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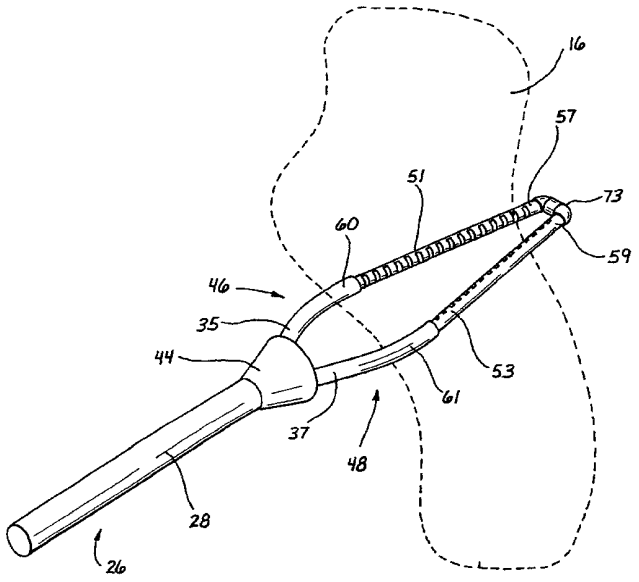

(57) Abstract: An electrosurgical instrument includes a handle (28) with a hollow elongate configuration and an electrosurgical assembly (48) having ends disposed within the hollow handle and forming a continuous loop (33) moveable by operation of the handle between an enlarged state and a contracted state. An electrosurgical element included in the assembly has an outer surface (64), and axis (55), and a lumen extending along the axis. Transverse portions of the element define a plurality of slots (66) extending transverse to the axis and providing fluid communication between the lumen and the outer surface of the element. The element includes an insulated backbone (64) and a plurality of ribs (62) disposed to extend in space relation to each other transverse to the backbone.

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ELECTROSURGICAL SNARE

Cross Reference to Related Applications

This is a Non-Provisional Application claiming the priority of Provisional Application Serial No. 60/159,321 filed on October 14, 1999 and entitled Arching-Gap Electrosurgical Snare for Partial Nephrectomy, which is incorporated herein by reference

Background of the Invention

This invention relates generally to surgical instruments and more specifically electrosurgical instruments, as well as methods for performing a partial nephrectomy.

Discussion of the Prior Art

A process for recovering the kidney of a patient is commonly referred to as a nephrectomy procedure. When only a portion of the kidney is to be removed, it is referred to as a partial nephrectomy. In this later instance, the procedure is primarily characterized by the nature of the organ itself which is highly vascularized. Cutting into the kidney therefore results in a large volume of blood loss. As a consequence, the partial nephrectomy procedure has been an open procedure which has provided immediate and general access to the organ.

This partial nephrectomy procedure is commonly performed using a scalpel to separate a diseased portion of the kidney from the remainder of the kidney. In order to control bleeding a separate instrument is used to cauterize the incision. The steps of cutting and cauterizing are performed repeatedly until the diseased portion is fully removed from the remainder of the kidney.

Snares are surgical instruments typically including a handle and a snare wire which forms a closed loop with the handle. As the wire is drawn into the handle, the size of the loop decreases and eventually severs any tissue within the loop. This procedure has most commonly been used for small appendages such as polyps that are typically nonvascular. Severing a polyp using a snare there does not create severe bleeding nor any reason to cauterize.

Summary of the Invention

These disadvantages of the apparatus and procedures associated with the related art are overcome with the present invention which comprise an electrosurgical snare. The snare includes an electrosurgical element having a backbone and a plurality of ribs which are formed to control the electrosurgical current density. This element forms at least a portion of the snare loop and provides a capability for electrosurgical cutting as well as cauterizing.

In a method associated with the present invention, the electrosurgical snare is placed over a kidney in proximity T a diseased portion of the kidney. The electrosurgical element is moved into the kidney cutting the diseased portion from the remainder of the organ. Importantly, cauterization occurs simultaneously with the cutting step so that the bleeding is immediately controlled in the procedure. The snare is provided with a low profile state to facilitate insertion through a trocar in a laparoscopic procedure.

In one aspect of the invention, an electrosurgical instrument includes a handle having an elongated configuration and extending between a proximal end and a distal end. An electrosurgical assembly extends from the distal end of the handle and forms a continuous loop.

The assembly is moveable by operation of the handle between an enlarged state, wherein the continuous loop has a first size, and a contracted state, wherein the continuous loop has a second size smaller than the first size. An electrosurgical element is included in the assembly, the element having an outer surface, an axis, and a lumen extending along the axis. Transverse portions of the electrosurgical element define a plurality of slots extending transverse to the axis and providing fluid communication between the lumen of the electrosurgical element and the outer surface of the electrosurgical element.

