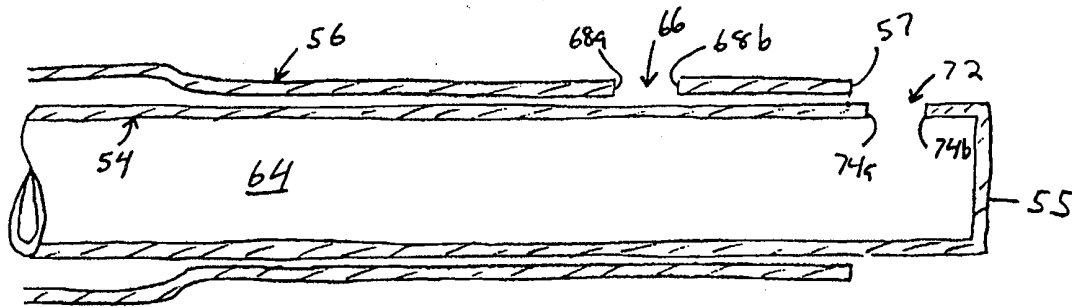




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(54) Title: METHOD AND APPARATUS FOR TRANSURETHRAL RESECTION OF THE PROSTATE



(57) Abstract

A method and apparatus for transurethral resection of the prostate, which includes inserting a transurethral incisional device through the patient's urethra, incising off at least one piece of targeted prostatic tissue using the incisional device, inserting a morcellation probe through the patient's urethra, morcellating the excised piece of targeted prostatic tissue with the morcellation probe, and aspirating the morcellated prostatic tissue through the morcellation probe and out of the patient. The morcellation probe of the present invention includes an elongated inner probe tube that defines an aspiration channel therein and an aperture with opposing cutting edges formed adjacent to its distal end. The inner probe tube is slidably disposed inside an outer probe tube, and moves relative thereto in a longitudinal reciprocating manner. The outer probe tube has an open distal end and another aperture with opposing cutting edges. During each reciprocating movement cycle, the apertures pass each other twice, and the inner probe tube aperture passes beyond the outer probe tube's open distal end once, where two cutting actions occur between the apertures' cutting edges when they pass each other, and a third cutting action occurs when a cutting edge of the inner probe tube aperture passes the outer probe tube's distal end. Target tissue that is cut by the cutting actions is then aspirated out of the patient's body through the aspiration channel.

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METHOD AND APPARATUS FOR TRANSURETHRAL RESECTION OF THE PROSTATE

FIELD OF THE INVENTION

5 The present invention relates to prostate resection, and in particular to an apparatus for transurethral resection of prostatic tissue.

BACKGROUND OF THE INVENTION

10 The prostate is a male reproductive system gland that is generally made of three lobes that are enclosed by an outer layer of tissue referred to as the capsule. The prostate surrounds the lower portion of the bladder (where urine is stored) and part of the urethra (the canal through which urine passes from the bladder out of the body).

15 Continued growth of the prostate causes Benign Prostatic Hypertrophy (BPH), where the continually growing prostate tissue squeezes the lower portion of the bladder and the urethra, making it difficult to pass urine.

20 BPH is often treated by surgically removing the excess prostatic tissue from the interior region of the prostate that is pressing on the urethra, which usually relieves the obstruction and the incomplete emptying of the bladder caused by the BPH, leaving the rest of the prostatic tissue and the capsule intact.

25 Surgeons often perform transurethral surgery to remove the excess prostate tissue (targeted prostatic tissue). This surgery is performed by inserting a resectoscope through the urethra. The resectoscope is used to view the interior of the urinary tract, and to cut (incise) off pieces of the targeted prostatic tissue. Following surgery, a urinary catheter is inserted into the urethra to drain urine from the bladder. This catheter is usually left in place until the presence of blood in the urine has diminished, usually within 1-4 days.

30 There are several prostate resection procedures currently being used. The TURP procedure (transurethral resection of the prostate) is a very

common treatment of BPH. During a TURP procedure, the surgeon uses a standard electrosurgical cutting loop to remove the obstructing tissue from the prostate. The electrosurgical cutting loop is inserted through the resectoscope to the targeted prostatic tissue. The electrosurgical cutting loop
5 uses electricity to "shave" off small pieces of the targeted prostate tissue from the interior of the prostate. During surgery, the shaved pieces of prostatic tissue are carried by irrigation fluid flowing through the resectoscope into the bladder. At the end of the operation, these pieces of excised prostatic tissue are flushed out of the bladder using irrigant,
10 aspirated out using a large bore syringe, and/or removed through the resectoscope using a grasping device.

The pieces of prostatic tissue excised by the electrosurgical loop must be small enough to flush out with the irrigant, aspirate out using the large bore syringe, or grasped and removed through the resectoscope. Therefore,
15 the surgeon must make many surgical incisions into the targeted prostatic tissue with the electrosurgical cutting loop, each of which resulting in the extraction of a piece of prostatic tissue having limited size and significant bleeding. The more surgical incisions made by the surgeon with the electrosurgical loop, the more opportunity for error. In addition, because
20 there is a high number of excised pieces of prostatic tissue to be removed from the bladder, the flushing, aspiration, and/or grasping methods of tissue removal can be time consuming.

There are also thermotherapy techniques that cook the prostatic tissue to reduce the size of the enlarged prostatic tissue. For example, VLAP
25 (visual laser ablation of the prostate) employs an Nd:Yag laser to irradiate and heat each of the prostatic lobes from within the urethra at a given power for a given time duration. Interstitial thermotherapy uses an Nd:Yag laser and/or microwave energy and injects heat into the lateral lobes of the prostate. Within two months of treatment the affected tissue dies and the
30 cells sluff off and eventually flush out of the patient through their urine. If the laser is used, the laser energy coagulates the treated tissue which limits

bleeding and preserves a clearer field of view for the surgeon. Tissue removal using thermotherapy techniques is inefficient, as it takes several months to fully clear the dead tissue from the patient's system. The patient can be catheterized for up to two weeks because of excessive swelling of the prostatic tissue. Also, these procedures are not very precise. It is difficult to control the thermal end point of the affected tissue, and hence difficult to control the extent of ultimate tissue necrosis. There is also no visual indication as to what tissue has been sufficiently heated, and to what depth. Lastly, the dead tissue being flushed out over a long period of time invites infection and causes prolonged irritative symptoms for the patient.

