PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : A61B 17/39	A1	**(11) International Publication Number:** WO 91/17717 **(43) International Publication Date:** 28 November 1991 (28.11.91)

(21) International Application Number: PCT/US91/02860

(22) International Filing Date: 25 April 1991 (25.04.91)

(30) Priority data:
522,254 11 May 1990 (11.05.90) US

(71) Applicant: APPLIED UROLOGY, INC. [US/US]; 26061 Merit Circle, #101, Laguna Hills, CA 92653 (US).

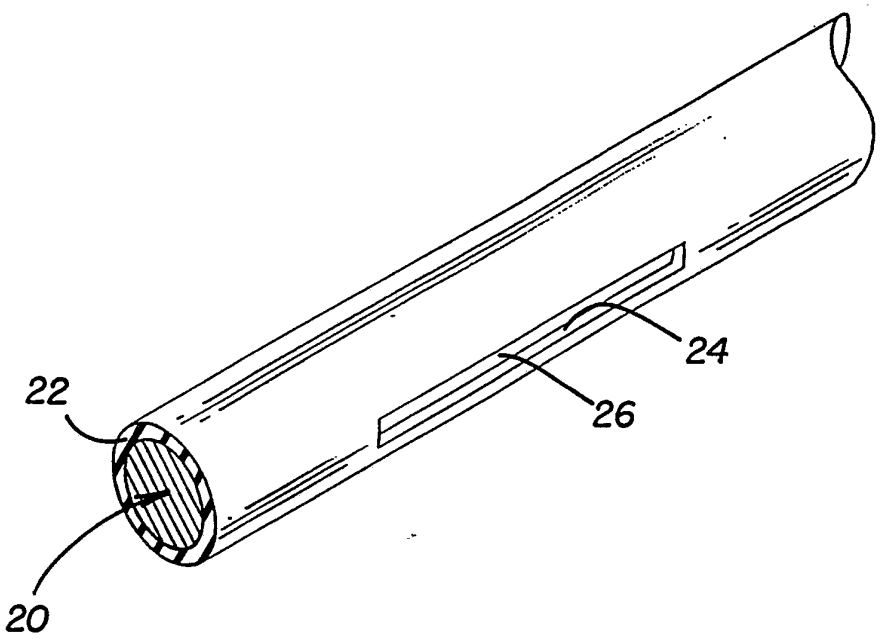
(72) Inventor: BUELNA, Terrence, J. ; 10 Mohave Way, Rancho Santa Margarita, CA 92688 (US).

(74) Agent: MYERS, Richard, L.; Applied Urology, Inc., 26061 Merit Circle, #101, Laguna Hills, CA 92653 (US).

(81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).

Published
With international search report.

(54) Title: ELECTROSURGICAL ELECTRODE



(57) Abstract

In accordance with an embodiment of the present invention an improvement is set forth in an electrosurgical electrode having a conductor (20) from which a radio frequency electrical signal is generated, which signal sparks to and performs a surgical procedure upon the tissue adjacent the conductor (20) and is received by a receiver. The improvement comprises a dielectric sheath (22) surrounding the conductor (20) in the region where the surgical procedure is being performed, the sheath (22) having a slit (24) extending longitudinally along it in the region exposing only a portion of the lateral surface (26) of the conductor (20).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**ES**	Spain	**MG**	Madagascar
AU	Australia	**FI**	Finland	**ML**	Mali
BB	Barbados	**FR**	France	**MN**	Mongolia
BE	Belgium	**GA**	Gabon	**MR**	Mauritania
BF	Burkina Faso	**GB**	United Kingdom	**MW**	Malawi
BG	Bulgaria	**GN**	Guinea	**NL**	Netherlands
BJ	Benin	**GR**	Greece	**NO**	Norway
BR	Brazil	**HU**	Hungary	**PL**	Poland
CA	Canada	**IT**	Italy	**RO**	Romania
CF	Central African Republic	**JP**	Japan	**SD**	Sudan
CG	Congo	**KP**	Democratic People's Republic of Korea	**SE**	Sweden
CH	Switzerland			**SN**	Senegal
CI	Côte d'Ivoire	**KR**	Republic of Korea	**SU**	Soviet Union
CM	Cameroon	**LI**	Liechtenstein	**TD**	Chad
CS	Czechoslovakia	**LK**	Sri Lanka	**TG**	Togo
DE	Germany	**LU**	Luxembourg	**US**	United States of America
DK	Denmark	**MC**	Monaco		

ELECTROSURGICAL ELECTRODE

Technical Field

The invention relates to electrosurgical cutting and coagulating and more particularly to improved electrosurgical cutting and coagulating electrodes.

Background of the Invention

In monopolar electrosurgical cutting a current is allowed to pass from an active cutting electrode through a patient's tissue and into a grounding pad or cable. The current cuts tissue at the active cutting electrode, the cutting rate being dependant on current density through the tissue in that area. At low current density heat is generated but no cut is achieved. At high current density fast cutting occurs.

In bipolar electrosurgical cutting the current passes from the active cutting electrode through the patient's tissue to a return electrode

which is located in, or is in contact with, the patient's tissue a short distance away from the cutting electrode. The cutting and return electrodes are generally carried by a single instrument.

Current density depends on the current (measured in watts) applied and can be controlled utilizing an adjustment present on a conventional generator designed for this purpose. The current density also depends on the series impedance of the overall circuit. Series impedance is equivalent to the sum total of the resistance to the current throughout the circuit. It is affected by the material and the design of the active electrode, by the patient, by the type of tissue to be cut, and by the condition of contact established between the patient and (when a monopolar electrode is utilized) the grounding pad as well as by the location of the grounding pad relative to the cutting site. During surgery, the generator setting is usually adjusted to compensate for this variability and to reflect the surgeon's preference. Generators used in this type of surgery have a wide range of power output to accommodate a variety of procedures and devices.