In another aspect, the invention includes an electrosurgical element having an axis and a backbone disposed to extend longitudinally along the axis. A plurality of rigs are included in the electrosurgical element and dispose to extend in a spaced relationship to each other and in a transverse relationship to the backbone. Insulation is disposed to extend along the backbone

In a method associated with the present invention, the electrosurgical instrument is manufactured by providing a handle having a longitudinal channel. An electrosurgical assembly is provided having a first end and a second end defining a closed loop and moveable within the longitudinal channel of the handle to vary the size of the loop. Slots are created in the electrosurgical element to form a plurality of ribs facing inwardly of the loop and a backbone facing outwardly of the loop. Insulation is placed over at least a portion of the backbone

Description of the Drawings.

Fig. 1 is a side elevational view showing a laparoscopic partial nephrectomy procedure using an electrosurgical snare of the present invention.

Fig. 2 is a perspective view of one embodiment of the electrosurgical snare of the present invention;

Fig. 3 is a top elevational view of the electrosurgical snare illustrated in Fig. 2;

Fig. 4 is a side elevational view of an electrosurgical element associated with the electrosurgical snare.

Fig. 5 is a cross-sectional view of the electrosurgical element taken along lines 5-5 of Fig. 5;

Fig. 6 is a cross-sectional view taken along lines 6-6 of Fig. 4;

Fig. 7 is a cross-sectional view taken along lines 7–7 of Fig. 3;

Fig. 8 is a cross-sectional view taken along lines 8-8 of Fig. 3;

Fig. 9 is an axial cross-sectional view taken along lines 8-8 of Fig. 3;

Fig. 10 is an axial cross-sectional view taken along lines 10-10 of Fig. 9; and

Fig. 11 is a top plan view of a further embodiment including a rigid extension arm and a single electrosurgical element.

Description of Preferred Embodiments and Best Mode of the Invention

In the side-elevational view of figure 1, a patient 4 is illustrated in a mono-polar electrosurgical procedure involving a ground plate 6 and an electrosurgical generator 8.

In the side-elevational view of Figure 1, a patient 4 is illustrated with an abdominal wall 12 which defines an abdominal cavity 14 enclosing a kidney 16. In a partial nephrectomy procedure illustrated, a diseased portion 18 of the kidney 16 is to be severed along a dotted line 21.

In electrosurgical snare 26 of the present invention includes a handle 28 and an electrosurgical assembly 31 in the form of a loop on snare 33. The electrosurgical instrument 26 is sized and configured to fit through a trocar 35 which extends through the abdominal wall 12 in a laparoscopic procedure

In the embodiment illustrated, the snare 33 is formed as a continuous loop with ends 35 and 37 which are directed through a distal end 40 of the handle 28 and operable from a proximal end 42 of the handle 28. In this embodiment the handle 28 functions as a sleeve and is moveable along the electrosurgical assembly 31 between a low profile insertion state, wherein the snare 33 has a relatively small size, and a high profile operative state wherein the snare 33 has a relatively large size. In the low profile state, the electrosurgical assembly can be easily inserted through the working channel of the trocar 35. When operatively disposed in the larger expanded state the snare 33 can be positioned around the kidney 16 as illustrated in Figure 1. The electrosurgical assembly 31 can then be energized and moved toward its low profile state. This closes the snare 33 around the kidney 165 at the dotted line 21. As the electrosurgical assembly 31 cuts the kidney 16, it also cauterizes the cut area to inhibit bleeding which is commonly associated with these procedures. Once the diseased portion 18 is severed from the remainder 23 of the kidney 16, it can be removed through the trocar 35, or perhaps through a hand port (not shown).

The perspective view of figure 2 shows the electrosurgical instrument 26 in greater detail. In this view it can be seen that the handle 28 preferably is formed as a hollow tube with a funnel 44 at its distal end. The electrosurgical assembly 31 is formed with a pair of

opposing legs, 46 and 48, with their respective ends35 and 37 extending through the funnel 44 into the handle 28.

In this embodiment, each of the legs 46 and 48 includes an electrosurgical element 51 and 53, respectively. The element can be formed from any electrically conductive material, but in the preferred embodiment, it is formed of hollow surgical stainless steel such as that used in hypodermic needles.