New procedures have been developed with the commercialization of laser systems that exhibit low penetration depths in tissue. For example, erbium (wavelength = 2.94 or 2.71 μm) and holmium (wavelength = 2.1 μm) laser systems produce optical outputs that penetrate only a few hundred microns in an aqueous environment. Therefore, side and end firing optical fibers can be inserted through the resectoscope to incise and ablate the prostatic tissue. The laser energy vaporizes the water content of cells and coagulates the underlying tissue, thus significantly reducing the bleeding and swelling that otherwise results from TURP and VLAP, as well as reducing the amount of catheterization time during recovery, while providing immediate relief of the BPH symptoms.

The tissue ablation rate of such laser systems is far too slow to simply use a side or end firing fiber to ablate away all the targeted prostatic tissue. However, holmium and erbium lasers have been used to incise a urination channel in the urethra after a thermotherapy procedure. The urination channel allows for an earlier removal of the catheter.

The HoLRP procedure (holmium laser resection of the prostate), has recently been developed, and uses laser light from a holmium laser system to remove the targeted prostatic tissue. The laser light is transmitted through an optical fiber inserted through the resectoscope to the targeted prostatic tissue. The laser light cuts the excess tissue from the interior of the prostate

in much the same way as the electrosurgical loop in TURP, while coagulating the underlying tissue. The excised pieces of prostatic tissue are carried by irrigation fluid flowing through the resectoscope into the bladder. At the end of the operation, these pieces of excised prostatic tissue are
5 flushed, aspirated, or grasped and removed from the bladder (and/or from the urethra (fossa)) in the same manner as the TURP procedure. As discussed above, these pieces of excised prostatic tissue must be of limited size, for removal by irrigation, large bore syringes and/or grasping tools, which can be a time consuming procedure. Further, the surgeon makes as
10 many as 50 to 60 incisions per procedure in order to limit the size of the excised pieces of prostatic tissue, thus increasing the risk of inadvertent damage to surrounding tissue.

All of the above procedures suffer from the limitation that the excised pieces of prostatic tissue must be small enough for removal from the
15 bladder. This limitation requires additional surgeon skill and time in incising the targeted prostatic tissue into small pieces, and more additional time removing all the excised pieces of tissue from the bladder. Prolonging the prostate resection procedure is costly in that it ties up operating room time, and requires the patient to be anesthetized longer thus increasing the risks of
20 this surgical procedure. There is a need for a transurethral prostatic tissue removal method and device that accurately, efficiently and safely incises and removes targeted prostatic tissue from the patient. Ideally, such a method and device would minimize the number of incisions performed by the surgeon, and reduce the time necessary to extract all the excised pieces of
25 tissue from the patient, thus reducing the time the operating room is occupied and the patient is anesthetized.

SUMMARY OF THE INVENTION

The present invention is an improved method and apparatus for transurethral prostate resection. The method and apparatus simplify the
30 resection of prostatic tissue by minimizing the number of the incisions made

into the targeted prostatic tissue, and simplifying the removal process of the excised pieces of tissue by using a novel morcellation probe.

The morcellation device of the present invention for morcellating and removing targeted body tissue from within a patient includes an elongated
5 outer probe tube and an elongated inner probe tube. The outer probe tube defines a first interior channel therein and has a first aperture formed in a sidewall thereof adjacent to an open distal end of the outer probe tube. The inner probe tube defines an aspiration channel therein and has a longitudinal axis and a second aperture formed in a sidewall thereof adjacent to a distal
10 end thereof. The inner probe tube is slidably disposed inside the first interior channel and movable in a reciprocating longitudinal direction parallel to the longitudinal axis and between a first position where the first and second apertures at least partially overlap each other, and a second position where the second aperture is extended at least partially beyond the open
15 distal end and out of the outer probe tube. A proximate end of the inner probe tube is connectable to a vacuum source.

The first aperture has a first cutting edge and the second aperture has second and third opposing cutting edges. The first and second cutting edges pass each other when the inner probe tube moves from the first position to
20 the second position, and the third cutting edge and the open distal end pass each other when the inner probe tube moves from the second position to the first position.

During operation, a portion of the targeted tissue is drawn into the first and second apertures by aspiration caused by a vacuum in the aspiration
25 channel from the vacuum source when the inner probe tube is in the first position, and is cut by the first and second cutting edges passing each other when the inner probe tube moves from the first position to the second position. Another portion of the targeted tissue is drawn into the second aperture by the vacuum when the inner probe tube is in the second position,
30 and is cut by the third cutting edge and open distal end passing each other when the inner probe tube moves from the second position to the first

position. The cut portions of targeted tissue are drawn into and through the aspiration channel.

In another aspect of the present invention, the outer probe tube defines a first interior channel therein and has a first aperture formed in a sidewall thereof adjacent to an open distal end of the outer probe tube. The first aperture has opposing first and second cutting edges. The inner probe tube defines an aspiration channel therein and has a longitudinal axis and a second aperture formed in a sidewall thereof adjacent to a distal end of the inner probe tube. The second aperture has opposing third and fourth cutting edges. The inner probe tube is slidably disposed inside the first interior channel and movable relative to the outer probe tube in a reciprocating longitudinal direction parallel to the longitudinal axis between a proximal and a distal position. The first and second apertures at least partially overlap each other when the inner probe tube is in a medial position that is in-between the proximal and distal positions, and do not overlap each other when the inner probe tube is in the proximal position. The second aperture is extended at least partially beyond the open distal end and out of the outer probe tube when the inner probe tube is in the distal position. The proximate end of the inner probe tube is connectable to a vacuum source.

During operation, a portion of the targeted tissue is drawn into the first and second apertures by aspiration caused by a vacuum in the aspiration channel from the vacuum source when the inner probe tube is in the medial position, and is cut by the first and third cutting edges passing each other when the inner probe tube moves from the medial position to the distal position. Another portion of the targeted tissue is drawn into the second aperture by the vacuum when the inner probe tube is in the distal position, and is cut by the fourth cutting edge and open distal end passing each other when the inner probe tube moves from the distal position toward the proximal position. A further portion of the targeted tissue is drawn into the first and second apertures when the inner probe tube is in the medial position, and is cut by the second and fourth cutting edges passing each other

when the inner probe tube moves from the medial position to the proximal position. The cut portions of targeted tissue are drawn into and through the aspiration channel.

