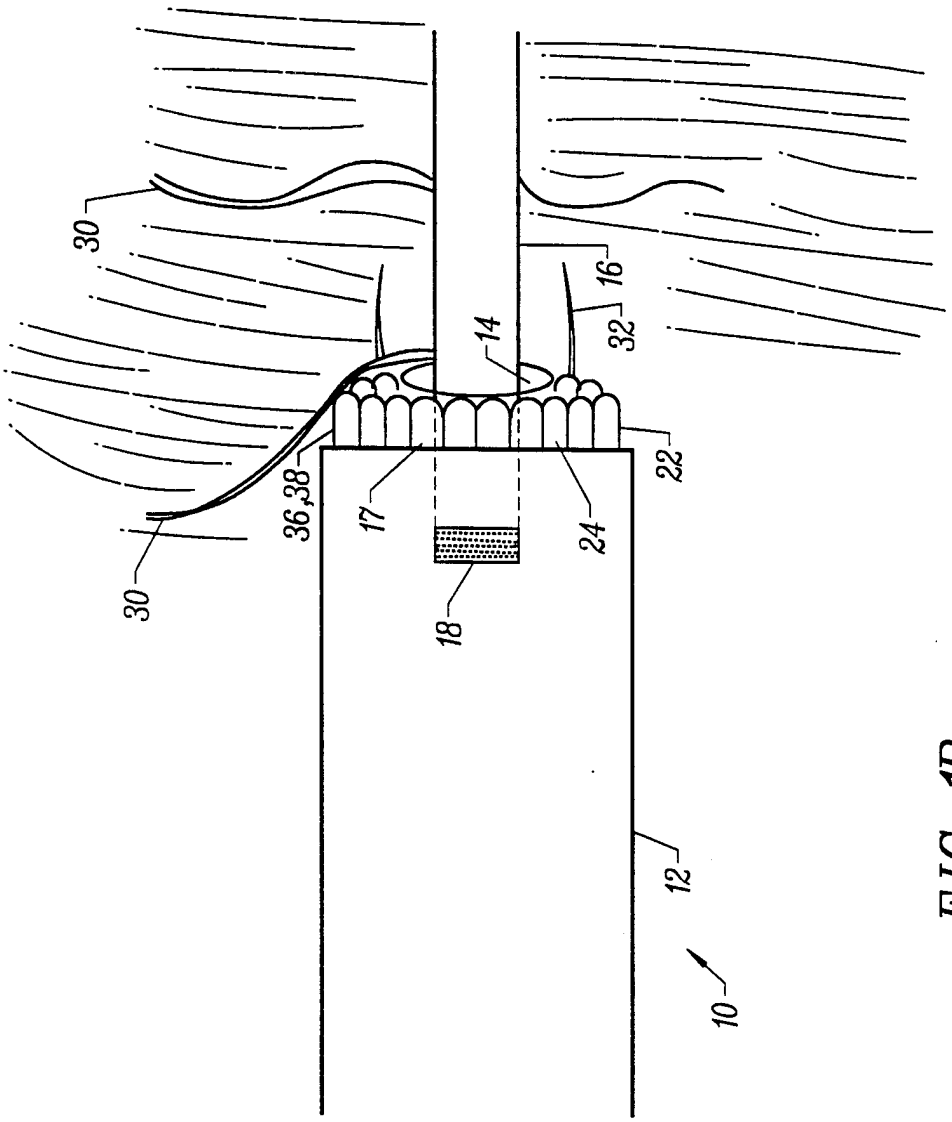


FIG. 1B

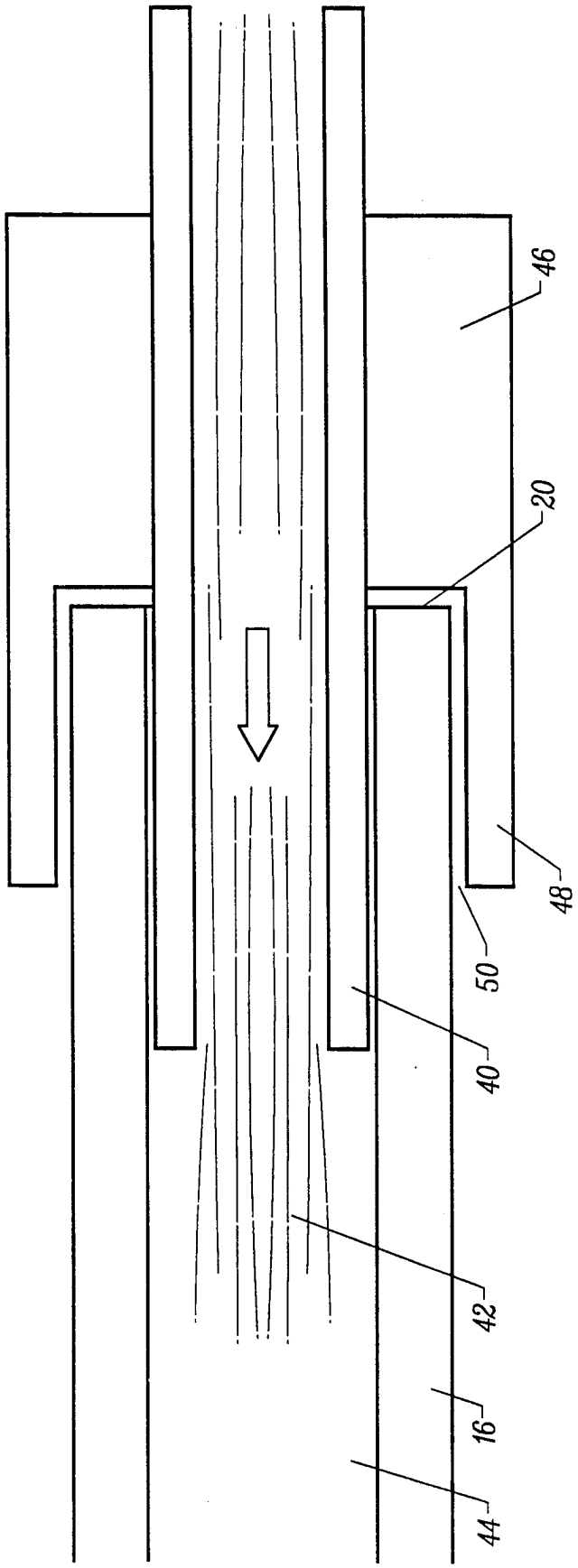


FIG. 2

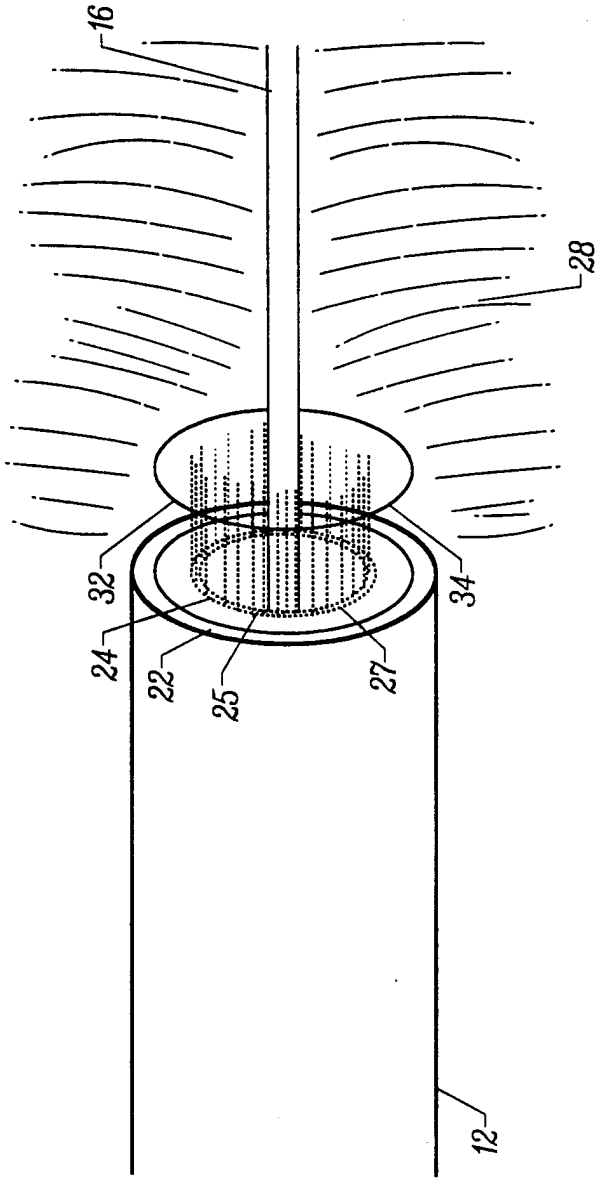


FIG. 3

FIG. 4A