The objective in electrosurgical cutting is

to heat the tissues cells so rapidly that they explode into steam leaving a cavity in the cell matrix. The heat is meant to be dissipated in the steam and to not conduct through the tissue to thereby dry out adjacent cells. When the electrode is moved and fresh tissue is contacted new cells are exploded and the incision is made. Such electrosurgical cutting involves the sparking of the current to the tissue. The current utilized is in the radio frequency range and operates by the radio frequency current jumping across an air gap to the tissue. This is known as sparking.

An explanation of electrosurgical cutting theory can be found in the FORCE 1 Instruction Manual published by Valleylab of Boulder, Colorado on March 1, 1986. The entire text of the FORCE 1 Instruction Manual is incorporated herein by reference.

An advantage claimed for electrosurgical cutting is that adjacent tissue is not supposed to become overly heated and thereby desiccated and damaged. Thus, what one desires is a clean cut without damage to adjacent tissue. Unfortunately, current electrosurgical cutting electrodes are of a construction such that sufficient heating of

adjacent tissue does occur whereby it is somewhat damaged and desiccated.

Electrosurgical fulguration/coagulation operates similarly but at different power levels and using shorter bursts of higher peak voltages as discussed on page 5 of the FORCE 1 publication.

The present invention is directed to overcoming one or more of the problems as set forth above.

DISCLOSURE OF INVENTION

In accordance with an embodiment of the present invention an improvement is set forth in an electrosurgical apparatus having an electrode in the form of an electrical conductor from which a radio frequency electrical signal is generated, which signal sparks to and thereby performs a surgical procedure upon body tissue of a patient. In monopolar electrodes, the signal is received by a receiver (grounding pad) removed from the tissue upon which the surgical procedure is being performed. In bipolar electrodes, the receiver is adjacent to the active electrode. The improvement comprises a dielectric sheath surrounding the

conductor in the region where it performs the surgical procedure, the sheath having a slit extending along it in the region exposing only a portion of the lateral surface of the conductor.

Utilizing an electrosurgical cutter and/or fulgurator/coagulator having a dielectric sheath as set forth above leads to the sparking being confined to the region of the slit. The dielectric sheath serves to protect adjacent tissue from being heated and desiccated. Yet, the wire can be as thick as conventional wires utilized in electrosurgical cutters whereby it maintains strength and integrity. As a result, a very clean cut can be made without damage to surrounding tissues, or to the cutting electrode. Or, fulguration/coagulation can be controllably carried out. Furthermore, cutting can only occur in the direction defined by the slit whereby improved orientation of the cutting is accomplished. The chances of accidentally cutting in an undesired direction is reduced as slit alignment may be such that accidental cutting does not occur in that direction.

Brief Description of the Drawings

The invention will be better understood by reference to the figures of the drawings wherein like numbers denote like parts throughout and wherein:

Fig. 1 illustrates, in partial isometric view, a detail of an improvement in accordance with an embodiment of the present invention;

Fig. 2 illustrates, in partial isometric view, a detail of an improvement in accordance with another embodiment of the present invention;

Fig. 3 illustrates, in partial isometric view, one embodiment of an electrosurgical cutting assembly including an improvement in accordance with an embodiment of the present invention;

Fig. 4 illustrates, in isometric view, another embodiment of an electrosurgical cutting assembly including an improvement in accordance with an embodiment of the present invention;

Fig. 5 illustrates, in partial isometric view, an embodiment in accordance with the present invention useful for transurethral resection of the prostate;

Fig. 6 illustrates, in partial isometric view, an embodiment in accordance with the invention

useful for transurethral incision of the prostrate;

Fig. 7 illustrates, in partial isometric view, still another embodiment in accordance with the invention;

Fig. 8 illustrates, in partial isometric view, a bipolar structure in accordance with yet another embodiment of the invention;

Fig. 9 illustrates, in a view similar to Fig. 1, an embodiment with one type of controllable effective sparking aperture; and

Fig. 10 illustrates, in a view similar to Fig. 1, an embodiment with a second type of controllable effective sparking aperture.

Best Mode For Carrying Out Invention

The present invention is directed to an improvement in a surgical electrode 10,110,210, 310,410,510,610 of any convenient configuration. Embodiments of such electrodes are shown in Figs. 3-10. The particular electrosurgical electrodes shown in Figs. 1-10 are adapted for operations in the genitourinary tract, more particularly for prostate operations. However, electrodes in accordance with the invention can be used in any surgical procedure

in which electrosurgical electrodes are suitable. In such instances other geometries can be utilized, as appropriate. An electrosurgical electrode in accordance with the present invention can be utilized with conventional commercial resectoscopes, radio frequency generators and grounding pads.

When the term surgical procedure is used herein it is used in a broad sense so as to include procedures in which cutting does or does not occur. For example, the electrodes of the invention can be used to form incisions and/or for fulguration/coagulation, with or without accompanying cutting. In either instance the procedure is considered surgical.

The cutting assembly 100 of Fig. 3 includes means for dilating a body vessel or conduit, such as a ureter or urethra, to treat a blockage or other obstruction. The main components of the embodiment of the nature shown in Fig. 3 are an adapter 11 that defines the proximal end 12 of the assembly, a site for various ports to the assembly; a catheter body 13 having a triple lumen 14; a longitudinally extending inflatable balloon or bladder member 15; and an electrosurgical cutter electrode 10. One of the three passageways of the triple lumen 14 serves

for inflation/deflation, a second serves as a drainage/infusion/guide wire passageway and a third carries the electrosurgical cutter electrode 10. The apparatus shown in Fig. 3 is more completely described in copending application Serial No. 07/298,477 filed January 18, 1989 which is incorporated herein in its entirety by reference thereto. The electrosurgical cutter electrode 10 is in the nature of a wire 20 which runs along generally parallel to the longitudinally extending inflatable bladder 15. In use, the bladder 15 is inserted longitudinally into a body conduit to the position where a surgical cut is required. The bladder 15 is then inflated (an inextensible bladder is generally used) with radio frequency current being passed through the wire 20. This leads to the wire being moved outwardly and incising adjacent tissue in that direction. A sheath 22, with a slit 24 in it and facing away from the bladder 15, surrounds the wire 20. The improvement of the present invention is particularly useful with the apparatus of Fig. 3.

