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(54) **SURGICAL COAGULATION DEVICE**

CHIRURGISCHE KOAGULATIONSVORRICHTUNG

DISPOSITIF DE COAGULATION CHIRURGICALE

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to the field of surgical coagulation of tissue.

Description of the Background Art

Controlling or arresting blood loss is of high priority during surgery so as to avoid or minimize the necessity of introducing foreign blood or blood products into a patient. This has increased in importance due to concern over contamination of the blood supply by viral agents which cause, for example, acquired immune deficiency syndrome (AIDS), hepatitis, and the like.

Presently, the standard means for controlling traumatic and surgical blood loss are electrosurgical generators and lasers, which respectively direct high-frequency electrical currents or light energy to localize heat in bleeding vessels so as to coagulate the overlying blood and vessel walls.

Recently, argon beam coagulators have been demonstrated to be effective tissue coagulators. Presently available argon beam coagulators include a flexible cable having a nozzle tip with an opening through which argon gas flows. The device includes a handle immediately adjacent the nozzle tip for placing the tip in position for tissue coagulation. Within the tip is located a tungsten needle for discharging radiofrequency (RF) current which ionizes the argon gas. The stream of ionized argon, a colorless, odorless, inactive gas, conducts the current to the tissue and blood vessels, while effectively blowing blood away from the vessels and allowing coagulation within vessel walls.

Argon beam coagulator systems have been utilized to control or arrest blood flow in various types of incisional surgeries, including radical head and neck surgery, Ward, et al., Archives of Autolaryngology-Head and Neck Surgery, 115:921-923 (1989); and partial nephrectomy, Hernandez, et al., The Journal of Urology, 143:1062-1065 (1990). The argon beam coagulator system has also been utilized for electrosurgical debulking of ovarian cancer, Brand, et al., Gynecologic Oncology, 39:115-118 (1990). However, the configuration of currently available argon beam coagulators has prevented their use in other forms of surgery.

US-A-4,060,088 discloses such an argon beam coagulator comprising the features of the preamble of claim 1. Said coagulator is however not adapted to be used in combination with typical endoscopes, such as hysteroscopes, gastroscopes, colonoscopes and laparoscopes.

There is a need in the art for an argon beam coagulator which can be utilized in surgical applications which are not presently available.

Summary of the Invention

In accordance with the present invention, a surgical tissue coagulator comprises an elongate, biocompatible, tube having an open distal end and a proximal end. Means are provided for connecting the proximal end of the tube with a source of an inert, ionizable gas, so that a stream of the gas can flow through the tube and exit the distal end of the tube. A flexible wire is provided within the tube for conducting radiofrequency (RF) current. The wire has a distal end for positioning adjacent the distal end of the tube, and means at the distal end of the wire for discharging an arc of RF energy away from the distal end of the wire within the stream of inert gas exiting the distal end of the tube. The wire has a proximal end opposite the distal end of the wire, and means for connecting the proximal end of the wire with a source of RF energy.

The tube and the wire are flexible and the tube has an external diameter of less than about 5 mm. The tube is further insertable into a surgical endoscope having a length of at least about 35 cm, and a handle is attached to said tube adjacent the proximal end of the tube for maneuvering the tube within the endoscope while said handle is outside the endoscope.

Brief Description of the Drawings

Fig. 1 is a partly schematic, elevational view of a surgical tissue coagulator in accordance with one embodiment of the present invention.

Fig. 2 is a partly schematic, plan view of a surgical tissue coagulator in accordance with one embodiment, attached to a base unit and inserted within a surgical endoscope for tissue coagulation in a patient.

Fig. 3 is a partly schematic, detailed view of the tip of a surgical tissue coagulator in accordance with one embodiment of the invention, having a polypectomy snare as an additional feature.

Fig. 4 is a partly schematic, detailed view showing the tip of a surgical tissue coagulator in accordance with another embodiment of the invention, having biopsy forceps as an additional feature.