As best illustrated in the top plan view of Figure 3, the electrosurgical elements 51 and 53 can be similarly formed and disposed on opposite sides of the snare 33. With this relationship, the electrosurgical elements 51 and 53 have an inner side, which faces the opposite element, and an outer side, which faces away from the opposite element. For example, the electrosurgical element 51 can be provided with a generally straight configuration so that it extends along an axis 55 outwardly from the handle 28 to a distal end 57. Similarly, the electrosurgical element 53 extends to a distal end 59. In proximity to the funnel 44 the electrosurgical element 51 is covered by insulation tubing 60 to form a non-cutting portion of the element 561. The remaining portions of the element 51, which extend generally to the distal end 57, include a plurality of ribs 62 backbone, which extends generally along the axis 55, and a plurality of ribs 62 which extend inwardly of the backbone 64. The ribs 62 are separated by slots 66 which extend transversely, preferably perpendicular, to the axis 55. with this configuration, the ribs 62 face inwardly while the backbone 64 faces outwardly of the snare 33.

In operation, the electrosurgical elements 51 and 53 are energized by the generator 8 (Figure 1), which causes cutting to occur where the rib 62 are in proximity to the tissue of the patent 4. In a particular embodiment, insulation covers 68 and 71 can be provided

along the backbones of the respective electrosurgical elements 51 and 53 in order to inhibit cutting outwardly of the snare 33. At the distal ends 57 and 59 of the respective electrosurgical elements 51 and 53, an insulator 73 can be used to hold these ends in a generally closely-spaced, fixed, but slight pivotal, relationship.

In operation, as the handle 28 and funnel 44 are advanced distally over the proximal end 35 and 37 of the electrosurgical elements 51 and 53. This causes the electrosurgical elements 51 and 53 to pivot at the insulator 73 in order to move the elements 51 and 63 against the tissue or kidney 16 captured by the snare 33. As the electrosurgical elements 51 and 3 move into close proximity with the tissue, the electrosurgical power emanating from the generator 8 cuts the tissue and simultaneously cauterized the cut area to inhibit bleeding

In order to facilitate the cutting operation, the size and configuration of the slots 66, ribs 62 and backbone 64 can be carefully controlled. In a preferred embodiment, the electrosurgical element 51 is formed of surgical stainless steel and begins with a generally cylindrically configuration. Thus the element 51 initially has an inner diameter "d" and an outer diameter "D" as illustrated in Figure 5. In order to form the slots 66, the cylindrical element 51 can be cut radially and generally perpendicular to the axis 55. A single one of the ribs 62 is formed between adjacent pairs of the slots 66. The depth of the cut forming the slots 66 will determine the size of the backbone with reference to Fig. 6, for example, it will be noted that a cut having a depth "P" which is greater than D/2, will provide the backbone 64 with a height "h" less than "D. This is off advantage in a preferred embodiment in order to ensure hat electrosurgical cutting does not occur at the backbone 64, but rather is restricted to the ribs 62.

This dimensional relationship is best illustrated in the elevational view of Figure 4 which shows the height "h" to be less than the diameter "D".

In a preferred embodiment, the diameter D of the electrosurgical element 51 is .042 [in], the slots 62 are cut with a 1 [mm] width and spaced to provide the ribs 62 with a 1 [mm] width..

The cross-sectional view of Figure 7 shows the electrosurgical element 51 enclosed by the insulation cover 60 at the proximal end 35. The insulation cover 60 enables the two electrosurgical elements 51 and 53 to be moved into proximity with each other without establishing continuity. Thus the handle 28 and funnel 44 can be moved over the insulation tubes 60 and 61 to move the electrosurgical elements 51 and 53 toward each other and into proximity with the tissue to be cut.

The cross-sectional view of figure 8 shows two electrosurgical elements 51 and 53 covered by the respective insulation tubes 60 and 61 within the handle 28. It is the relative movement of the tube 28 and funnel 44 over the proximal insulated ends 35 and 37 of the elements 51 and 53, respectively, which closes the snare 33 against the tissue to be cut.

A cross-sectional view taken along lines 9-9 of Figure 8 is illustrated in Figure 9 and shows one of the electrosurgical elements 51 within the funnel 44. A cross-sectional view taken along lines 10-10 of figure 9 is illustrated in Figure 10 and shows the two electrosurgical elements 51 and 53 within the funnel 44

A further embodiment of the invention is illustrated in Fig. 11 wherein the handle 28 includes a distal extension 75 which extends to a distal end 77. The electrosurgical element 51 is the only cutting element in this embodiment. Its distal end is attached to the distal end 77

of the extension 75 while its proximal end is moveably supported within a lumen 81 of the handle 28. In this embodiment, the snare 33 is defined by the extension75 and the electrosurgical element 51.

The extension 75 is of particular advantage to T his embodiment as it provides a generally rigid carrier for the distal end of the electrosurgical element 51. This facilitates not only insertion of the instrument 26 through the trocar 35 (Figure 1), but also facilitates disposition of the snare 33 around the kidney 16. In this step of the process, the electrosurgical element 51 can be advanced through the lumen 81 in the handle 28 to form a loop and thereby enlarge the size of the snare 33. Using the generally rigid extension 75, the electrosurgical element 51 can then be more easily moved over the kidney 16 to its operative position.