Figure 4 shows an alternative electrosurgical cutting assembly 200 which can be used for transurethral resection of the prostate.

The electrosurgical cutting assembly 200 of Fig. 4 includes a cutter electrode 110 which includes a wire 20 in shape of a cutting loop 21. An electrosurgical cutting assembly 200 of this nature is conventionally passed through a resectoscope which is inserted into the urethra. A radio frequency signal is then applied to the cutter electrode 110 whereby the signal is passed from the wire 20 through the tissue to a grounding pad (not illustrated) in contact with the patient's body at a position removed from the wire 20. The electrosurgical cutter electrode 110 can be moved longitudinally toward the surgeon to cut away or resection the prostate.

Figure 5 shows the distal end of the electrosurgical cutter electrode 110 of Fig. 4 in more detail. A dielectric sheath 22 surrounds the wire 20 and has a slit 24 in it facing proximally (towards the surgeon).

Fig. 6 shows a cutter electrode 210 with the wire 20 having a closed loop 121 in it rather than an open loop 21 whereby it can be used to cut a thin line into the prostate or other organ as the overall electrosurgical cutting assembly 200 is moved longitudinally. Note the presence of the sheath 22

with the slit 24 facing proximally and located adjacent a bend 23 in the closed loop 121. Such a procedure is known as transurethral incision of the prostate when used in prostate operations.

Fig. 7 illustrates a Bovie blade type of monopolar cutting electrode 310 covered by the sheath 22 which may be a surface coating and with a slit 24 exposing a portion of the surface of the underlying conductor 320 which is flat in shape. As with other embodiments of the invention, cutting (or fulguration/coagulation) is only in the direction of the slit 24.

Fig. 8 illustrates a bipolar electrosurgical cutter electrode 410 along with a return electrode 34 which can be fully exposed. The cutter electrode 410 is covered by the sheath 22 with a slit 24 exposing a portion of the lateral surface 26 of the wire 20. Cutting is in the direction of the slit 24 and the return electrode 34 serves to complete the circuit.

Fig. 9 illustrates an electrosurgical cutter electrode 510 wherein a sleeve structure 42 is located concentrically about the sheath 22 and has a window 36 through it. In Fig. 9 the window 36 exposes only a portion of the slit 24 whereby the

resulting cutting aperture 40 is narrower than the slit 24. The sleeve structure 42 can be rotated about, and generally slid longitudinally along, the sheath 22 to control the width of the effective cutting aperture 40 (and usually its length, as well). Thus, a relatively narrow aperture 40 can be used for cutting and a wider effective aperture 40 for fulguration/coagulation.

Figure 10 illustrates an electrosurgical cutter electrode 610 wherein a sleeve structure 44 has a relatively narrow window 46 covering a wide slit 24 in the sheath 22, the window 46 being of a size selected to provide an effective cutting aperture 40. The sleeve structure 44 is longitudinally moveable along the sheath 22 sufficiently to entirely expose the wide slit 24 for faster fulguration/coagulation.

Figures 1 and 2 illustrate, in enlarged view, alternative embodiments of the improvement of the present invention.

Fig. 1 illustrates an embodiment wherein a dielectric sheath 22 surrounds the wire 20 in the region where it performs the cutting and wherein the sheath 22 has a slit 24 which extends along it in the region where it performs the cutting, the slit

24 exposing only a portion of the lateral surface 26 of the wire 20. Generally, the slit 24 extends longitudinally along the sheath 22. The sheath 22 can be slidably placed about the wire 20 to allow adjustable placement of the slit 24. In the embodiment shown in Fig. 1 the slit 24 is in the sheath 22 only in the region where the wire 20 is to perform the cutting.

In the embodiment of Fig. 2, the slit 24 runs along the sheath 22 and exposes the wire 20 over a longer region than that where the tissue is to be cut. For example, the slit 24 can run substantially the entire length of the wire 20. However, in this embodiment dielectric sleeves 28 and 30 fit over the sheath 22 whereby the only region of the wire 20 which is exposed through the slit 24 is that region where the wire 20 performs the cutting. Reference to Figs. 5 and 6 will make clear the placement of the sleeves 28 and 30. The sleeves 28 and 30 can be slidably disposed about the sheath 22, whereby the length and positioning of the region of the wire 20 can be adjusted by the surgeon.

It should be noted that while the wires 20 are illustrated as being circular in cross-section the shape of the wires 20 is a matter of design

choice and the invention is not so limited.

The material used for the wire 20 can be any conductive material, for example, it can be made of any of the materials currently used for electrosurgical cutting wires. For example, the wire 20 can be made of stainless steel or tungsten.

The dielectric sheath 22 may be in the nature of a surface coating bonded or deposited onto the wire 20. Alternatively, it may be in the nature of a non-attached sheath which slidingly or bindingly fits about the wire 20. The sheath 22 can be made of any convenient material which has dielectric properties such that the wire 20 is prevented from sparking to and thereby cutting adjacent tissue other than through the slit 24. Any of a number of polymeric materials can be used for the material of the sheath 22. For example, Teflon (trademark of Du Pont), is one such material. Teflon has the advantages of high lubricity whereby it does not have a tendency to stick to tissue and of thermal stability.

The electrosurgical cutting wires of the invention are generally of substantially the same cross-sectional dimensions as are the electrosurgical cutting wires of the prior art. If

they are circular in cross-section they will generally comprise wires have a diameter of from about 0.010 inch to about 0.100 inc. Thus, the electrosurgical electrodes of the invention can have equal strength and structural integrity as do the electrodes of the prior art. Yet, due to the presence of the sheath 22 and the slit 24, cutting and coagulation are much more controllable and adjacent tissue damage is greatly reduced.

Industrial Applicability

The present invention provides electrosurgical electrodes 10,110,210,310,410,510,610 with which surgical procedures can be carried out with reduced damage to adjacent tissue.