Fig. 5 is a partly schematic, detailed view of a surgical tissue coagulator tip according to another embodiment of the present invention, having a dissection needle as an additional feature.

Detailed Description of the Preferred Embodiments

With reference to Figs. 1 and 2, a surgical tissue coagulator A in accordance with the present invention includes an elongate, biocompatible, flexible tube 10 having an open distal end 12 and a proximal end 14. Tube 10 can be formed of any suitable biocompatible, flexible material, and in preferred embodiments, is formed of polymeric material. In particularly preferred

embodiments, tube 10 is SILASTIC® tubing (Dow).

Tube 10 has an external diameter of less than about 5 mm, and is insertable into, and maneuverable within, a surgical endoscope 16 (shown in Fig. 2). The present invention is usable with any suitable endoscope, such as those manufactured by Olympus, Pentax and Fujinon. Typical endoscopes, such as hysteroscopes, gastroscopes, colonoscopes and laparoscopes, have a length within the range of from about 35 cm to about 120 cm.

Endoscopes with which preferred embodiments of the present invention are usable have working channels through which surgical instruments can be inserted into the patient. Such working channels have diameters of about 3.8 mm to about 4 mm. A coagulator in accordance with the present invention must have a tube 10 with an outer diameter less than the internal diameter of the working channel of an endoscope through which tube 10 is inserted. Accordingly, with endoscopes having working channels of from about 3.8 mm to about 4 mm, coagulators in accordance with a preferred embodiments of the present invention have a flexible tube 10 with an outer diameter of about 3-3.5 mm. In particularly preferred embodiments, tube 10 has an external diameter of about 3 mm.

Referring back to Fig. 1, a handle 18 is attached to tube 10 adjacent the proximal end 14 of the tube. Handle 18 is provided for maneuvering tube 10 within endoscope 16 (shown in Fig. 2) while handle 18 is outside the endoscope.

As shown in Fig. 1, end 14 of tube 10 is connected to a passageway 20 in handle 18 which in turn is connected to connector means 22 for connecting the proximal end 14 of tube 10 with a source of an inert, ionizable gas, such as argon. Connection with the source of gas provides for a stream of inert gas to flow through tube 10 and exit distal end 12 of the tube.

A flexible wire 28 is provided within tube 10 for conducting radiofrequency (RF) current. In preferred embodiments, wire 28 has an external diameter of about 1 mm.

Wire 28 has a distal end 30 for positioning adjacent the distal end 12 of tube 10. Means 32 are provided at the distal end 30 of wire 28 for discharging an arc 34 of RF energy away from the distal end of wire 28, within the stream of inert gas (represented by arrows 36 exiting the distal end 12 of tube 10.)

In preferred embodiments, the RF discharging means at the end 30 of wire 28 comprises a tungsten tip 32. In accordance with one embodiment, tungsten tip 32 is at least partly spherical. In the embodiment shown in Fig. 1, tungsten tip 32 comprises a tungsten ball.

The inert, ionizable argon gas provides the medium through which the arc 34 travels to the surface of tissue 38 so as to coagulate tissue 38.

Wire 28 has a proximal end 40 and connector means 42 for connecting the proximal end of the wire with a source of RF energy.

The surgical tissue coagulator A of the present invention can easily be configured for use with commercially available argon gas coagulator base units, such as the base unit for the Bard System 6000™ electrosurgical generator with argon beam coagulation (ABC) shown schematically in Fig. 2 with reference letter B (Bard Electromedical Systems, Inc., Englewood Colorado).

Base unit B includes a source of argon gas 24 and a source of RF energy in the form of RF generator 44.

Base unit B includes a coaxial outlet 54 with a gas source 24 and RF generator 44. Outlet 54 is the coaxial terminus of gas line 24a connected with gas source 24, and RF line 44a connected with RF generator 44.

Handle 18 of coagulator A includes a coaxial inlet 56 which includes gas connector means 22, within which is coaxially located RF connector means 42.