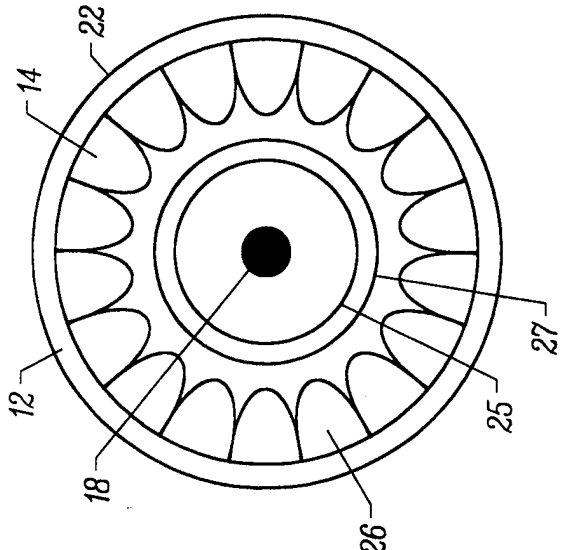


FIG. 4B

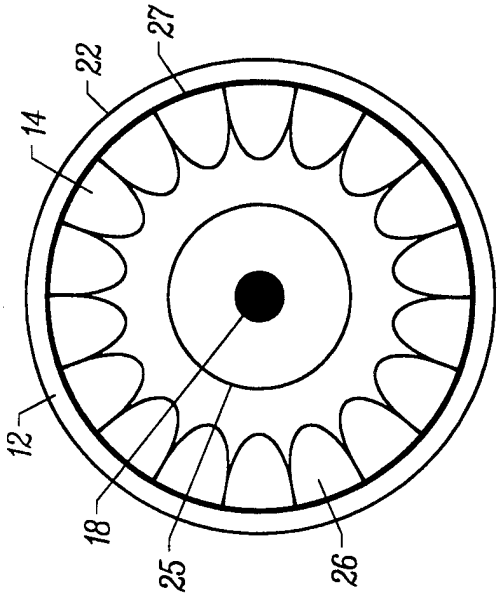


FIG. 4C

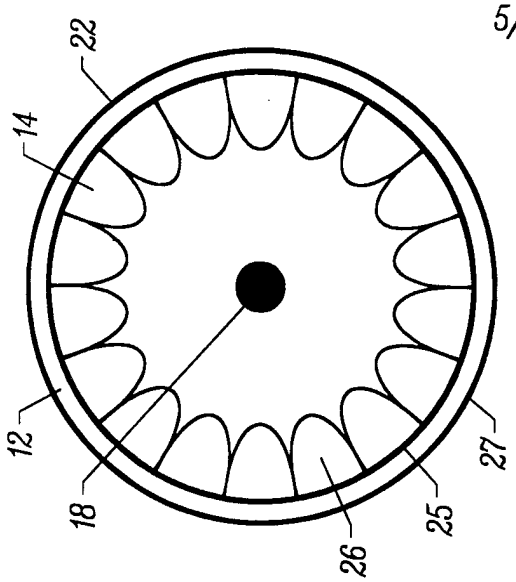
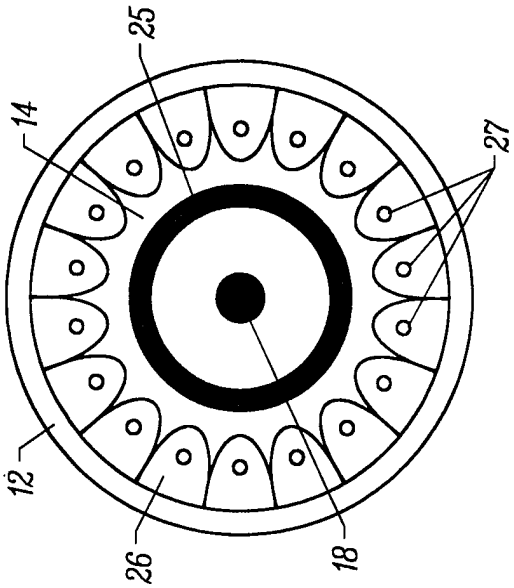