While the invention has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the

present disclosure as come within known or customary practice in the art to which the invention pertains and as may be applied to the essential features hereinbefore set forth, and as fall within the scope of the invention and the limits of the appended claims.

Claims

That which is claimed is:

1. In an electrosurgical electrode having an electrical conductor from which a radio frequency electrical signal is generated, which signal sparks to and performs a surgical function upon body tissue of a patient and is received by a receiver which is in conductive contact with the patient, an improvement comprising:

a dielectric sheath surrounding said conductor in the region where the surgical function is being performed, the sheath having a slit extending therealong in said region exposing only a portion of the lateral surface of the conductor.

2. An electrosurgical electrode as set forth in claim 1, wherein said sheath is coated onto said conductor.

3. An electrosurgical electrode as set forth in claim 1, wherein said slit does not extend beyond said region.

4. An electrosurgical electrode as set forth in claim 1, wherein said slit extends beyond said region and further including:

an insulating sleeve structure about said conductor in position to restrict the portion of the conductor exposed through the sheath to being in said region.

5. An electrosurgical electrode as set forth in claim 4, wherein said insulating sleeve structure fits slidably about the conductor to allow adjustment of the length of the region.

6. An electrosurgical electrode as set forth in claim 1, wherein said slit extends longitudinally along the sheath.

7. An electrosurgical electrode as set forth in claim 1, wherein said conductor is a wire which runs along a longitudinally extending inflatable bladder which is positionable along the interior of a body conduit and the slit faces away from the bladder.

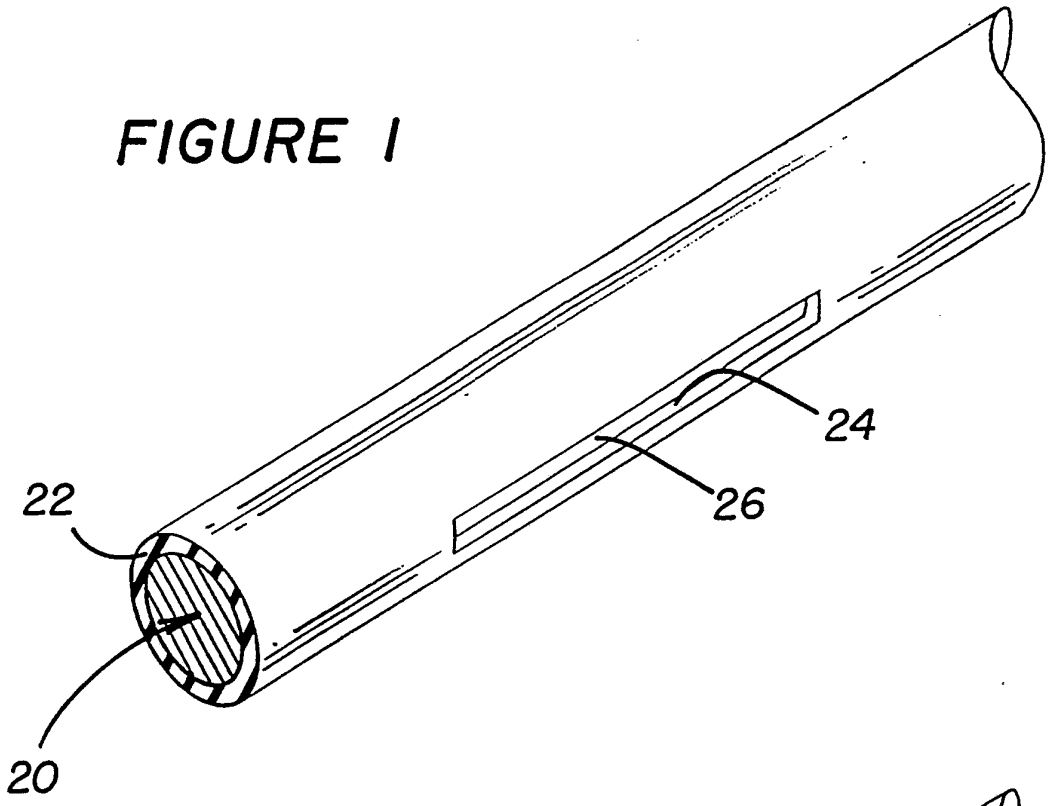
8. An electrosurgical electrode as set forth in claim 1, wherein said insulating sleeve structure covers said sheath and has a longitudinally extending window extending therethrough, said insulating sleeve structure being moveable for providing an aperture defined by said window and by at least a portion of said slit for selectively exposing a desired width of the slit to expose a desired portion of the conductor.

9. An electrosurgical electrode as set forth in claim 1, wherein said receiver is adjacent to the tissue upon which the surgical procedure is being performed.

10. An electrosurgical electrode as set forth in claim 1, wherein said receiver is removed from the tissue upon which the surgical procedure is being performed.

11. An electrosurgical electrode as set forth in claim 1, wherein the dielectric sheath is made of a non-stick material to minimize adhesion of the tissue upon which the surgical procedure is being performed to the electrode.