The coaxial inlet 56 of coagulator A is connectable with the coaxial outlet 54 of base unit B by means of gas line 26, within which is located RF line 46. Thus, gas line 26 connects gas inlet 42 of coagulator A with argon source 24 of base unit B via line 24a, while RF line 46 connects RF inlet 42 of coagulator A with RF generator 44 of base unit B via line 44a.

Any suitable connector means can be utilized to connect the ends of line 26 with coaxial outlet 54 and coaxial inlet 56, such as threaded connectors, leur lock connectors, and the like. Also, any suitable electrical connector can be utilized to connect line 46 with line 44a of base unit B and RF inlet 42 of coagulator A.

A ground plate 48 in contact with patient 50 is provided for return of RF current to generator 44 via line 52.

Base unit B is activated by a single pedal foot switch 58 connected to base unit B via line 60. Activation of switch 58 opens argon source 24 and activates generator 44.

Argon gas can be provided by source 24 with a variable gas flow rate of, for example, from 1 to 12 liters/minute.

RF generator 44 can deliver, for example, from 40 to 150 W radiofrequency current. RF current flows when tip 30 of wire 28 comes within about 1 cm of tissue 38, while foot pedal switch 58 is depressed. The arcing current in the gas jet ionizes the argon gas. The inert, noncombustible argon gas provides the medium through which the argon travels.

Fig. 2 shows an endoscope 16 within patient 50 in the vicinity of tissue 38 to be coagulated. Tube 10 of coagulator A has been inserted within endoscope 16 in the proximity of tissue 38, i.e., within about 1 cm thereof.

With foot pedal switch 58 depressed, a stream of argon gas exits distal end 12 of tube 10 while RF energy is discharged from tip 30 of wire 28 into tissue 38.

Referring back to Fig. 1, wire 28 is longitudinally movable within tube 10 in directions shown by double-ended arrow 62 so that the distal end 30 and tip 32 of wire 28 is movable from a position within tube 10 to the position shown outside the distal end of tube 10. Control

of the movement of wire 28 within tube 10 can be by any suitable means, such as under the control of flexible handle 18.

If desired, additional surgical instruments can be provided at the distal end 30 of wire 28. For example, in the embodiment shown in Fig. 3, a polypectomy snare 64 is attached to the distal end 30 of wire 28. In the embodiment shown, polypectomy snare 64 is movable with wire 28 from inside tube 10 to outside tube 10, in the directions shown by double-ended arrow 66. In accordance with this embodiment, polyps can be captured with snare 64 and tissue can be cauterized by RF energy passing from the distal end 30 of wire 28.

In another embodiment, biopsy forceps 68 for grasping tissue are attached to the distal end 30 of wire 28 as shown in Fig. 4. In accordance with this embodiment, forceps 68 are movable from inside tube 10 to outside tube 10, along with wire 28, in the directions shown by double-ended arrow 70. In accordance with this embodiment, RF current can be delivered from end 30 of wire 28. The biopsy forceps can be advanced out of tubing 10 and the biopsy forceps can grasp tissue. The biopsy forceps can also be pulled back into tubing 10.

In yet another embodiment, the RF discharging means at the end 30 of wire 28 further comprises a titanium dissection needle 72 for dissecting tissue. The dissecting needle 72 is movable with the end 30 of wire 28 from inside tube 10 to outside tube 10 in the directions shown by double-ended arrow 74. In accordance with this embodiment, titanium needle 72 can be advanced out of tubing 10 and the titanium needle can be utilized to discharge RF current within the argon gas stream so as to coagulate tissue. Subsequently, tissue can be dissected from its origin of attachment using needle 72.

Since many modifications, variations and changes in detail may be made to the described embodiments, it is intended that all matter in the foregoing description and shown in the accompanying drawings be interpreted as illustrative and not in a limiting sense.