FIG. 4D



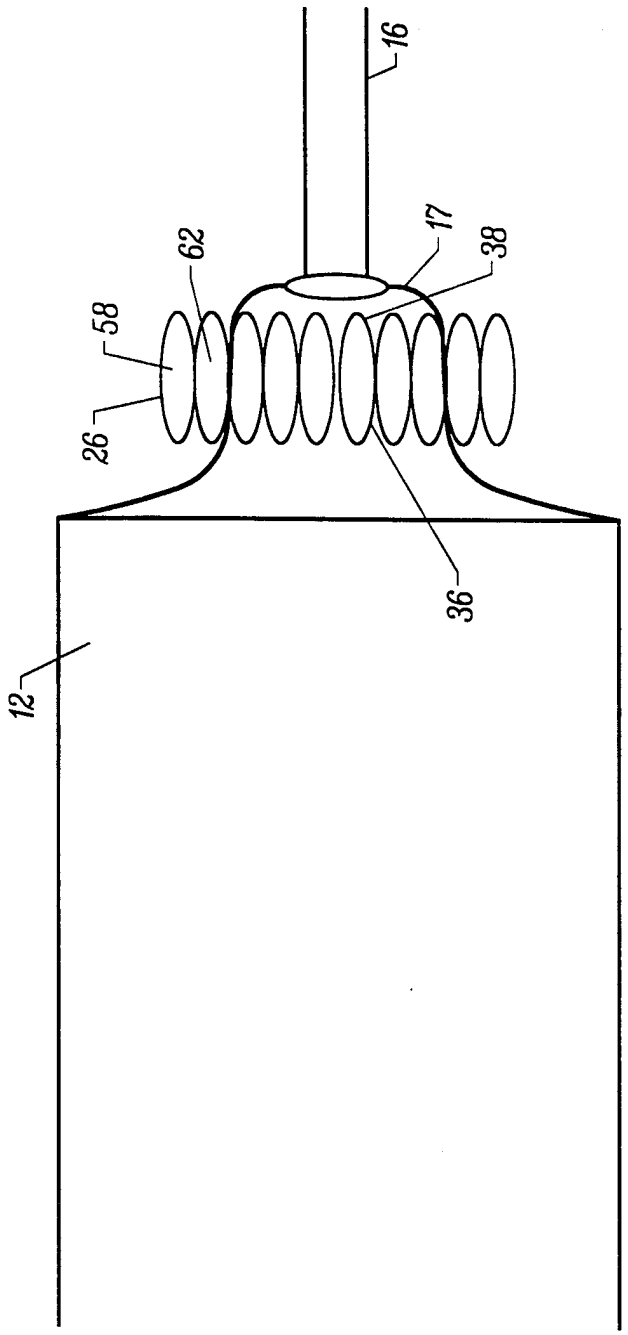


FIG. 5A

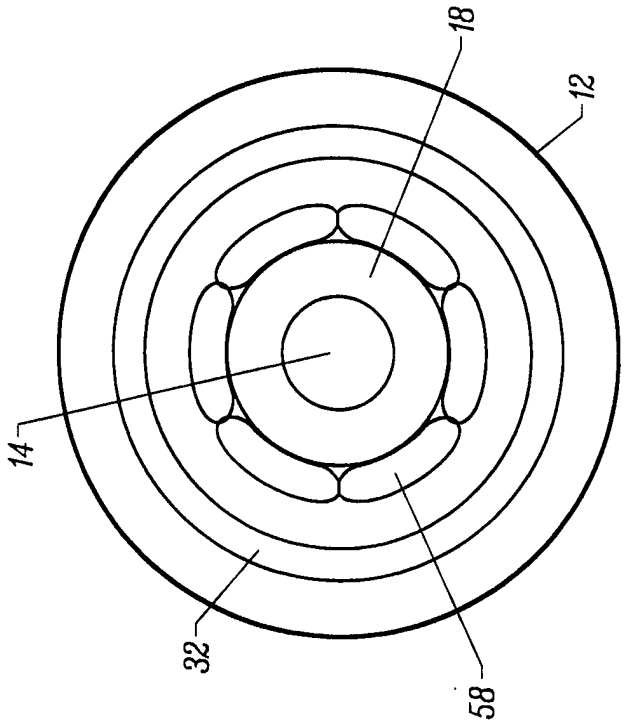