FIGURE 1



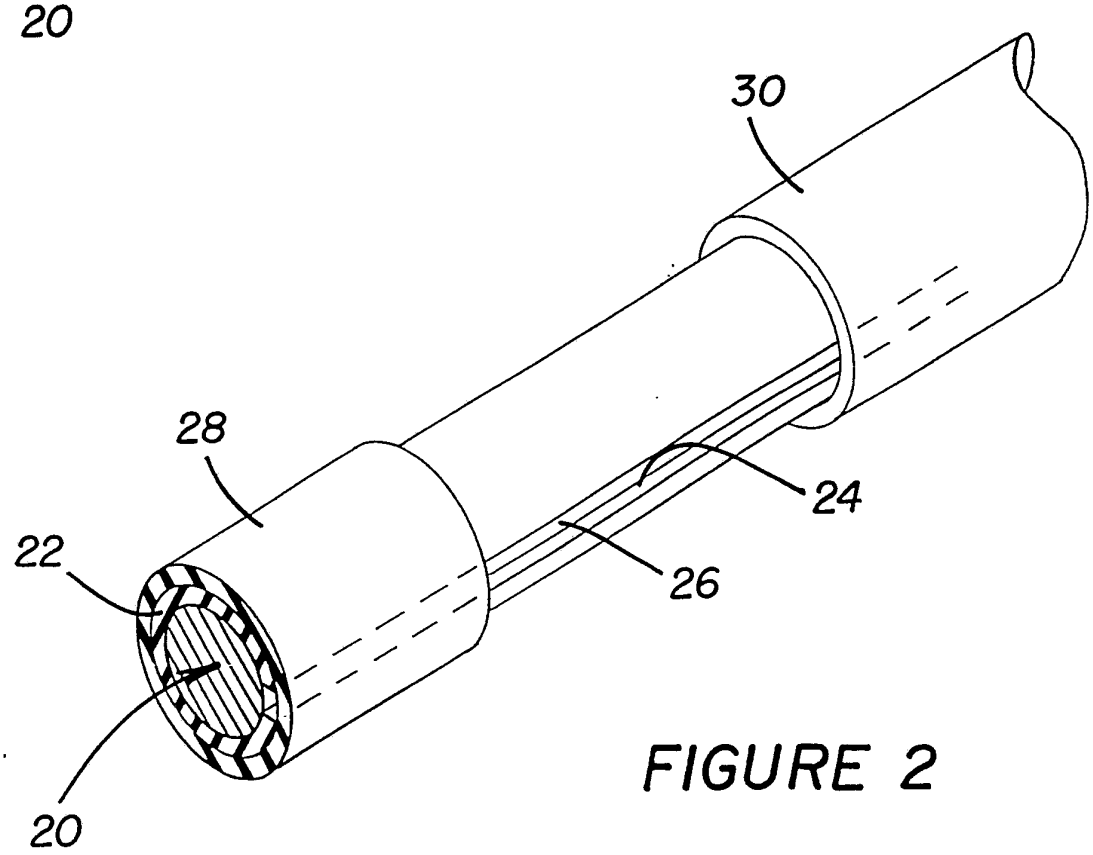


FIGURE 2

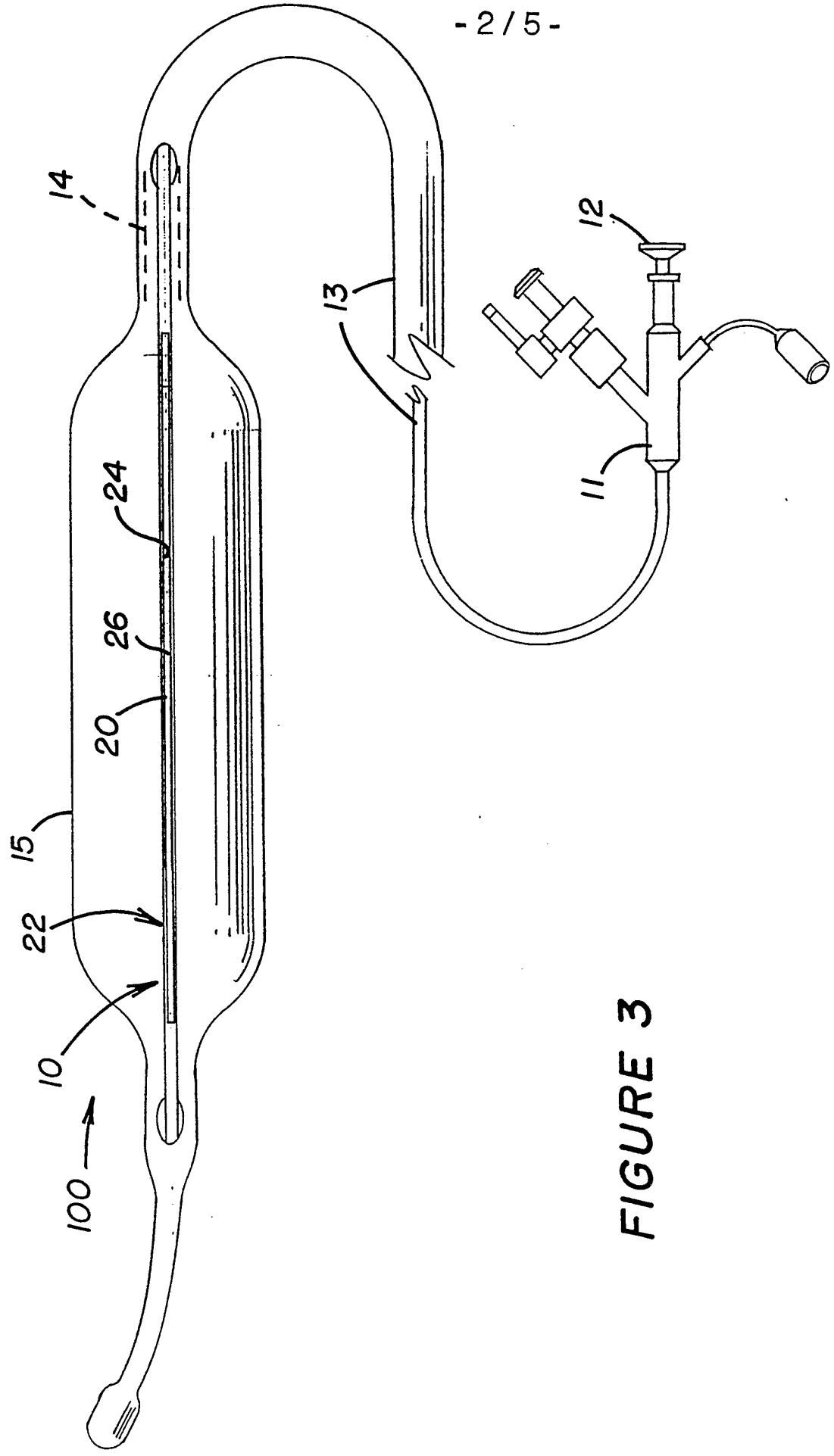


FIGURE 3

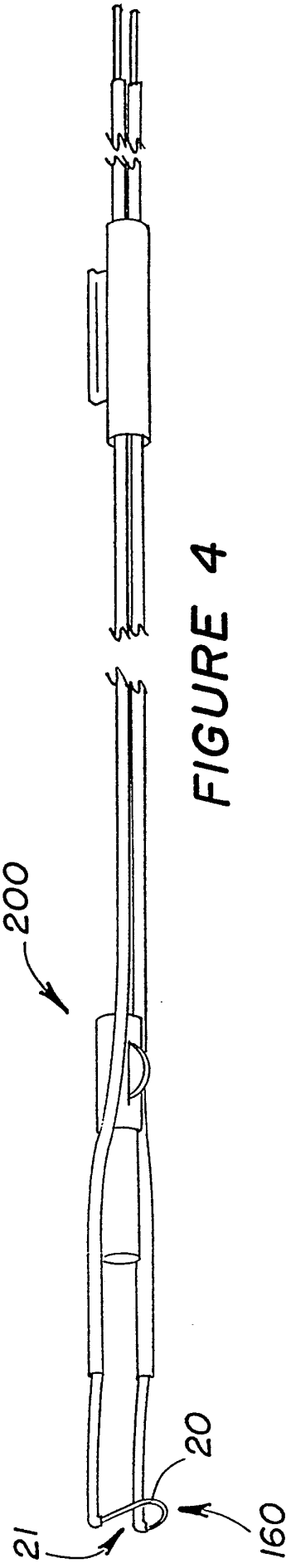