5 In still another aspect of the present invention, a method for
transurethral removal of targeted prostatic tissue from within a patient
includes the steps of inserting a transurethral incisional device through the
patient's urethra, incising off at least one piece of targeted prostatic tissue
using the incisional device, inserting a morcellation probe through the
10 patient's urethra, morcellating the excised piece of targeted prostatic tissue
with the morcellation probe, and aspirating the morcellated prostatic tissue
through the morcellation probe and out of the patient. The morcellation
probe used in this method includes an elongated outer probe tube and an
elongated inner probe tube. The outer probe tube defines a first interior
15 channel therein and has a first aperture formed in a sidewall thereof adjacent
to an open distal end of the outer probe tube. The first aperture has
opposing first and second cutting edges. The inner probe tube defines an
aspiration channel therein and has a longitudinal axis and a second aperture
formed in a sidewall thereof adjacent to a distal end of the inner probe tube.
20 The second aperture has opposing third and fourth cutting edges. The inner
probe tube is slidably disposed inside the first interior channel and movable
relative to the outer probe tube in a reciprocating longitudinal direction
parallel to the longitudinal axis between a proximal position and a distal
position. The first and second apertures at least partially overlap each other
25 when the inner probe tube is in a medial position in-between the proximal
and distal positions, and do not overlap each other when the inner probe tube
is in the proximal position. The second aperture is extended at least partially
beyond the open distal end and out of the outer probe tube when the inner
probe tube is in the distal position. The proximate end of the inner probe
tube is connectable to a vacuum source.

30 During operation, a portion of the targeted tissue is drawn into the
first and second apertures by aspiration caused by a vacuum in the aspiration

channel from the vacuum source when the inner probe tube is in the medial position, and is cut by the first and third cutting edges passing each other when the inner probe tube moves from the medial position to the distal position. Another portion of the targeted tissue is drawn into the second aperture by the vacuum when the inner probe tube is in the distal position, and is cut by the fourth cutting edge and open distal end passing each other when the inner probe tube moves from the distal position toward the proximal position. A further portion of the targeted tissue is drawn into the first and second apertures when the inner probe tube is in the medial position, and is cut by the second and fourth cutting edges passing each other when the inner probe tube moves from the medial position to the proximal position. The cut portions of targeted tissue are drawn into and through the aspiration channel.

Other aspects and features of the present invention will become apparent by a review of the specification, claims and appended figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is a side view of the transurethral resectoscope with an optical fiber.

5 **Fig. 1B** is a cross-sectional end view of the transurethral resectoscope with an optical fiber.

Fig. 1C is a side view of the transurethral resectoscope with an electrosurgical device.

Fig. 1D is a perspective view of the telescope used with the transurethral resectoscope.

10 **Fig. 2A** is a side view of the transurethral morcellation scope of the present invention.

Fig. 2B is a perspective view of the transurethral morcellation scope of the present invention.

15 **Fig. 2C** is a cross-sectional end view of the transurethral morcellation scope of the present invention.

Fig. 3A is a perspective view of the morcellation probe of the present invention.

Fig. 3B is a cross-sectional view of the morcellation probe of the present invention.

20 **Fig. 4A** is a top view of the distal end of the outer tube for the morcellation probe.

Fig. 4B is a top view of the distal end of the inner tube for the morcellation probe.

25 **Figs. 5A-5C** are side cross-sectional views of the morcellation probe distal end, illustrating the different positions of the reciprocating inner tube.

Figs. 6A-6C are side cross-sectional views of the morcellation probe distal end, illustrating the cutting action of the inner and outer tubes.

Figs. 7A/B are top views of an alternate embodiment of the morcellation probe of the present invention.

30 **Figs. 8A/B** are top views of a second alternate embodiment of the morcellation probe of the present invention.

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Figs. 9A/B are top views of a third alternate embodiment of the morcellation probe of the present invention.

Figs. 10A/B are top views of a fourth alternate embodiment of the morcellation probe of the present invention.

5 **Figs. 11A/B** are top views of a fifth alternate embodiment of the morcellation probe of the present invention.

Figs. 12A/B are top views of a sixth alternate embodiment of the morcellation probe of the present invention.

10 **Figs. 13A/B** are top views of a seventh alternate embodiment of the morcellation probe of the present invention.

Figs. 14A/B are top views of a eighth alternate embodiment of the morcellation probe of the present invention.

Figs. 15A/B are top views of a ninth alternate embodiment of the morcellation probe of the present invention.

15 **Figs. 16A/B** are top views of a tenth alternate embodiment of the morcellation probe of the present invention.

Figs. 17A/B are top views of a eleventh alternate embodiment of the morcellation probe of the present invention.

20 **Figs. 18A/B** are top views of a twelfth alternate embodiment of the morcellation probe of the present invention.

Figs. 19A/B are top views of a thirteenth alternate embodiment of the morcellation probe of the present invention.

Figs. 20A/B are top views of a rotating morcellation probe embodiment of the present invention.

25 **Figs. 21A/B** are top views of an auger type morcellation probe embodiment of the present invention.

Figs. 22A-22D are side cross-sectional views of a fourteenth alternate embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is a method and apparatus for transurethral resection of the prostate, which includes incising off pieces of targeted prostatic tissue, and morcellating the excised pieces of prostatic tissue for aspiration out of the patient.

5 In the preferred embodiment, the incising step is performed using optical energy delivered by a transurethral resectoscope 1 as shown in Figs. 1A and 1B. Resectoscope 1 includes an inner sheath 2 surrounded by an outer sheath 4, with an aspiration channel 6 formed therebetween. A port 8 is located at the proximate end 5 of outer sheath 4, and is connected to an aspiration line 10 that connects to a vacuum source 26. The vacuum source 10 26 is a mechanical pump capable of creating a variable vacuum, and with a tissue trap 30 to collect tissue and fluids aspirated from the patient. Alternately, the vacuum source 26 is a gravity drainage system that can provide a variable vacuum based upon its height below the resectoscope 1.

15 Inner sheath 2 forms an irrigation channel 28 therein that terminates with irrigation port 25. Irrigation line 24 connects to port 25 to an irrigation source 12, which provides suitable irrigation fluid through irrigation line 24, channel 28, and out the delivery end 13 of the outer sheath 4. The proximate end 3 of inner sheath 2 attaches to and forms a seal with proximate end 5 of outer sheath 4.