FIG. 5B

FIG. 6A

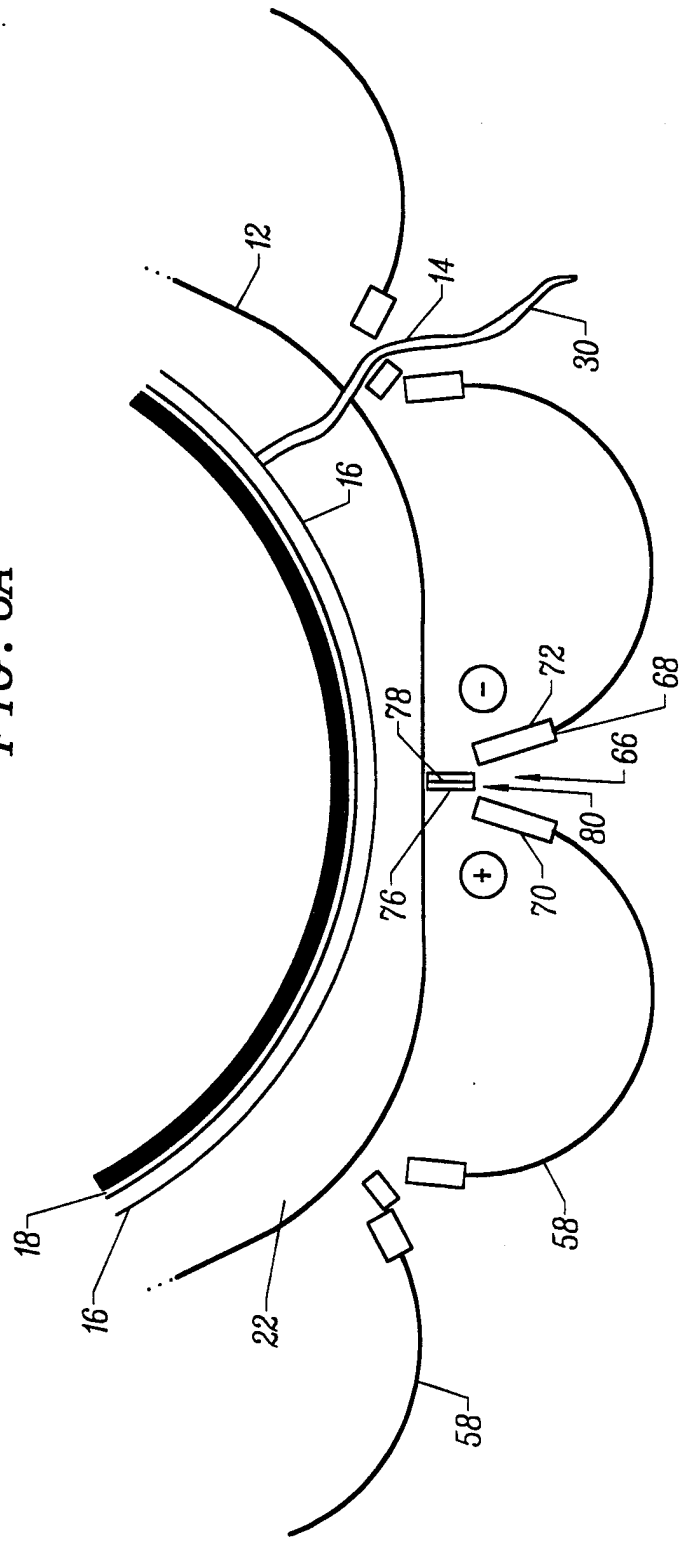
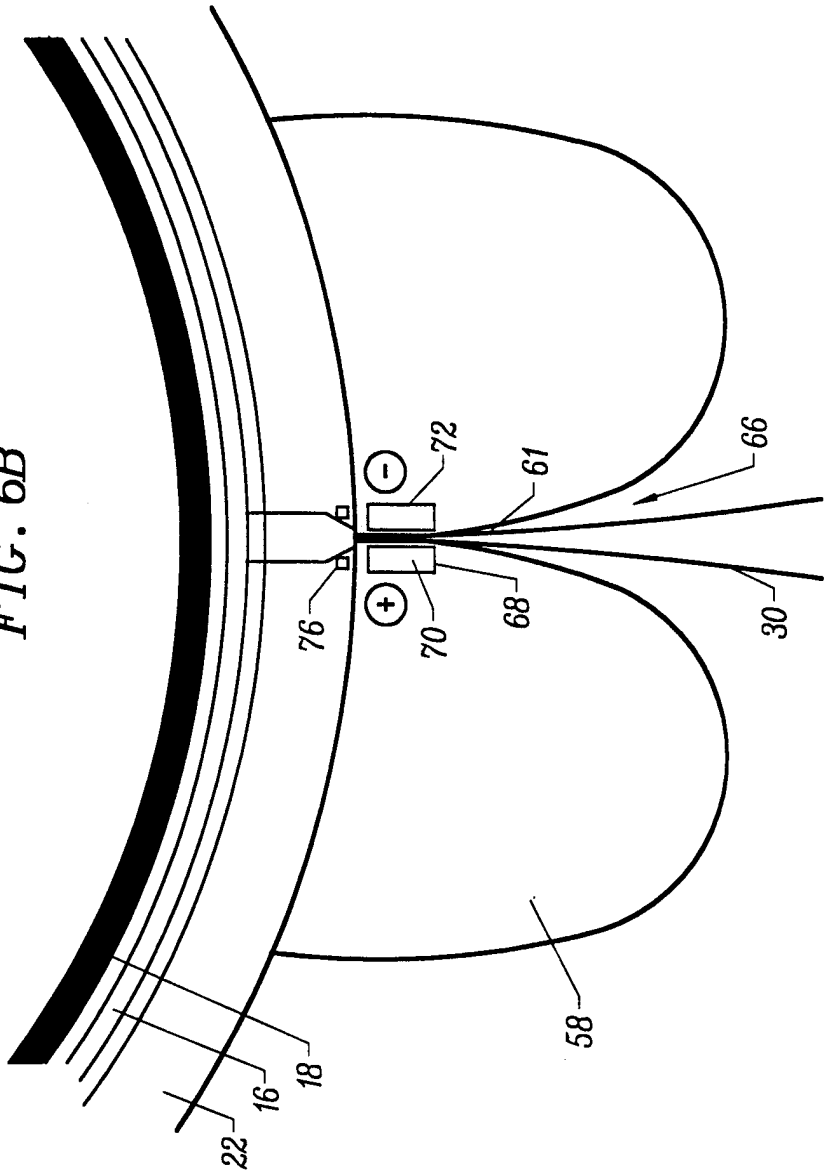