Once the instrument 26 is operatively positioned over the kidney 16, the electrosurgical element 51 can be energized and drawn proximally through the lumen 81 relative to the handle 28. This will begin moving the element 51 into a more parallel relationship with the extension 70, closing the snare 33 around the kidney 16 and creating the desired cut through the kidney 16. As previously noted, the electrosurgical frequencies, provided by the generator 8 (Figure 1) will not only cut the tissue, but simultaneously cauterize the tissue to inhibit bleeding. In this embodiment, cutting is restricted to only one side of the snare 33 and therefore is easier to control. The electrosurgical element 51 can be formed as in the previous embodiment where the slots 66, ribs 62, and backbone 64 can be controlled to provide the desired current density.

CLAIMS

1. An electrosurgical instrument comprising:

a handle an elongate configuration and extending between a proximal end and a distal end:

an electrosurgical assembly extending from the distal end of the handle and forming a continuous loop, the electrosurgical assembly being moveable by operation of the handle between an enlarged state wherein the continuous loop has a first size in the contracted state wherein the continuous loop has a second size smaller than the first size.

an electrosurgical element included in the assembly, the element having an outer surface, an axis, and a lumen extending along the axis;

transverse portions of the electrosurgical element defining a plurality of slots extending transverse to the axis and providing fluid communication between the lumen and the outer surface.

2. The electrosurgical instrument recited in Claim 1 wherein;

the electrosurgical element has the configuration of a cylinder with a radius;

the slots extend into the electrosurgical element a particular distance not less than the radius of cylinder.

3. The electrosurgical element recited in claim 1, further comprising:

longitudinal portions of the electrosurgical element defining a backbone of the electrosurgical element extending along the axis of the electrosurgical element; and

insulation disposed on the outer surface of the electrosurgical element along the backbone.

4. The electrosurgical element recited in Claim 1 wherein the slots are disposed generally radially of the axis.

5. The electrosurgical element recited in Claim 1 further comprising:

a rigid arm included in the electrosurgical assembly and extending from the distal end of the handle to engage the electrosurgical element at a location space from the distal end of the handle.

6. The electrosurgical element recited in Claim 1 wherein the handle includes a hollow sleeve and the electrosurgical assembly is sized and configured to be moved into the sleeve toward the contracted state and to be moved out of the sleeve toward the enlarged state.

7. The electrosurgical element recited in claim 1 wherein the electrosurgical element is accessible at the proximal end of the handle to permit the injection of a fluid into the lumen, and through the lumen and the slots to the outer surface of the electrosurgical element.

8. The electrosurgical element recited in Claim 5, further comprising:

longitudinal portions of the electrosurgical element defining a backbone facing away from the arm of the electrosurgical assembly.

9. The electrosurgical element re cited in Claim 1 wherein at least one of the slots has a first side defined in a first plane and a second side defined in a second plane generally parallel to the first plane.

10. The electrosurgical element recited in Claim A1 wherein the electrosurgical element is a first electrosurgical element and the instrument further comprises a further electrosurgical element opposing the fist electrosurgical element.

11. The electrosurgical element recited in Claim 10 herein the second electrosurgical element is coupled to the first electrosurgical element by an insulator.

12. An electrosurgical instrument, comprising:

a handle having an elongate configuration and extending between a proximal end and a distal end;

an electrosurgical assembly extending from the distal end of the handle and being moveable by operation of the handle between an enlarged state and a contracted state;

an electrosurgical element included in the electrosurgical assembly and having an axis;

a backbone disposed to extend longitudinal along the axis;

a plurality of ribs included in the electrosurgical element and disposed to extend in a spaced relationship to each other transverse to the backbone; and

insulation disposed to extend along the backbone.

13. The electrosurgical instrument recited in Clam 12 wherein the electrosurgical element in cross-section has the general shape of a circle.

14. The electrosurgical instrument recited in Claim 13 wherein the electrosurgical instrument is hollow.

15. The electrosurgical element recited in Claim 12 wherein at least two of the ribs are generally parallel to each other and generally perpendicular to the backbone.