Claims

1. A surgical tissue coagulator (A) comprising an elongate, biocompatible, tube (10) having an open distal end (12) and a proximal end (14);

   means (22) for connecting the proximal end (14) of said tube (10) with a source (24) of an inert, ionizable gas so that a stream of said gas can flow through said tube (10) and exit the distal end (12) of said tube (10);
   a handle 18 attached to said tube (10) adjacent the proximal end (14) of the tube (10) for maneuvering said tube;
   a wire (28) within said tube (10) for conducting radiofrequency current, the wire (28) having a distal end (30) for positioning adjacent the distal end (12) of said tube (10), and means (32) at the distal end (30) of said wire (28) for discharging an arc (34) of radiofrequency energy away from the distal end (30) of said wire (28) within said stream of inert gas exiting the distal end (12) of said tube (10) so as to form an ionized gas stream which is capable of coagulating tissue (38) during endoscopic surgery within a patient, the wire (28) having a proximal end (40) opposite the distal end (30) of the wire (28), and means (42) for connecting the proximal end (40) of the wire (28) with a source (44) of radiofrequency energy,
   characterized in that said tube (10) and said wire (28) are flexible, the tube has further an external diameter of less than about 5 mm, is insertable into a surgical endoscope (16) having a length of at least about 35 cm, and in that said handle is adapted for maneuvering said tube (10) within said endoscope (16) while said handle (18) is outside said endoscope (16).

2. The surgical tissue coagulator of claim 1, wherein said wire (28) is longitudinally movable within said tube (10).

3. The surgical tissue coagulator of claim 2, wherein the distal end (30) of said wire (28) is movable from a position within said tube (10) to a position outside the distal end (12) of said tube (10).

4. The surgical tissue coagulator of claim 3, further including a polypectomy snare (64) attached to the distal end (30) of said wire (28), which snare is movable (64) from inside said tube (10) to outside said tube (10).

5. The surgical tissue coagulator of claim 3, further including biopsy forceps (68) for grasping tissue, said forceps (68) being attached to the distal end (30) of said wire (28), said forceps (68) being movable from inside said tube (10) to outside said tube (10).

6. The surgical tissue coagulator of claim 3, wherein the discharging means further comprises a titanium dissection needle (72) for dissecting tissue, said needle (72) being movable from inside said tube (10) to outside said tube (10).

7. The surgical tissue coagulator of claim 1, wherein said wire (28) has an external diameter of about 1 mm.

8. The surgical tissue coagulator of claim 1, wherein the discharging means at the distal end (30) of said wire (28) comprises a tungsten tip (32).

9. The surgical tissue coagulator of claim 8, wherein said tungsten tip (32) is at least partly spherical.

10. The surgical tissue coagulator of claim 9, wherein said tip (32) comprises a tungsten ball.

11. The surgical tissue coagulator of claim 1, wherein said means (22) for connecting the proximal end (14) of said tube (10) with a source of inert gas comprises a means for connecting the proximal end (14) of said tube (10) with a source of argon gas so that a stream of said argon gas can flow through said tube (10) and exit the distal end (12) of said tube (10).

12. The surgical tissue coagulator of claim 1 in combination with a surgical endoscope (16).

13. The surgical tissue coagulator of claim 13, wherein said endoscope (16) is selected from the group consisting of gastroscope, hysteroscope, colonoscope and laparoscope.