FIGURE 4

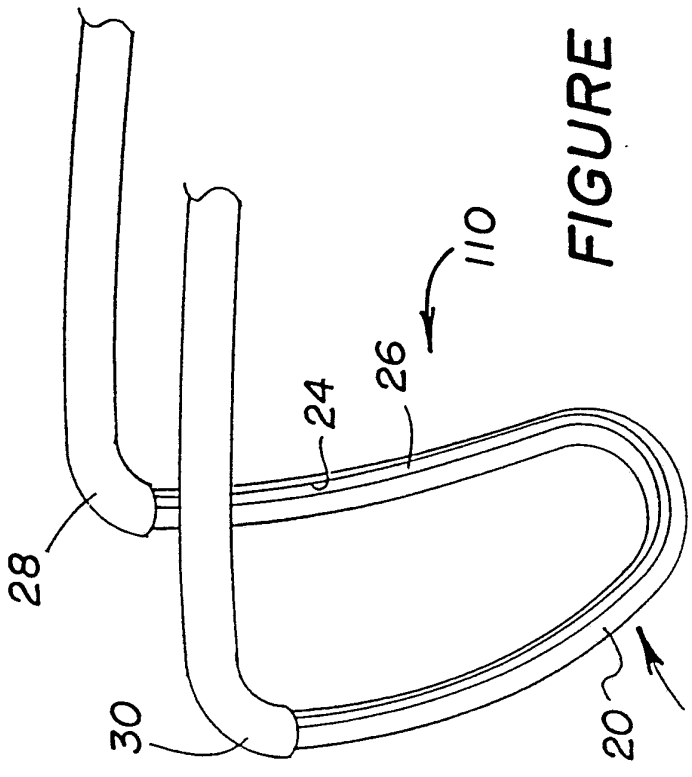


FIGURE 5

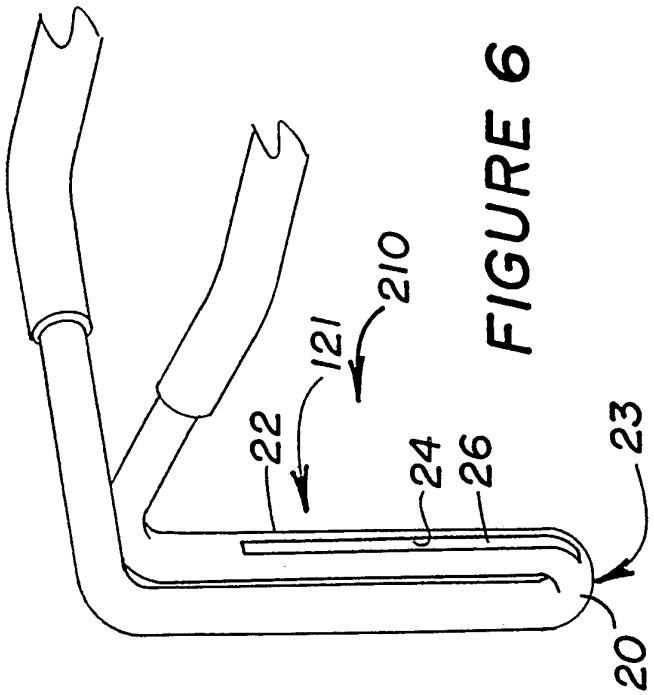
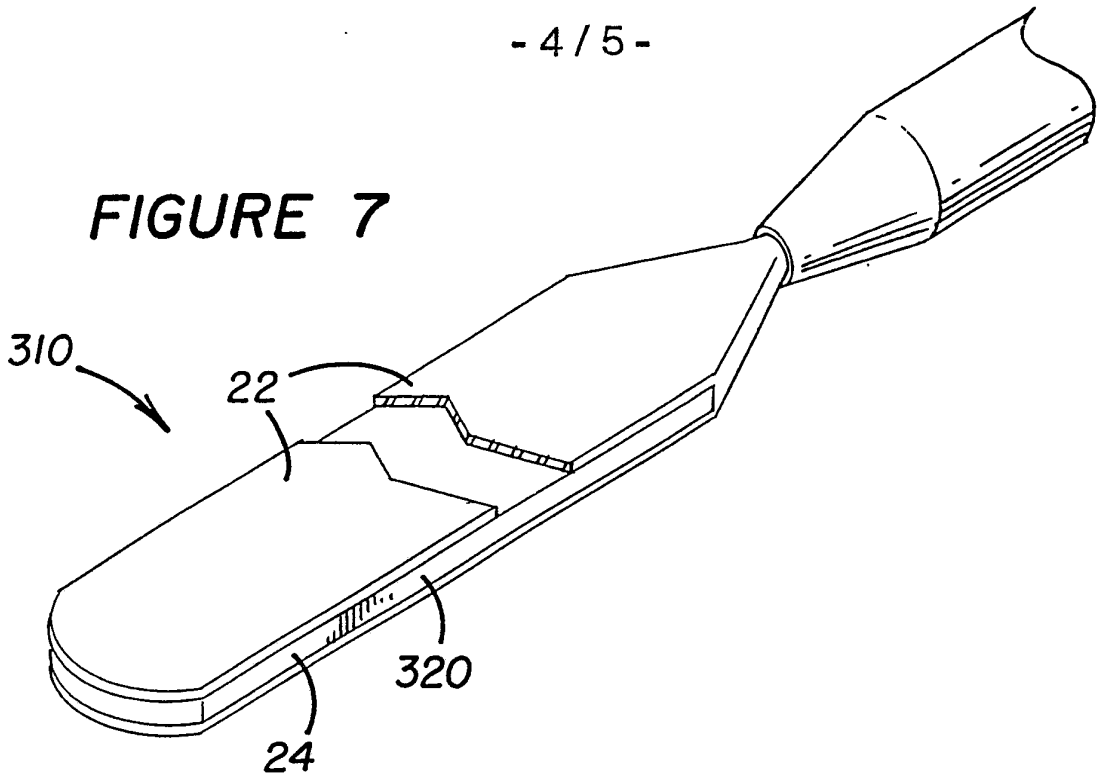