FIG. 6B



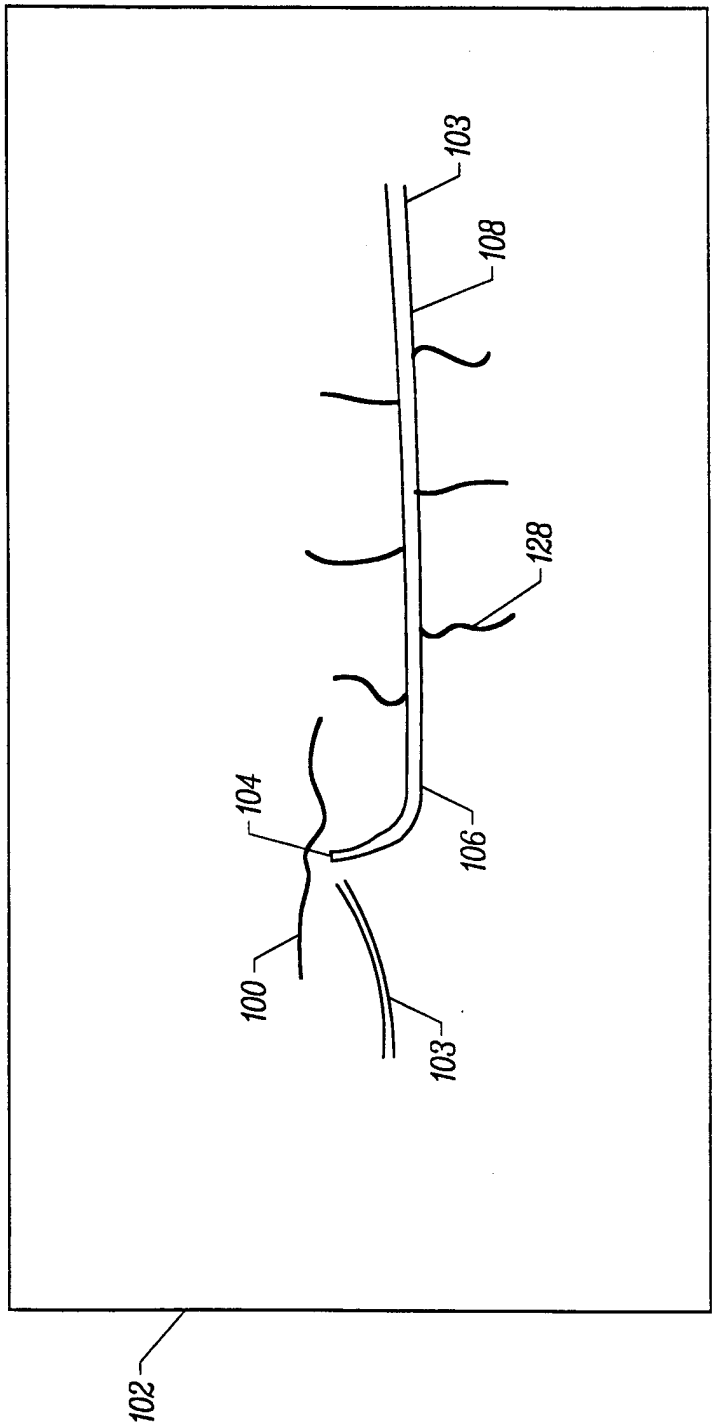


FIG. 7