20 A telescope 14 includes a viewing channel 17 surrounded by a plurality of optical fibers 19, as best illustrated in Fig. 1D. The telescope 14 inserts through proximate end 3 and extends along the inside length of the inner sheath 2. The proximate end of telescope 14 includes an eyepiece 16 for viewing down the viewing channel 17, and an illumination port 18. The 25 optical fibers 19 extend from illumination port 18, down the outside of viewing channel 17 and terminate at the distal end of telescope 14. A light source (not shown) connects to the illumination port 18 to illuminate the area beyond the distal end of telescope 14 via the optical fibers 19.

30 An optical fiber 20 is attached at one end to laser system 22. The fiber 20 extends through a input port 21, along the inside length of the inner

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sheath 2, and out the delivery end 13 of outer sheath 4. The delivery end 23 of optical fiber 20 can direct the laser energy out longitudinally (end firing fiber) or laterally (side firing fiber). The optical fiber 20 can be held in place by a wire loop, metal strap, or any equivalent thereof attached near the end, or along the length, of inner sheath 2.

The laser system 22 can be any laser system operating with a wavelength between approximately 200 nm and 3.0 um. Preferably, laser system 22 is a holmium laser that operates at 2.1 um, with 2-2.8 joules per pulse running at 25 Hz or higher. Alternately, laser system 22 could be an erbium laser system operating at 2.94 or 2.71 um, or an Nd:Yag laser operating at 1064 nm, or a doubled Nd:Yag laser system using, for example, a KTP doubling configuration operating at 532 nm.

Under the method of the present invention, the resectoscope 1 is inserted through the patient's urethra until the delivery end 13 is adjacent the targeted prostatic tissue. The irrigation source 12 and vacuum source 26 are activated to provide irrigation and aspiration (suction) at the delivery end 13. The combination of irrigation and aspiration maintains a clean environment for the procedure, and a clear field of view for the surgeon.

The surgeon, viewing through the eyepiece 16, positions the delivery end 23 of fiber 20 adjacent the tissue to be incised. Feeding the fiber 20 through input port 21 extends the delivery end 23 of fiber 20 further away from the delivery end 13 of outer sheath 4. The laser system 22 is activated and the targeted prostatic tissue is incised using the optical energy exiting the optical fiber 20. The targeted prostatic tissue can be incised and separated from the surgical capsule either in its entirety, or in relatively large pieces. It is preferable to incise the targeted prostatic tissue off in its entirety to minimize the number of incisions made during the procedure. Further, by making one continuous incision along the capsule (wall of the prostate), it is much easier to visualize and incise along the margin between the prostatic tissue to be resected and the capsule wall.

The excised pieces of prostatic tissue are then pushed into the bladder either by the irrigation fluid exiting the distal end of inner sheath 2, or by manually pushing the tissue with delivery end 13 of outer sheath 4. It is preferable to position the excised pieces of prostatic tissue in the bladder so that morcellation removal of this tissue can be performed in the relatively large and safe space of the bladder, to minimize the risk of damaging adjacent tissue.

Although incising the targeted prostatic tissue with laser energy provides superior results compared to TURP (less bleeding and catheterization time), an electrosurgical device 110 can be used with resectoscope 1 as the incisional device to incise the targeted prostate tissue, as illustrated in Fig. 1C, instead of using optical fiber 20 and laser system 22. The electrosurgical device 110 includes two leads 112 connected together at their distal ends with an electrosurgical cutting loop 114. The leads 112 extend through the input port 21, along the inside length of the inner sheath 2, and out the delivery end 13 of outer sheath 4 (the same path as optical fiber 20 in the embodiment of Figs. 1A/B). The proximate ends of leads 112 are connected to a power source 116, for passing electrical current through leads 112. Handle assembly 118, through which leads 112 pass, slides along telescope 14. By grasping handle assembly 118 and handle 120 (attached to proximate end 3 of inner sheath 2), the leads 112 are fed through port 21 to retract and project loop 114 in and out relative to delivery end 13 of outer sheath 4. When the power source 116 is activated, electrical current passes through leads 112 and loop 114, which then becomes an efficient cutting tool for incising the targeted prostatic tissue. The electrically energized loop 114 is used to incise off large pieces of the targeted prostatic tissue.

After all the targeted prostatic tissue has been incised off and pushed into the bladder, the resectoscope 1 is replaced with, or reconfigured into, the morcellation scope 50 illustrated in Figs. 2A-2C.

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Morcellation scope 50 includes the same outer sheath 4, port 8, line 24, irrigation source 12, vacuum source 26, line 10 and telescope 14 as the resectoscope 1. However, line 24 from irrigation source 24 is connected to port 8, and thus aspiration channel 6 of resectoscope 1 becomes irrigation channel 29 inside outer sheath 4.

Morcellation scope 50 also includes a morcellation probe 52, as illustrated in Figs. 3A-3B, having a motor assembly 58, and an inner tube 54 slidably disposed inside an outer tube 56. Tubes 54/56 extend inside and along the length of outer sheath 4. The proximate end of outer tube 56 mounts to the motor assembly 58 via a threaded locking nut 59 that engages a bushing 63 attached to the outer tube 56.

The inner tube 54 extends through motor assembly 58, with the proximate end thereof protruding out the back side of motor assembly 58 with a downward bend to allow clearance for the eyepiece 16. Aspiration line 24 from vacuum source 26 connects to the proximate end of the inner tube 54. Inner tube 54 defines an aspiration channel 64 therein. The distal end 55 of inner tube 54, and the distal end 57 of outer tube 56, extend out the delivery end 13 of the outer sheath 4.

The telescope 14 inserts through a telescope guide channel 61 in the motor assembly 58, and extends through outer sheath 4 parallel to inner/outer tubes 54/56. A seal 62 attaches to the proximate end 5 of outer sheath 4 and forms a seal around telescope 14 and outer tube 56 to prevent irrigation fluid from leaking therefrom. Preferably, seal 62 fixably clamps telescope 14 to outer sheath 4, while allowing outer tube 56 to slide freely relative to outer sheath 4. The motor assembly 58 is then freely slidable along telescope 14 between the illumination port 18 and proximate end 5 of outer sheath 4. Sliding the motor assembly 58 along the telescope 14 extends and retracts the distal end 57 of outer tube 56 relative to the delivery end 13 of outer sheath 4.