16. A method of manufacturing an electrosurgical instrument, comprising the steps of:

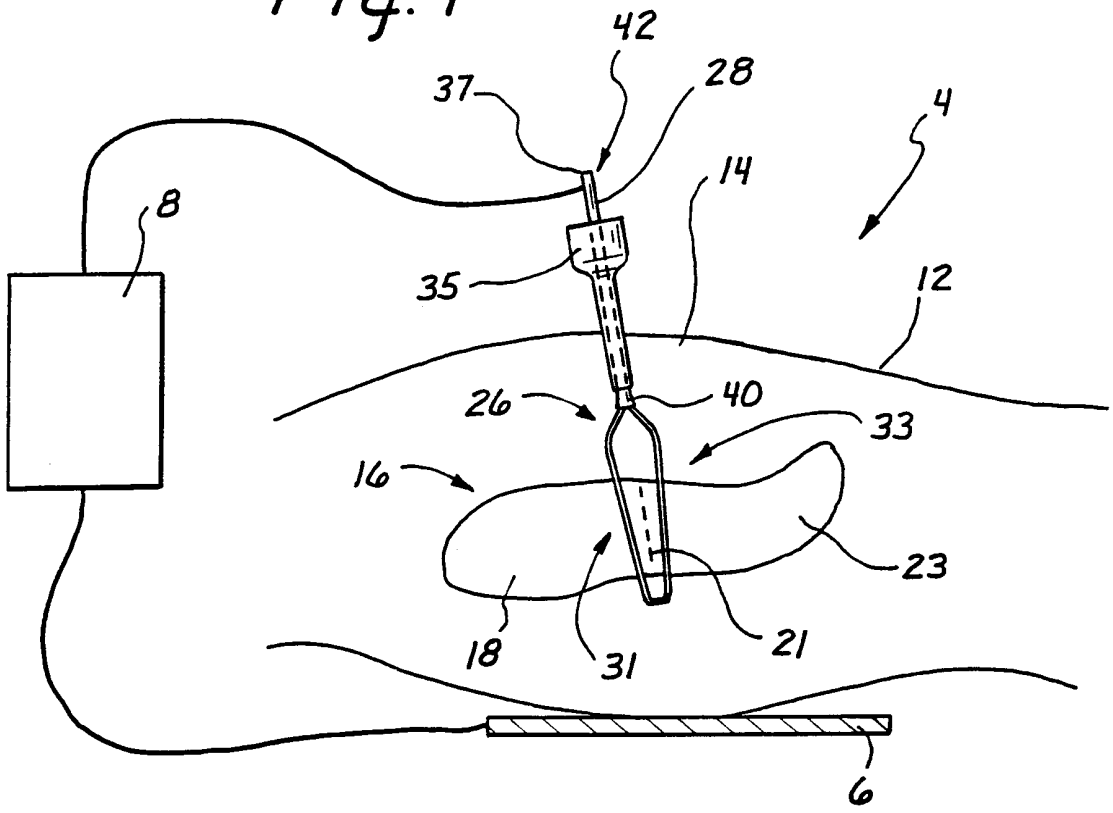
providing a handle having a longitudinal channel;

providing an electrosurgical assembly having a first end and a second end defining a closed loop. The first end and the second end being moveable within the longitudinal channel of the handle to vary the size of the loop;

creating slots in the electrosurgical element to define a plurality of ribs facing inwardly up the loop, and a backbone facing outwardly of the loop; and

placing insulation over at least a portion of the backbone.