Patentansprüche

1. Chirurgischer Gewebekoagulator (A) mit

einem langgestreckten, biokompatiblen Schlauch (10), der ein offenes distales Ende (12) und ein proximales Ende (14) aufweist;
Mitteln (22) zum Anschließen des proximalen Endes (14) des Schlauches (10) an eine Quelle (24) für ein inertes, ionisierbares Gas, so daß ein Gasstrom durch den Schlauch (10) fließen und am distalen Ende (12) des Schlauches (10) austreten kann;
einem an dem Schlauch (10) angrenzend an das proximale Ende (14) des Schlauches (10) befestigten Griff (18) zur Bewegung des Schlauches;
einem Draht (28) innerhalb des Schlauches (10) zur Leitung von Hochfrequenzstrom, wobei der Draht (28) ein angrenzend an das distale Ende (12) des Schlauches (10) angeordnetes distales Ende (30) sowie ein Mittel (32) an dem distalen Ende (30) des Drahtes (28) zur Erzeugung einer von dem distalen Ende (30) des Drahtes (28) weggerichteten Hochfrequenz-Lichtbogenentladung (34) innerhalb des am distalen Ende (12) des Schlauches (10) austretenden Inertgasstroms aufweist, so daß während einer endoskopischen Operation bei einem Patienten ein Strom ionisierten Gases zur Koagulation von Gewebe (38) gebildet wird, wobei der Draht (28) ein dem distalen Ende (30) des Drahtes (28) gegenüberliegendes proximales Ende (40) sowie Mittel (42) zum Anschließen des proximalen Endes (40) des Drahtes (28) an eine Hochfrequenzenergiequelle (44) aufweist,
dadurch gekennzeichnet, daß der Schlauch (10) und der Draht (28) biegsam sind, daß der Schlauch ferner einen Außendurchmesser von weniger als etwa 5 mm hat, in ein chirurgisches Endoskop (16) mit einer Länge von wenigstens etwa 35 cm einsetzbar ist und daß der Griff zur Bewegung des Schlauches (10) innerhalb des Endoskops (16) ausgebildet ist, während sich der Griff (18) außerhalb des Endoskops (16) befindet.

2. Chirurgischer Gewebekoagulator nach Anspruch 1, dadurch gekennzeichnet, daß der Draht (28) in dem Schlauch (10) in Längsrichtung bewegbar ist.

3. Chirurgischer Gewebekoagulator nach Anspruch 2, dadurch gekennzeichnet, daß das distale Ende (30) des Drahtes (28) aus einer Lage innerhalb des Schlauches (10) in eine Lage außerhalb des distalen Endes (12) des Schlauches (10) bewegbar ist.

4. Chirurgischer Gewebekoagulator nach Anspruch 3, ferner gekennzeichnet durch eine an dem distalen Ende (30) des Drahtes (28) befestigte Schlinge (64) zur Polypenentfernung, die vom Inneren des Schlauches (10) in eine Lage außerhalb des Schlauches (10) bewegbar ist.

5. Chirurgischer Gewebekoagulator nach Anspruch 3, ferner gekennzeichnet durch eine Biopsiezange (68) zum Ergreifen von Gewebe, wobei die Zange (68) an dem distalen Ende (30) des Drahtes (28) befestigt und vom Inneren des Schlauches (10) in eine Lage außerhalb des Schlauches (10) bewegbar ist.

6. Chirurgischer Gewebekoagulator nach Anspruch 3, dadurch gekennzeichnet, daß das Mittel zur Erzeugung der Entladung ferner eine Seziernadel (72) aus Titan zum Sezieren von Gewebe umfaßt, wobei die Nadel (72) vom Inneren des Schlauches (10) in eine Lage außerhalb des Schlauches (10) bewegbar ist.

7. Chirurgischer Gewebekoagulator nach Anspruch 1, dadurch gekennzeichnet, daß der Draht (28) einen Außendurchmesser von etwa 1 mm hat.

8. Chirurgischer Gewebekoagulator nach Anspruch 1, dadurch gekennzeichnet, daß das Mittel zur Erzeugung der Entladung an dem distalen Ende (30) des Drahtes (28) eine Wolframspitze (32) umfaßt.

9. Chirurgischer Gewebekoagulator nach Anspruch 8, dadurch gekennzeichnet, daß die Wolframspitze (32) wenigstens teilweise kugelförmig ist.

10. Chirurgischer Gewebekoagulator nach Anspruch 9, dadurch gekennzeichnet, daß die Spitze (32) eine Wolframkugel umfaßt.