In the preferred embodiment of morcellation probe 52, the motor assembly 58 includes a motor 60 that rotates a cam 90, which in turn drives

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a cam lever 92 in a reciprocating motion, as best illustrated in Fig. 3B. The cam lever 92 is engaged with a pin 94, which engages with a bushing 96 that is attached to the inner tube 54. Rotation of the cam 90 by motor 60 drives the inner tube 54 in a reciprocating motion within outer tube 56. Pin 94 can be disengaged from bushing 96 by movement of push button 98, which
5 pushes down on end-flange 100 of pin 94. Once pin 94 is disengaged from bushing 96, inner tube 54 can be removed from the motor assembly 58 and the outer tube 56 (i.e. for replacement, sterilization, etc).

The distal ends 55/57 of inner/outer tube 54/56 are illustrated in Figs. 4A and 4B. An aperture 66 is formed adjacent the distal end 57 of outer tube 56, with cutting edges 68a and 68b. Ports 70 are formed adjacent to the cutting edges 68a/b. An aperture 72 is formed adjacent the distal end 55 of inner tube 54, with cutting edges 74a and 74b.
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During the reciprocating motion of the inner tube 54, the inner tube 54 travels between three positions: a retracted position (Fig. 5A), a medial position (Fig. 5B), and an extended position (Fig. 5C). In the medial position, the apertures 66 and 72 fully overlap each other, thus providing direct access to the aspiration channel 64. In the retracted and extended positions, the inner tube 54 seals aperture 66 and one of the ports 70, while
15 providing access to aspiration channel 64 through the other of the ports 70.
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Ideally, the diameter of the outer tube 56 is tapered down in diameter near distal end 57, as shown in Fig. 4A. Tapering down outer tube 56 isolates and reduces the running friction between the outer tube 56 and inner tube 54 and achieves a tight, small diametrical tolerance between the inner and outer tube 54/56 adjacent the tube ends 55/57, which enhances the cutting action of the reciprocating motion between these tubes. By limiting the precise, tight clearance between tubes 54/56 to the length of the tapered section of outer tube 56, fabrication costs are reduced, the device is less sensitive to slightly bent or deflected tubes 54/56, and binding of inner tube 54 inside outer tube 56 is prevented.
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A control box 75, connected to a footswitch 76, operates the vacuum source 26 and motor 60. Slightly depressing the footswitch 76 activates the vacuum source 24 to create a low level aspiration action (suction) through apertures 66/72 and ports 70. Depressing the footswitch further increases the vacuum from source 24, and thereby increases the aspiration action through apertures 66/72 and ports 70. Further depression of the footswitch causes the motor 60 to activate and drive the inner tube 54 in the reciprocation motion at a predetermined rate relative to the outer tube 56. Gradually increasing the depression of footswitch 76 results in a gradual increase in the vacuum from source 24 and/or the speed of reciprocation of the inner tube 54 by motor 60. The control box 75 can be set to provide the desired combination of suction and motor speed at various positions of the footswitch 76.

The morcellation procedure of the present inventive method is carried out by inserting the morcellation scope 50 through the urethra until the delivery end 13 is positioned in the bladder. The irrigation source 12 is then activated. The surgeon, viewing through the eyepiece 16, locates a piece of prostatic tissue that had previously been deposited in the bladder. By activating the vacuum source 26 at a low vacuum setting with footswitch 76 and positioning the distal end 57 of outer tube 56 adjacent the targeted piece of prostate, the low level aspiration action of the probe draws the tissue to, and attaches the tissue against, the apertures 66/72 and ports 70. The surgeon then re-positions the distal end 57 of outer probe 56, with the target tissue attached thereto, toward the center of the bladder, where it is safe to operate the morcellation probe without damaging surrounding tissue.

Once the tissue and outer probe tube distal end 57 are positioned away from the bladder walls, the surgeon depresses the footswitch 76 further until motor 60 is activated at the desired speed. The reciprocating action of inner tube 54 together with the aspiration from the vacuum source 26 efficiently morcellates the targeted prostatic tissue (cuts the tissue into very small pieces), and aspirates the targeted tissue from the patient. As

illustrated in Figs. 6A-6C, when the apertures 66/72 become misaligned (for example during movement from the medial position to the extended position), the small portion of tissue 102 drawn into the apertures 66/72 is cut by the approaching cutting edges 74a and 68b, and aspirated out of the patient via the aspiration channel 64 and aspiration line 24. The ports 70 function to manipulate the targeted tissue position by maintaining continuous aspiration adjacent aperture 66. The continuous aspiration prevents the targeted tissue mass 102 from disengaging from aperture 66 so that upon reverse reciprocal motion of inner tube 54, another portion of the tissue mass 102 will be drawn through apertures 68/72 for cutting/aspiration using cutting edges 74b and 68a. The surgeon need only maintain the position of the distal end 57 of tube 56 away from the bladder walls and allow the morcellation probe 52 to efficiently and quickly morcellate the target tissue 102 bit by bit until fully morcellated and aspirated out of the patient. Once the tissue is fully aspirated out of the patient, the footswitch is released to cease the reciprocation motion of inner tube 54 and to lower the aspiration to a safe level, so that the next piece of excised prostatic tissue can be retrieved and morcellated.

During each reciprocation cycle of the inner tube 54, two cutting actions occur. When the inner tube 4 reaches the retracted position of Fig. 5A or the extended position of Fig. 5C, aperture 66 is momentarily sealed. Continuous aspiration provided through ports 70 positioned on either side of aperture 66 helps maintain a position of the targeted tissue mass 102 that is disposed over aperture 66. This positioning of the target tissue maximizes the morcellation efficiency, and maintains the tissue attachment to outer tube 56, which prevents the surgeon from having to cease the motor operation to retrieve dislodged pieces of target tissue.

Also during each cycle, cutting edges 74a and 74b alternately pass and seal ports 70 at different times. This cutting and sealing action at ports 70 serves an important self cleaning function, so that any tissue or debris that may clog the ports 70 is cut and aspirated, or released. If one of ports

70 becomes clogged, then continuous aspiration may be lost, which could result in disengagement of the target tissue 102 from the probe 52, thus reducing morcellation efficiency.

5 Ideally, outer sheath 4 is inserted into the urethra only once during the prostate resection procedure. Therefore, resectoscope 1 can be reconfigured to morcellation scope 50 without removing outer sheath 4 from the patient. After the targeted prostatic tissue is incised and pushed into the bladder with the resectoscope 1, the inner sheath 2 (containing the telescope 14 and either the optical fiber 20 or electrosurgical leads 112 and loop 114) is detached from, and slid rearwardly out of, outer sheath 4. The telescope 14 is removed from inner sheath 2 and inserted through telescope guide channel 61 in the motor assembly 58. The aspiration line is detached from port 8 and attached to the proximate end of inner tube 54. The irrigation line is detached from port 25 and attached to port 8. Seal 62 is then placed over the telescope 14 and outer tube 56. Telescope 14 and outer tube 56 are inserted into the outer sheath 4, whereby seal 62 is affixed to the proximate end 5 of outer sheath 4 for sealing the telescope 14 and outer tube 56 in place.