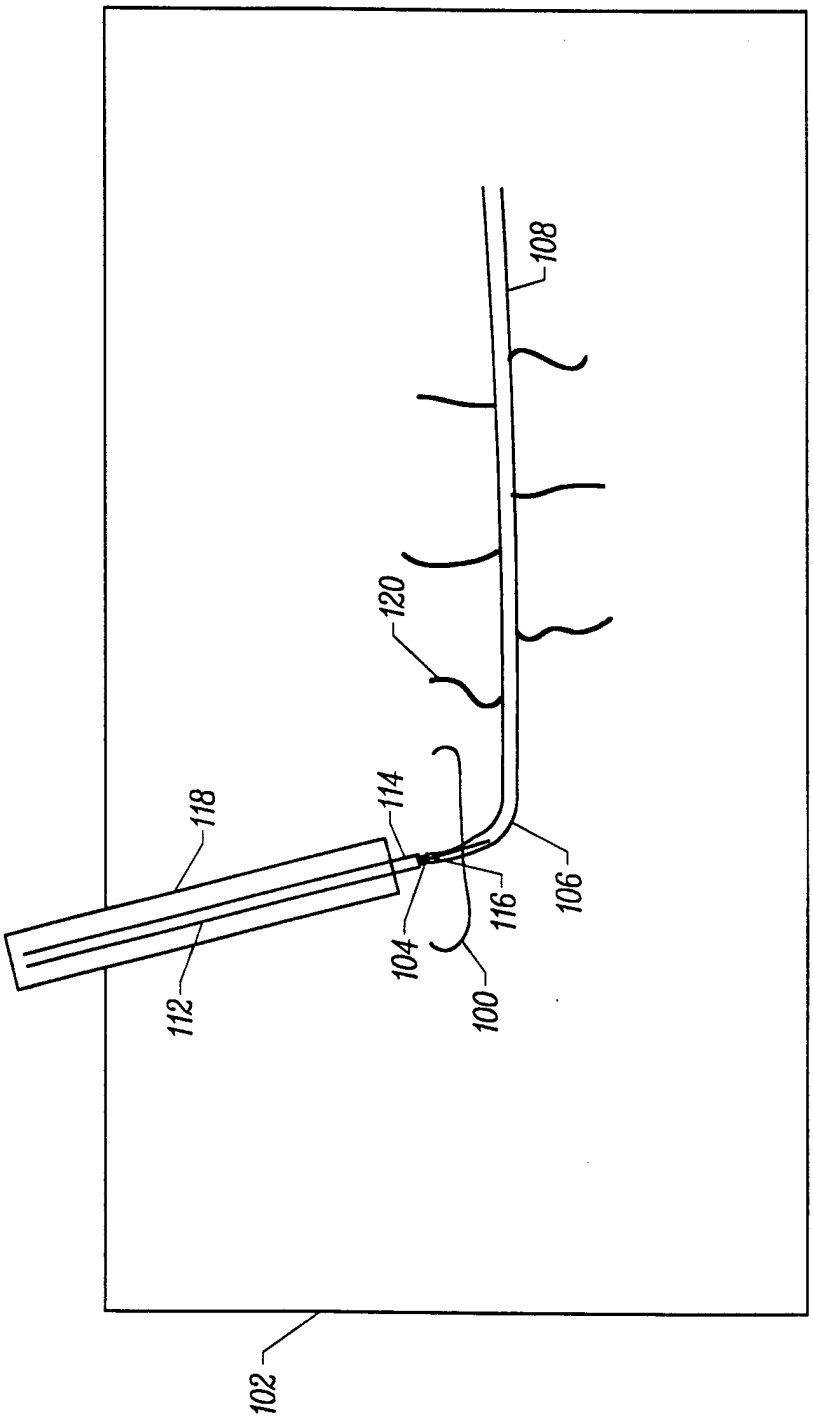


FIG. 8