Fig. 1



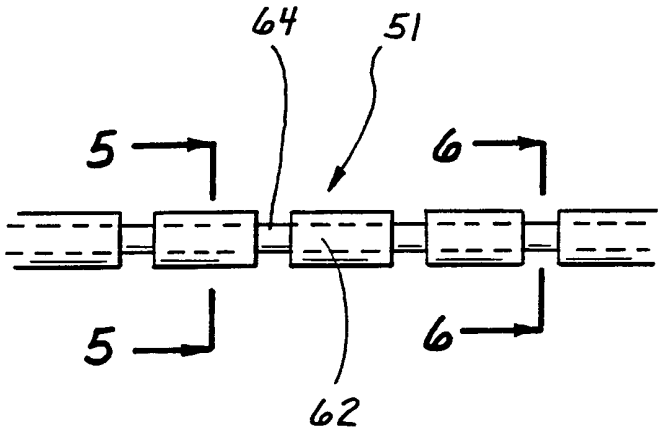


Fig. 4

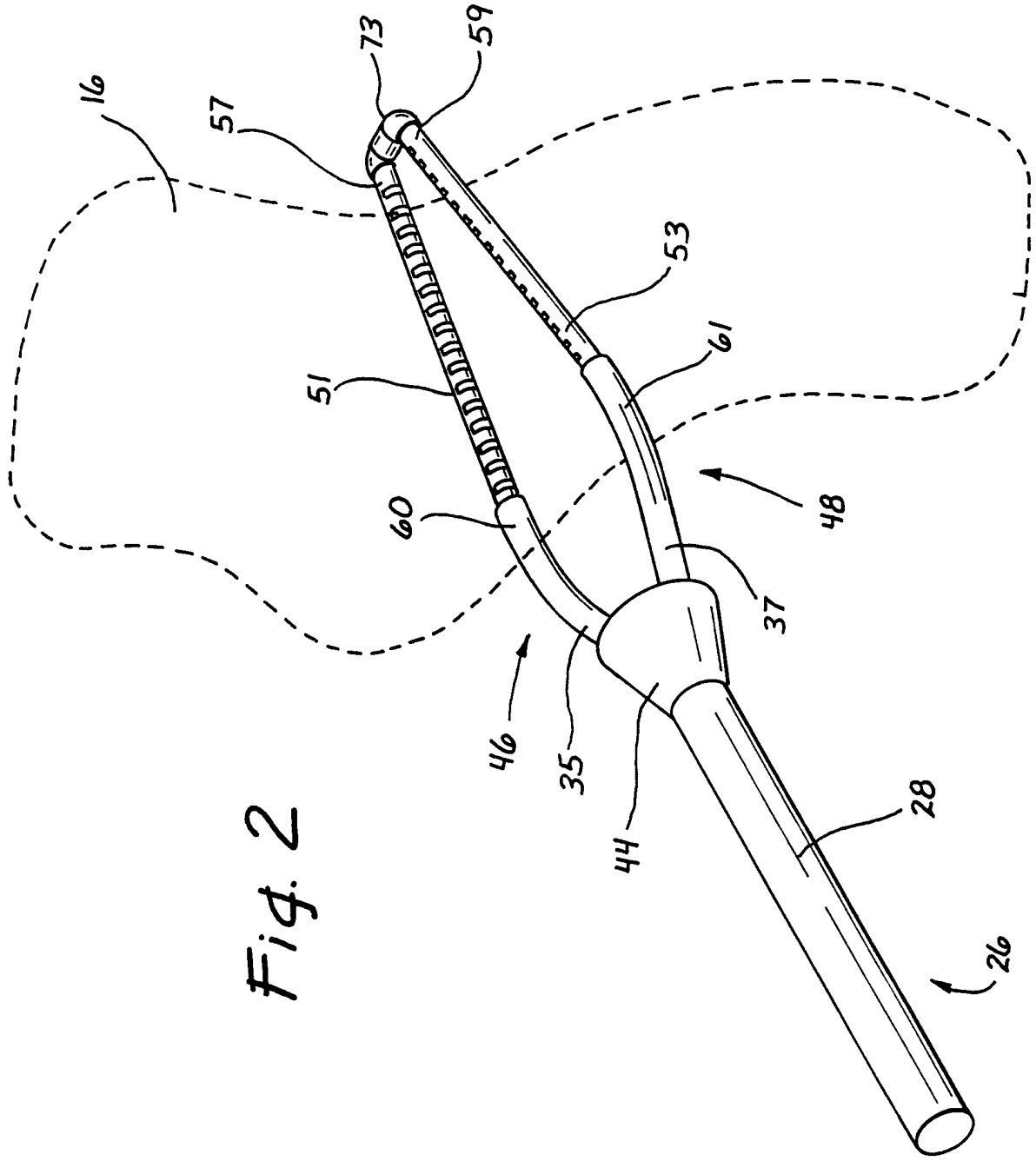


Fig. 2

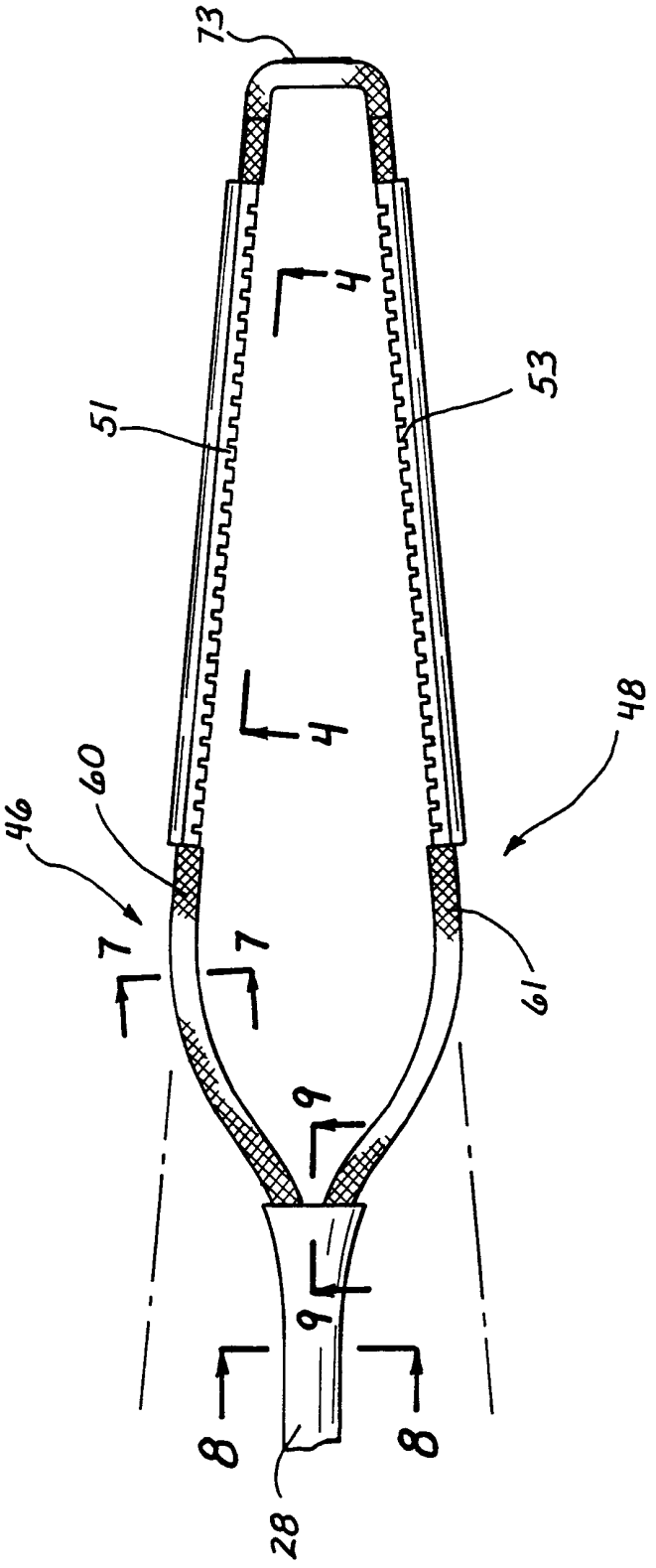


Fig. 3

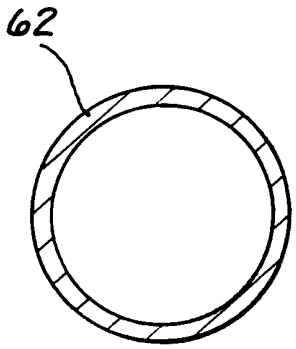