20 The aspiration apertures 66 and 72, and ports 70, can have various shapes and configurations. For maximum morcellation efficiency, these various shapes and configurations should maintain the continuous aspiration adjacent aperture 66 throughout the reciprocating motion of the inner tube 54, while incorporating the self-cleaning feature of closing off any apertures or ports in the outer tube 56 at least once during the reciprocating cycle.

25 For example, Figs. 7A and 7B illustrate slots 78 formed continuously with aperture 66, for providing continuous aspiration. Alternately, the cutting edges 68a/b of aperture 66 can be angled relative to cutting edges 74a/b as shown in Figs. 8A and 8B, which decreases the peak cutting power required to cut tissue by cutting tissue in a continuous scissor-like action, instead of the relatively instantaneous cutting action from parallel cutting edges passing each other. For even more cutting power, the cutting edges 74a/b can be

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angled in the opposite direction as the angled cutting edges 68a/b of aperture 66 as shown in Figs. 9A and 9B. Apertures 66/72 can instead be circular shaped, as shown in Figs. 10A/B.

5 A second aperture 66 or 72 can be formed on outer/inner tubes 56/54, as shown in Figures 11A/B, 12A/B, 14A/B and 15A/B, to increase the cutting action per cycle. If multiple apertures formed on the same inner or outer tube 54/56 are close enough together, and the travel of inner tube 54 is limited to maintain continuous aspiration, ports 70 can be eliminated (i.e. Figs. 11A/B).

10 The shape and numbers of apertures 66 and 72, and ports 70, formed on outer/inner tubes 56/54 can be varied to achieve the desired cutting action, as illustrated in Figs. 13A/B, 14A/B, 15A/B, 16A/B and 17A/B. The cutting edges can be non-linear (Figs. 10A/B, 13A, 14A, and 15A/B) or irregularly shaped (Fig. 17A) to provide varying cutting angles between the
15 cutting edges 68a and 74b, and/or between 68b and 74a, during one or both cutting actions per reciprocation cycle of inner tube 54.

If additional fluid is needed to aspirate the morcellated tissue without clogging aspiration channel 64, additional ports 70 can be added to inner/outer tubes 54/56, as illustrated in Figs. 18A/B. These additional
20 ports 70 should be located away from aperture 66, for example on the opposing underneath side of inner/outer tubes 54/56, such that they do not manipulate the targeted tissue. The additional ports 70 will supply additional fluid to the aspiration channel 64 when in a fluid environment to prevent blockage thereof without manipulating the targeted tissue being morcellated
25 by apertures 66/72. These additional ports 70 should be sealed at least once per reciprocation cycle to prevent clogging thereof.

It should be noted that it is well within scope of the present invention to combine different variations of the patterns of apertures/ports illustrated herein to achieve the desired cutting action of the morcellation probe 52.
30 For example, any or all apertures and ports shown on outer tube 56 can instead be formed on inner tube 54, and vice versa (i.e. one or both ports 70

in Figs. 4A/B etc. can be formed on inner tube 54 instead of outer tube 56, or apertures 66 of Fig. 15A can be formed on inner tube 54 and aperture 72 of Fig. 15B can be formed on outer tube 56, etc.). Further, part or all of the aperture/port pattern of inner tube 54 in one figure can be used with part
5 or all of the aperture/port pattern of outer tube 56 in other figure (i.e. inner tube 54 of Fig. 10B can be used with outer tube 56 of Fig. 11A). Moreover, additional sets of aperture and port patterns can be added to those illustrated in the figures, either longitudinally along, or rotatably around, tubes 54/56. For example, the apertures and ports of Figs. 7A/B could
10 formed on a top side of inner/outer tubes 54/56, and the apertures and ports of Figs. 8A/B could be formed on an opposing bottom side of the inner/outer tubes 54\56. Lastly, for some applications, it may be possible to have a single port 70 as shown in Figs. 19A\B and either limit travel of the inner tube 54 to not seal aperture 66 when the inner tube is in the retracted
15 position, or have intermittent loss of continuous aspiration once per cycle while still maintaining proper tissue position (i.e. through very high repetition rates in conjunction with the single port 70).

While the preferred embodiment of morcellation probe 52 has been described above as longitudinally reciprocating the inner tube 54 relative to
20 the outer tube 56, the scope of the present invention also includes using a rotating morcellator, where inner tube 54 spins about its longitudinal axis relative to outer tube 56. For a rotating morcellator, the aperture/port patterns illustrated in Figs. 4A/B and 7A/B-19A/B are formed around tubes 54/56 instead of along the longitudinal length of tubes 54/56 (i.e. the
25 patterns are rotated 90°). For example, Figs. 20A/B illustrate the 90° reorientation of the aperture/ports patterns shown in Figs. 4A/B. Therefore, as inner tube 54 rotates relative to outer tube 56, tissue drawn into the apertures 66/72 is cut by the approaching cutting edges 68a and 74b, and cutting edges 68b and 74a. Motor 60 rotates inner tube 54 about its
30 longitudinal axis either continuously in one direction, or in an oscillating fashion. To maintain constant aspiration where the inner tube 54 rotates

continuously in one direction, the aperture/port patterns can be formed all the way around the inner/outer tubes 54/56. If the inner tube 54 rotationally oscillates, then constant aspiration is achieved by rotating between two rotational positions in the same manner as longitudinally reciprocating
5 between the two extended/retracted positions as described above.