FIGURE 6

FIGURE 7



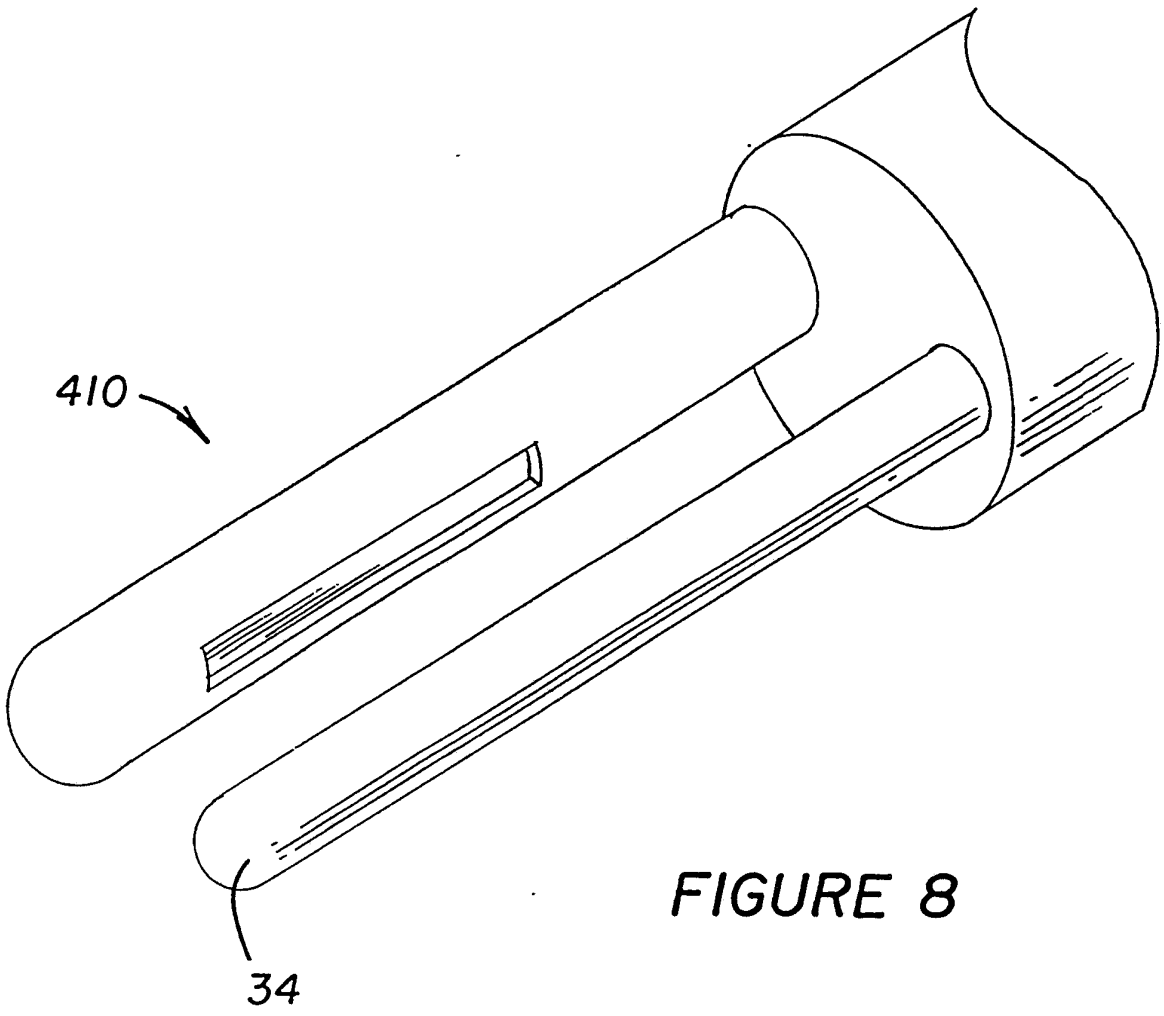
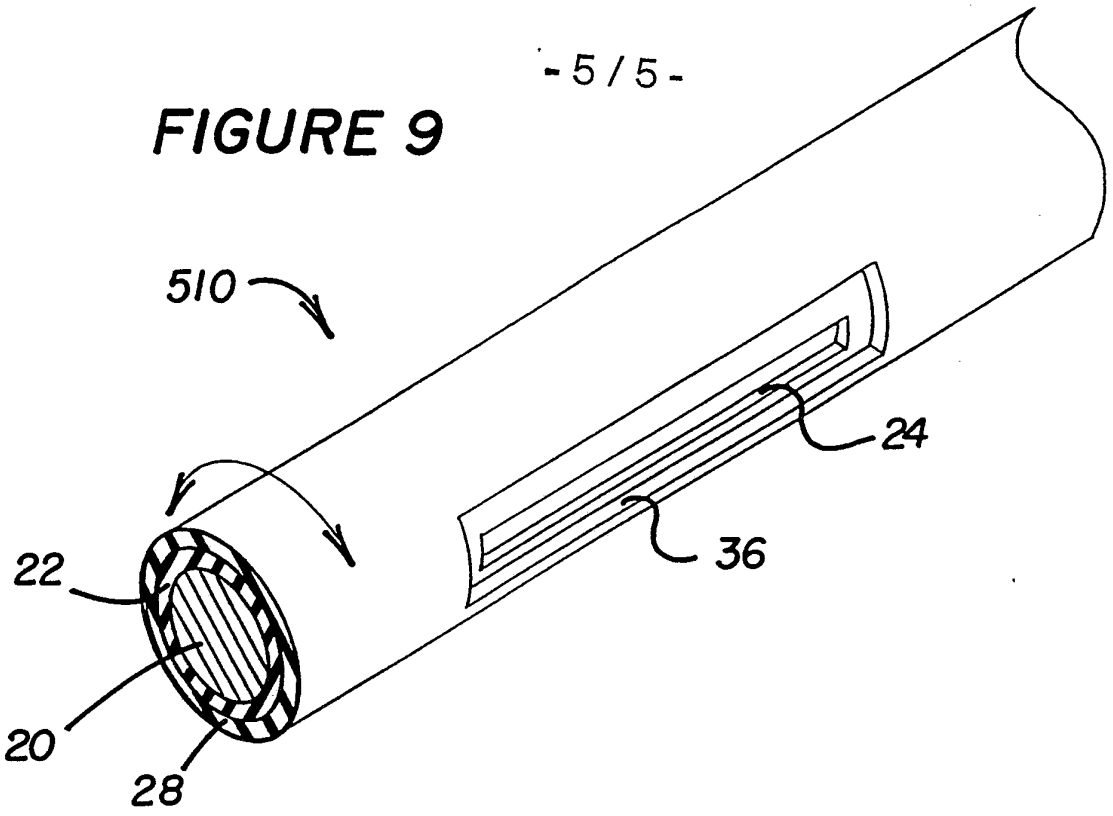