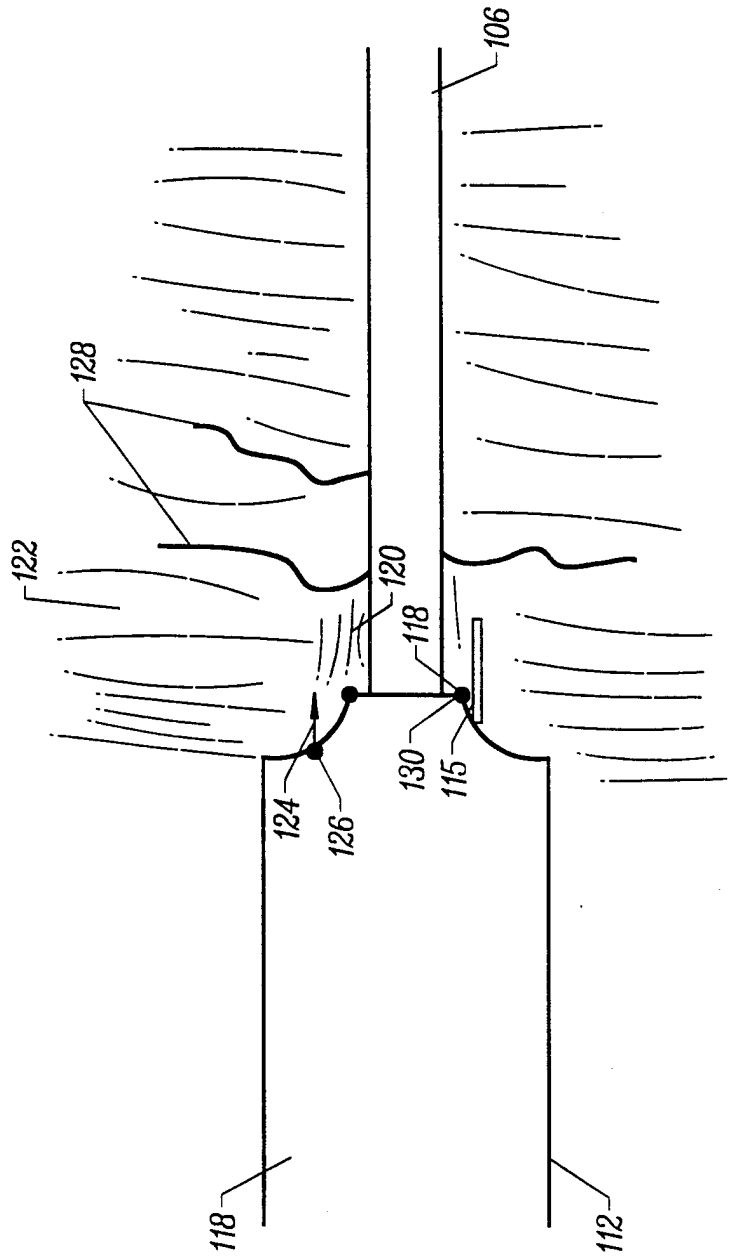
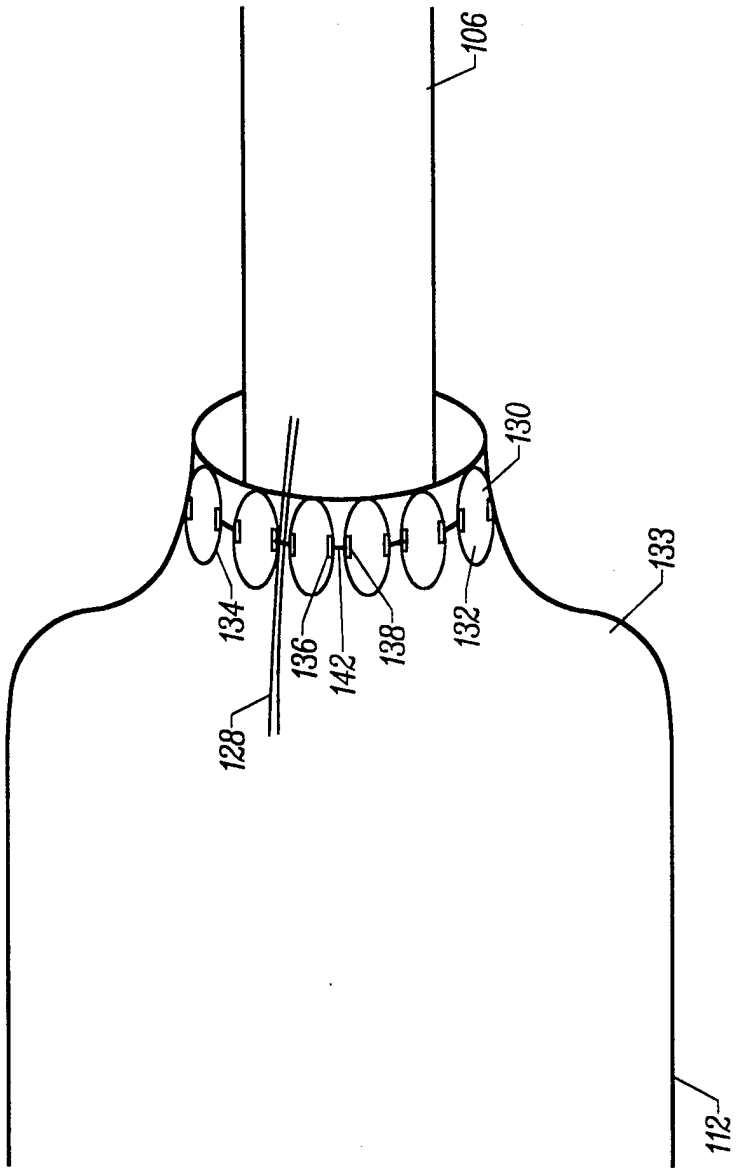