Fig. 5

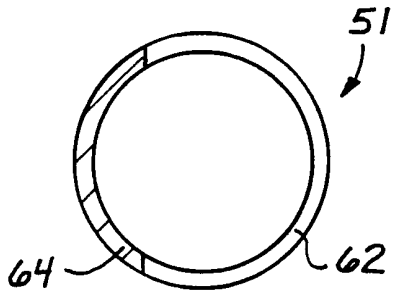


Fig. 6

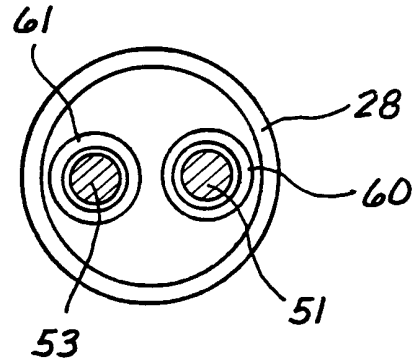


Fig. 8

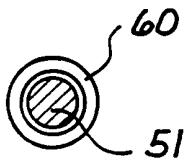
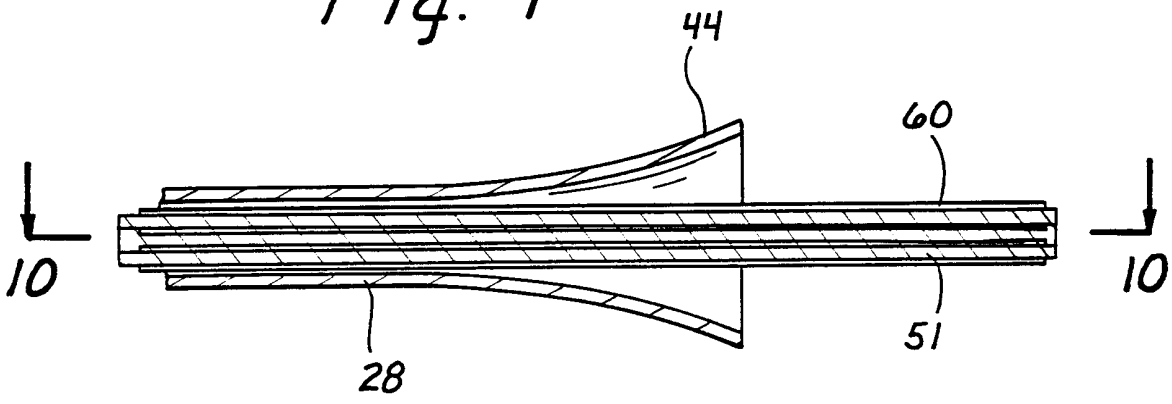