11. Chirurgischer Gewebekoagulator nach Anspruch 1, dadurch gekennzeichnet, daß die Mittel (22) zum Anschließen des proximalen Endes (14) des Schlauchs (10) an eine Inertgasquelle ein Mittel zum Anschließen des proximalen Endes (14) des Schlauches (10) an eine Argongasquelle umfassen, so daß ein Argongasstrom durch den Schlauch (10) fließen und am distalen Ende (12) des Schlauches (10) austreten kann.

12. Chirurgischer Gewebekoagulator nach Anspruch 1 in Kombination mit einem chirurgischen Endoskop (16).

13. Chirurgischer Gewebekoagulator nach Anspruch 12, dadurch gekennzeichnet, daß das Endoskop (16) aus der aus einem Gastroskop, Hysteroskop, Kolonoskop und Laparoskop bestehenden Gruppe ausgewählt ist.

Revendications

1. Coagulateur de tissu chirurgical (A) comprenant une tube (10) allongé biocompatible ayant une extrémité distale ouverte (12) et une extrémité proximale (14);

   un moyen (22) pour relier l'extrémité proximale (14) dudit tube (10) à une source (24) d'un gaz ionisable inerte de telle sorte qu'un courant dudit gaz peut s'écouler à travers ledit tube (10) et sortir par l'extrémité distale (12) dudit tube (10); une poignée (18) attachée audit tube (10) adjacente à l'extrémité proximale (14) du tube (10) pour manoeuvrer ledit tube (10);
   un fil (28) à l'intérieur dudit tube (10) pour conduire un courant de radiofréquence, le fil (28) ayant une extrémité distale (30) à mettre en place de façon adjacente à l'extrémité distale (12) dudit tube (10), et un moyen (32) à l'extrémité distale (30) dudit fil (28) pour décharger un arc (34) d'énergie de radiofréquence à partir de l'extrémité distale (30) dudit fil (28) à l'intérieur dudit courant de gaz inerte sortant de l'extrémité distale (12) dudit tube (10) de façon à former un courant de gaz ionisé qui est capable de coaguler un tissu (38) au cours d'une opération chirurgicale endoscopique à l'intérieur d'un patient, le fil (28) ayant une extrémité proximale (40) opposée à l'extrémité distale (30) du fil (28), et un moyen (42) pour relier l'extrémité proximale (40) du fil (28) à une source (44) d'énergie de radiofréquence,
   caractérisé en ce que ledit tube (10) et ledit fil (28) sont flexibles, que le tube a de plus un diamètre extérieur inférieur à environ 5 mm, qu'il peut être inséré à l'intérieur d'un endoscope chirurgical (16) ayant une longueur d'au moins environ 35 cm, et en ce que ladite poignée est adaptée pour manoeuvrer ledit tube (10) à l'intérieur dudit endoscope (16) tandis que ladite poignée (18) est à l'extérieur dudit endoscope (16).

2. Coagulateur de tissu chirurgical suivant la revendication 1, dans lequel ledit fil (28) peut être déplacé de façon longitudinale à l'intérieur dudit tube (10).

3. Coagulateur de tissu chirurgical suivant la revendication 2, dans lequel l'extrémité distale (30) dudit fil (28) peut être déplacée depuis une position à l'intérieur dudit tube (10) jusqu'à une position à l'extérieur de l'extrémité distale (12) dudit tube (10).

4. Coagulateur de tissu chirurgical suivant la revendication 3, comprenant de plus un serre-noeud pour polypectomie (64) attaché à l'extrémité distale (30) dudit fil (28), lequel serre-noeud (64) peut être déplacé depuis l'intérieur dudit tube (10) vers l'extérieur dudit tube (10).

5. Coagulateur de tissu chirurgical suivant la revendication 3, comprenant de plus un forceps pour biopsie (68) pour saisir un tissu, ledit forceps (68) étant attaché à l'extrémité distale (30) dudit fil (28), ledit forceps (68) pouvant être déplacé depuis l'intérieur dudit tube (10) vers l'extérieur dudit tube (10).