FIGURE 8

FIGURE 9



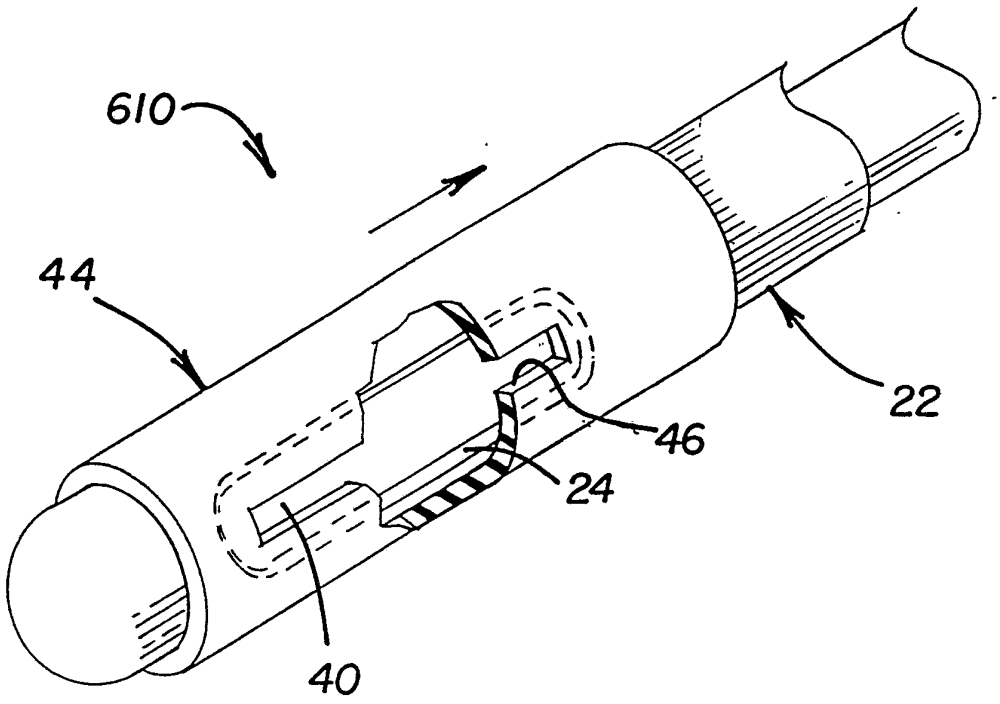


FIGURE 10

INTERNATIONAL SEARCH REPORT

International Application No PCT/US91/02860

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (5) A61B 17/39
US Cl. 606/45; 606/49

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
US	606/41, 42, 45-50

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US,A, 1,814,791 (ENDE) 14 July 1931, See entire document.	1
A	US,A, 3,987,795 (MORRISON) 26 October 1976, See entire document.	1
X,P	US,A, 4,976,711 (PARINS) 11 December 1990, See entire document.	1-3,6,7,9-11

* Special categories of cited documents: [15]

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

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
23 May 1991	04 SEP 1991
International Searching Authority [1]	**Signature of Authorized Officer** [20]
ISA/US	Fm Lee S. Cohen NGUYEN NGOC-HO INTERNATIONAL DIVISION

Form PCT/ISA/210 (second sheet) (May 1986)