Fig. 7

Fig. 9



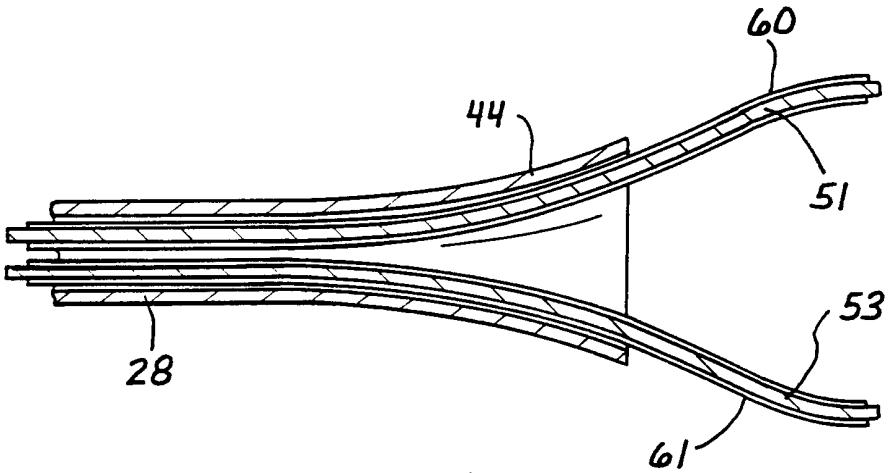


Fig. 10

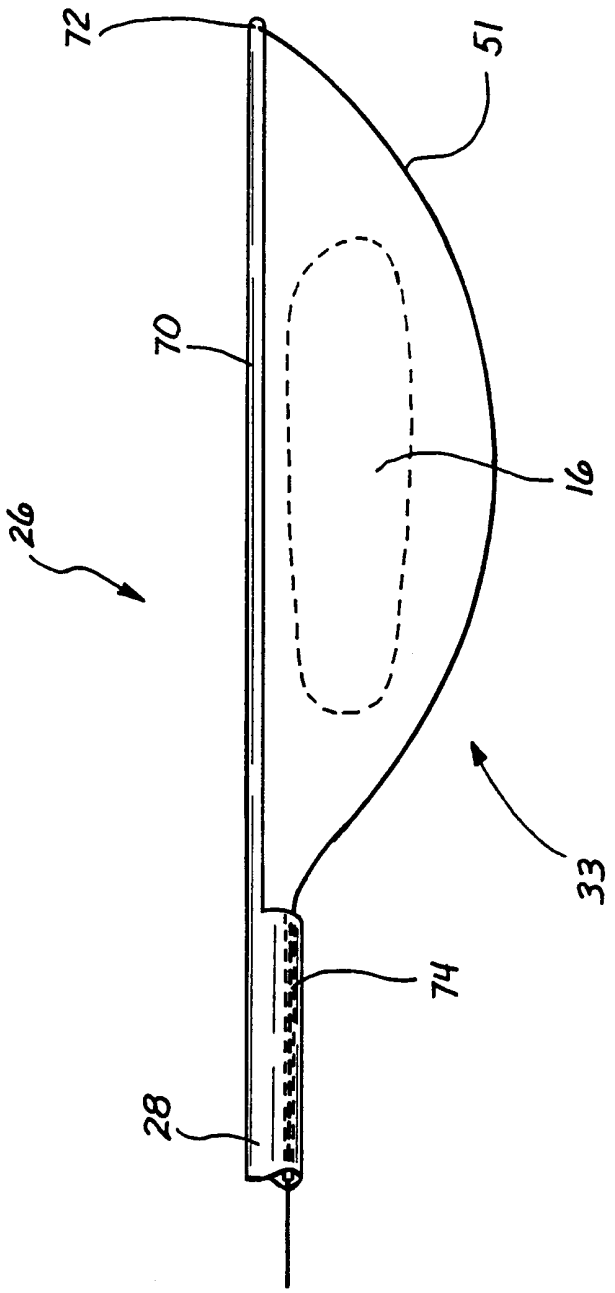


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/28675

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :A61B 18/18
US CL :606/47
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)

U.S. : 606/47

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,582,610 A (GROSSI ET AL.) 10 DECEMBER 1996, SEE FIGS. 3-5, 7 and 11	1-5, 8-16
A	US 5,078,716 A (DOLL) 07 JANUARY 1992, SEE ENTIRE DOCUMENT.	1-16
A	US 5,318,564 A (EGGERS) 07 JUNE 1994 ., SEE ENTIRE DOCUMENT.	1-16
A	US 5,895,417 A (POMERANZ ET AL.) 20 APRIL 1999, SEE ENTIRE DOCUMENT.	1, 6, 7, 14

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

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