6. Coagulateur de tissu chirurgical suivant la revendication 3, dans lequel le moyen de décharge comprend de plus une aiguille de dissection en titane (72) pour la dissection de tissu, ladite aiguille (72) pouvant être déplacée depuis l'intérieur dudit tube (10) vers l'extérieur dudit tube (10).

7. Coagulateur de tissu chirurgical suivant la revendication 1, dans lequel ledit fil (28) a un diamètre extérieur d'environ 1 mm.

8. Coagulateur de tissu chirurgical suivant la revendication 1, dans lequel le moyen de décharge à l'extrémité distale (30) dudit fil (28) comprend une extrémité (32) en tungstène.

9. Coagulateur de tissu chirurgical suivant la revendication 8, dans lequel ladite extrémité (32) en tungstène est au moins partiellement sphérique.

10. Coagulateur de tissu chirurgical suivant la revendication 9, dans lequel ladite extrémité (32) comprend une bille en tungstène.

11. Coagulateur de tissu chirurgical suivant la revendication 1, dans lequel ledit moyen (22) pour relier l'extrémité proximale (14) dudit tube à une source de gaz inerte comprend un moyen pour relier l'extrémité proximale (14) dudit tube (10) à une source d'argon gazeux de telle sorte qu'un courant dudit argon gazeux peut s'écouler à travers ledit tube (10) et sortir à l'extrémité distale (12) dudit tube (10).

12. Coagulateur de tissu chirurgical suivant la revendication 1, en combinaison avec un endoscope chirurgical (16).

13. Coagulateur de tissu chirurgical suivant la revendication 12, dans lequel ledit endoscope (16) est choisi dans le groupe consistant en gastroscope, hystéroscope, colonoscope et laparoscope.