Figures 21A/B illustrate another embodiment of the present invention: an auger type morcellation probe 52. Outer tube 56 has an aperture 66 with cutting edges 122. A spiral shaped groove 124 is formed on the outer surface of inner tube 54, either along its entire length or preferably on just a
10 portion near its distal end. The spiral shaped groove 124 forms a continuous cutting edge 126 for cutting tissue against cutting edges 122 of aperture 66. One or more aspiration ports 128 are formed in groove 124 (preferably at the bottom of groove 124) and are continuous with aspiration channel 64. Fluid ports 130 can be formed in outer tube 56, located away from aperture
15 66 (i.e. on the opposing underneath side of outer tube 56) for supplying additional fluid to aspiration ports 128 without manipulating the targeted tissue outside aperture 66. When the inner tube 54 is rotated about its longitudinal axis relative to outer tube 56 in the direction of arrow A, tissue drawn into aperture 66 is cut by cutting edge 126 passing beyond cutting
20 edges 122. The cut tissue is drawn along groove 124, through aspiration ports 128, and out through aspiration channel 64. Continuous aspiration through aperture 66 is preserved because at least some portion of groove 124 is exposed to aperture 66 at all times. Aperture 66 can have any of the aperture/ports shapes illustrated in Figs. 7A/B-20A/B. Alternately, inner
25 tube can have no ports 128 (and even be a solid tube with no aspiration channel 64 therein). In that case, the vacuum source is attached to the motor assembly 58 or outer tube 56 to provide a vacuum between inner tube 54 and outer tube 56, whereby the cut tissue is aspirated by being drawn along groove 124, between inner and outer tubes 54/56, and out to the vacuum
30 source 26.

Figs. 22A-22D illustrate one last embodiment of the present invention. In this embodiment, the distal ends of inner/outer tubes 54/56 are the same as illustrated in Figs. 5A-5C, except that there are no aspiration ports 70, and the distal end 57 of outer tube 56 is open instead of closed to form a cutting edge. During the reciprocating motion of the inner tube 54, the distal end 55 of the inner tube 54 travels out through the open distal end 57 of the outer tube 56 to provide three cutting actions per cycle instead of two. Fig. 22A illustrates the first cutting action where cutting edges 74a and 68b pass each other as the inner tube 54 travels toward the open distal end 57 of outer tube 56. Fig. 22B illustrates the distal end 55 of inner tube 54 protruding from the open distal end 57 of outer tube 56. Fig. 22C illustrates the second cutting action where cutting edge 74b and distal end 57 pass each other as the inner tube 54 retracts back inside of outer tube 56. Fig. 22D illustrates the third cutting action where cutting edges 74b and 68a pass each other as the inner tube 54 further retracts into outer tube 56.

This last embodiment has the advantage of providing three cutting actions instead of two per reciprocating cycle. During each cutting action, tissue is drawn into aperture 72, after which cutting edges sever the tissue so that it can be aspirated out of the patient via the aspiration channel 64 and aspiration line 24. With the additional cutting action (total of three) per reciprocating cycle, in most cases the tissue is properly held in place without the need for aspiration ports.

It is to be understood that the present invention is not limited to the embodiments described above and illustrated herein, but encompasses any and all variations falling within the scope of the appended claims. For example, the surgeon may wish to morcellate some of the excised prostatic tissue while still positioned in the urethra, without pushing the excised prostatic tissue into the bladder. Further, it is conceivable to add the morcellation probe 52 to the resectoscope 1 for either simultaneous or alternate prostatic tissue incision and morcellation, without reconfiguring between scopes 1 and 52 between these steps. Lastly, the embodiment of

Figs. 22A-22D can have shaped apertures 66/72, and the amount of movement of inner tube 54 can be reduced to eliminate the third cutting action between cutting edges 74b and 68a in an effort to selectively reduce the overall cutting action of the morcellating probe per reciprocating cycle.

CLAIMS

What is claimed is:

1. A morcellation device for morcellating and removing targeted body tissue from within a patient, comprising:

5 an elongated outer probe tube defining a first interior channel therein and having a first aperture formed in a sidewall thereof adjacent to an open distal end of said outer probe tube;

10 an elongated inner probe tube defining an aspiration channel therein and having a longitudinal axis and a second aperture formed in a sidewall thereof adjacent to a distal end of said inner probe tube, said inner probe tube is slidably disposed inside said first interior channel and movable in a reciprocating longitudinal direction parallel to said longitudinal axis and between a first position where said first and second apertures at least partially overlap each other and a second position where said second aperture is extended at least partially beyond the open distal end and out of said outer probe tube, a proximate end of said inner probe tube being connectable to a vacuum source; and

15 said first aperture having a first cutting edge and said second aperture having second and third opposing cutting edges, wherein said first and second cutting edges pass each other when said inner probe tube moves from said first position to said second position, and said third cutting edge and said open distal end passing each other when said inner probe tube moves from said second position to said first position;

wherein during operation:

25 a portion of the targeted tissue is drawn into said first and second apertures by aspiration caused by a vacuum in said aspiration channel from the vacuum source when said inner probe tube is in said first position, and is cut by said first and second cutting edges passing each other when said inner probe tube moves from said first position to said second position, and

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another portion of the targeted tissue is drawn into said second aperture by the vacuum when said inner probe tube is in said second position, and is cut by said third cutting edge and open distal end passing each other when said inner probe tube moves from said

5 second position to said first position,

the cut portions of targeted tissue being drawn into and through said aspiration channel.

2. The morcellation device as recited in claim 1, wherein said first and second cutting edges are non-parallel to each other.

10 3. The morcellation device as recited in claim 1, wherein at least one of said first, second, and third cutting edges is arc shaped.

4. The morcellation device as recited in claim 2, wherein at least one of said first and second cutting edges is non-linearly shaped to provide a varying cutting action as said inner tube moves from said first position to

15 said second position.

5. The morcellation device as recited in claim 1, further comprising:

a motor assembly having a motor, said motor assembly connected to a proximate end of said outer probe tube, said motor connected to said inner

20 probe tube for driving said inner probe tube in said reciprocating longitudinal movement relative to said outer probe tube.

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6. The morcellation device as recited in claim 5, further comprising:

a cam attached to said motor;

5 a pin engaged with said cam and removably engaged with said inner probe tube, wherein said motor rotates said cam which in turn drives said pin in a reciprocating movement, said pin is disengageable from said inner probe tube for removal of said inner probe tube from said morcellation device.

7. The morcellation device as recited in claim 5, wherein said
10 motor assembly has a telescope port for inserting a telescope parallel to said inner and outer probe tubes.

8. The morcellation device as recited in claim 7, further comprising:

15 an irrigation fluid source that provides irrigation fluid into an irrigation line; and

20 an outer sheath tube defining an irrigation channel in fluid communication with an irrigation port connected to said irrigation line, said outer sheath tube surrounding said telescope and said outer probe tube with an open end adjacent to said outer probe tube distal end for directing the irrigation fluid thereto.