FIG. 9

FIG. 10



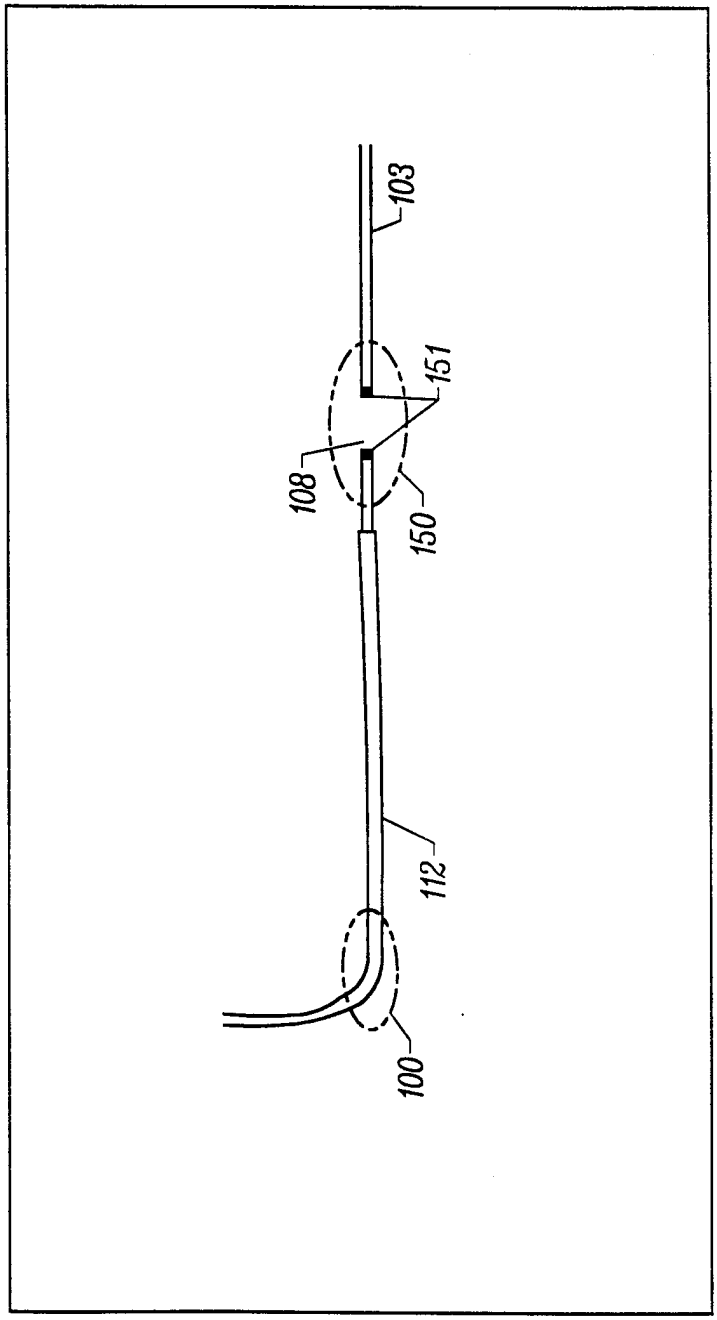
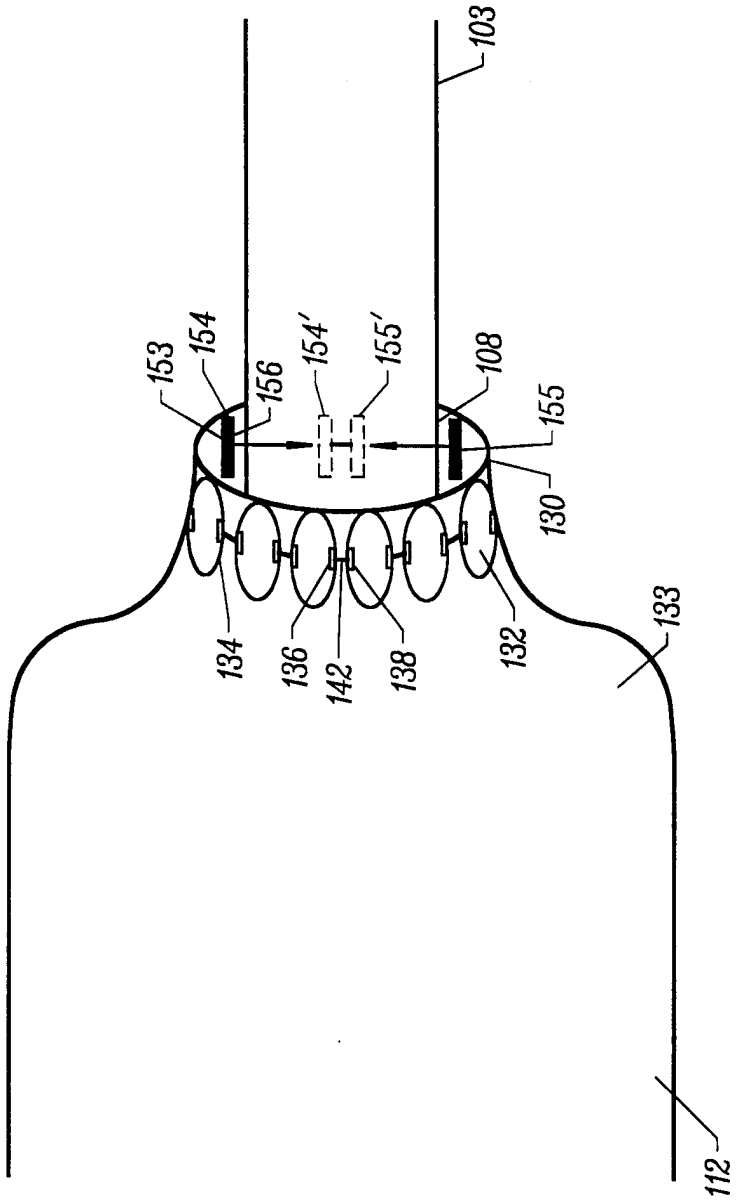


FIG. 11

FIG. 12



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 98/03360

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 35-50
because they relate to subject matter not required to be searched by this Authority, namely:

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

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

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Internat. ...l Application No
PCT/US 98/03360

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61B17/00

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 6 A61B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 194 736 A (MINDICH BRUCE) 16 March 1988 see page 1, line 126 - page 2, line 20 ---	1-3,16
A	GB 2 082 459 A (ATRIUM MEDICAL CORP) 10 March 1982 see page 2, line 113 - page 3, line 10 ---	1,16
A	US 5 373 840 A (KNIGHTON DAVID R) 20 December 1994 see column 5, line 42 - column 6, line 66 see column 9, line 25 - line 32 -----	1,5,16

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

☒ Patent family members are listed in annex.

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

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Date of the actual completion of the international search	Date of mailing of the international search report
17 June 1998	25.05.98

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Gérard, B

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat al Application No
PCT/US 98/03360

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		FR 2614777 A	10-11-1988
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