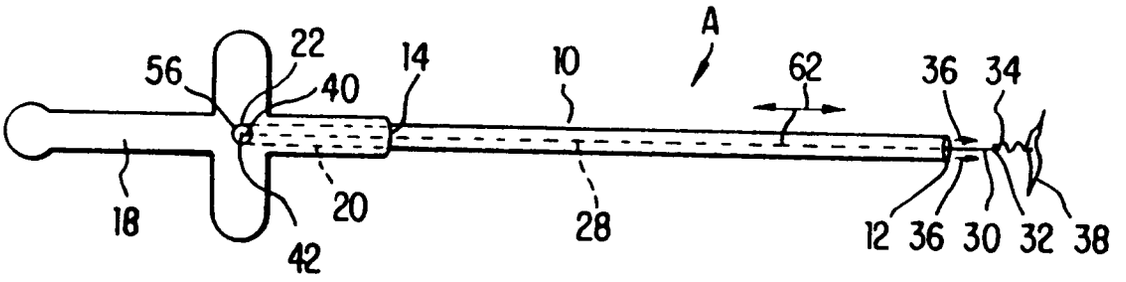
A
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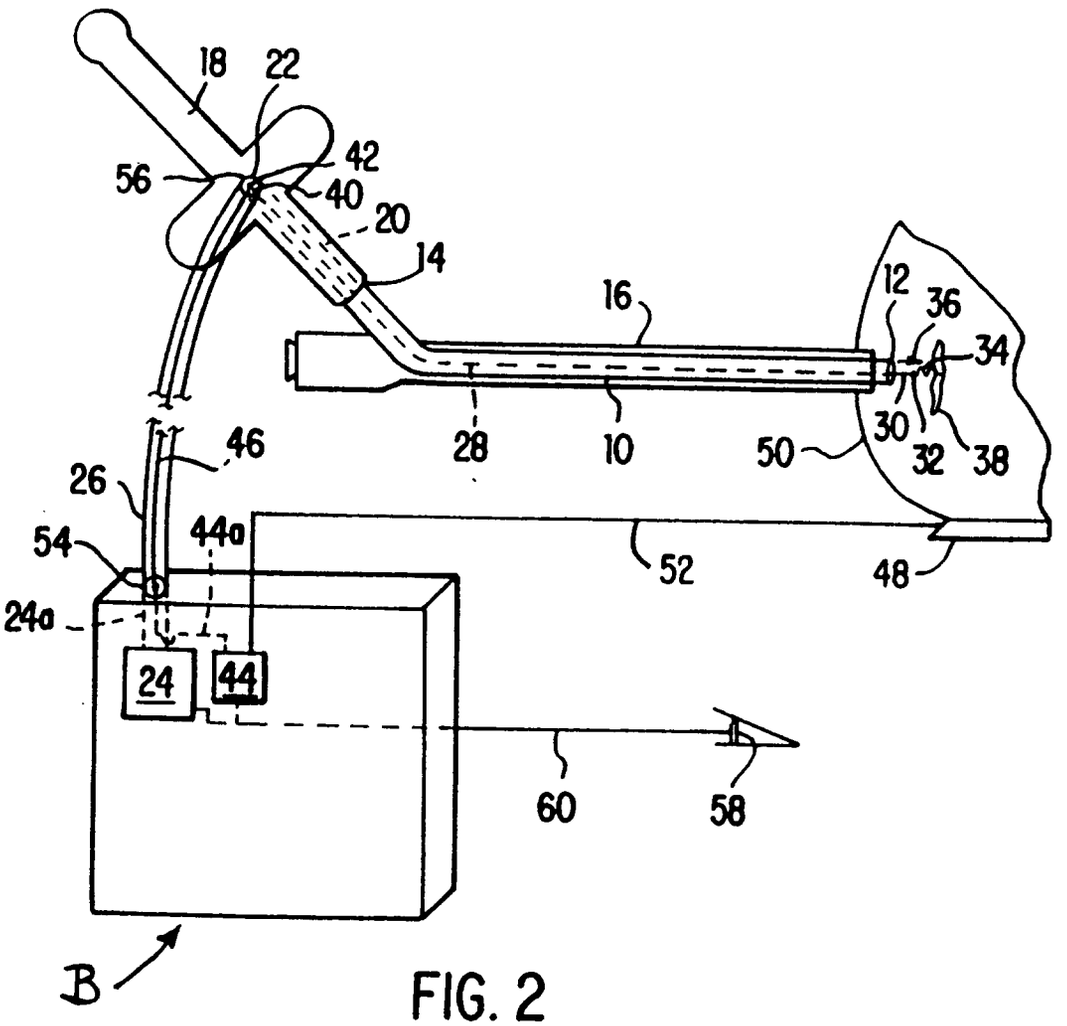
FIG. 1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58
B

FIG. 2

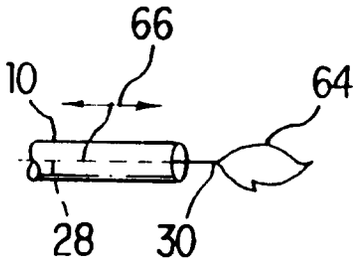

FIG. 3

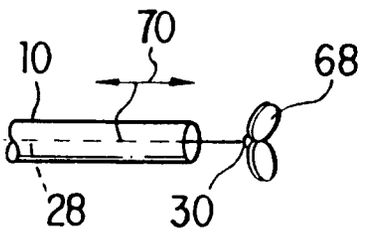

FIG. 4

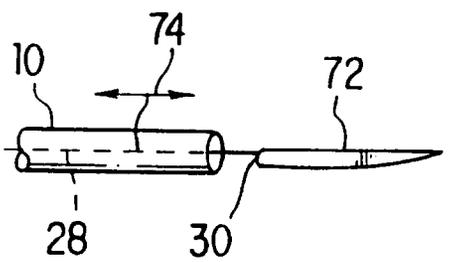

FIG. 5