9. The morcellation device as recited in claim 5, further comprising:

5 a footswitch connected to said motor and connectable to the vacuum source for controlling said motor and the vacuum source, wherein when said footswitch is slightly depressed, the vacuum source is activated to create a low level vacuum in said aspiration channel, and when said footswitch is depressed to a mid-position said motor is activated to drive said inner probe tube in said movement relative to said outer probe tube, wherein as said footswitch is gradually depressed beyond said mid-position, said motor and vacuum source are controlled to gradually increase the motor speed and aspiration channel vacuum.

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10. The morcellation device as recited in claim 1, wherein said outer probe tube is tapered down in diameter adjacent said distal end of said outer probe tube.

15 11. The morcellation device as recited in claim 1, wherein:
the first aperture has a fourth cutting edge opposing the first cutting edge, and

the inner probe tube is movable to a proximal position at which the entire second aperture is located proximal to said first aperture, such that during the operation, still yet another portion of the targeted tissue is drawn into said first and second apertures by aspiration caused by a vacuum in said aspiration channel from the vacuum source when said inner probe tube is in said first position, and is cut by said third and fourth cutting edges passing each other when said inner probe tube moves from said first position to said proximal position.

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12. A morcellation device for morcellating and removing targeted body tissue from within a patient, comprising:

an elongated outer probe tube defining a first interior channel therein and having a first aperture formed in a sidewall thereof adjacent to an open distal end of said outer probe tube, said first aperture having opposing first and second cutting edges;

an elongated inner probe tube defining an aspiration channel therein and having a longitudinal axis and a second aperture formed in a sidewall thereof adjacent to a distal end of said inner probe tube, said second aperture having opposing third and fourth cutting edges, wherein:

said inner probe tube is slidably disposed inside said first interior channel and movable relative to said outer probe tube in a reciprocating longitudinal direction parallel to said longitudinal axis between a proximal position and a distal position,

said first and second apertures at least partially overlap each other when said inner probe tube is in a medial position that is in-between the proximal and distal positions, and do not overlap each other when said inner probe tube is in said proximal position,

said second aperture is extended at least partially beyond the open distal end and out of said outer probe tube when said inner probe tube is in said distal position, and

a proximate end of said inner probe tube is connectable to a vacuum source;

wherein during operation:

a portion of the targeted tissue is drawn into said first and second apertures by aspiration caused by a vacuum in said aspiration channel from the vacuum source when said inner probe tube is in said medial position, and is cut by said first and third cutting edges passing each other when said inner probe tube moves from said medial position to said distal position,

another portion of the targeted tissue is drawn into said second aperture by the vacuum when said inner probe tube is in said distal position, and is cut by said fourth cutting edge and open distal end passing each other when said inner probe tube moves from said distal position toward said proximal position, and

a further portion of the targeted tissue is drawn into said first and second apertures when said inner probe tube is in said medial position, and is cut by said second and fourth cutting edges passing each other when said inner probe tube moves from said medial position to said proximal position;

the cut portions of targeted tissue being drawn into and through said aspiration channel.

13. The morcellation device as recited in claim 12, wherein said first and third cutting edges are non-parallel to each other.

14. The morcellation device as recited in claim 12, wherein said second and fourth cutting edges are non-parallel to each other.

15. The morcellation device as recited in claim 12, wherein at least one of said first, second, third and fourth cutting edges is arc shaped.

16. The morcellation device as recited in claim 12, wherein at least one of said first, second, third and fourth cutting edges is non-linearly shaped to provide a varying cutting action as said inner tube moves from said medial position to one of said proximal and distal positions.

17. The morcellation device as recited in claim 12, further comprising:

5 a motor assembly having a motor, said motor assembly connected to a proximate end of said outer probe tube, said motor connected to said inner probe tube for driving said inner probe tube in said reciprocating longitudinal direction relative to said outer probe tube.

18. The morcellation device as recited in claim 17, further comprising:

a cam attached to said motor;

10 a pin engaged with said cam and removably engaged with said inner probe tube, wherein said motor rotates said cam which in turn drives said pin in a reciprocating direction, said pin is disengageable from said inner probe tube for removal of said inner probe tube from said morcellation device.

15 19. The morcellation device as recited in claim 17, wherein said motor assembly has a telescope port for inserting a telescope parallel to said inner and outer probe tubes.

20. The morcellation device as recited in claim 19, further comprising:

20 an irrigation fluid source that provides irrigation fluid into an irrigation line; and

25 an outer sheath tube defining an irrigation channel in fluid communication with an irrigation port connected to said irrigation line, said outer sheath tube surrounding said telescope and said outer probe tube with an open end adjacent to said outer probe tube distal end for directing the irrigation fluid thereto.

21. The morcellation device as recited in claim 17, further comprising:

5 a footswitch connected to said motor and connectable to the vacuum source for controlling said motor and the vacuum source, wherein when said footswitch is slightly depressed, the vacuum source is activated to create a low level vacuum in said aspiration channel, and when said footswitch is depressed to a mid-position said motor is activated to drive said inner probe tube in said movement relative to said outer probe tube, wherein as said footswitch is gradually depressed beyond said mid-position, said motor and vacuum source are controlled to gradually increase the motor speed and aspiration channel vacuum.

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22. The morcellation device as recited in claim 12, wherein said outer probe tube is tapered down in diameter adjacent said distal end of said outer probe tube.

15 23. A method for transurethral removal of targeted prostatic tissue from within a patient, comprising the steps of:

inserting a transurethral incisional device through the patient's urethra;

20 incising off at least one piece of targeted prostatic tissue using the incisional device;

inserting a morcellation probe through the patient's urethra; morcellating the excised piece of targeted prostatic tissue with the morcellation probe; and

25 aspirating the morcellated prostatic tissue through the morcellation probe and out of the patient;

wherein the morcellation probe comprises:

an elongated outer probe tube defining a first interior channel therein and having a first aperture formed in a sidewall thereof

adjacent to an open distal end of said outer probe tube, said first aperture having opposing first and second cutting edges;

an elongated inner probe tube defining an aspiration channel therein and having a longitudinal axis and a second aperture formed in a sidewall thereof adjacent to a distal end of said inner probe tube, said second aperture having opposing third and fourth cutting edges, wherein:

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said inner probe tube is slidably disposed inside said first interior channel and movable relative to said outer probe tube in a reciprocating longitudinal direction parallel to said longitudinal axis between a proximal position and a distal position,

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said first and second apertures at least partially overlap each other when said inner probe tube is in said medial position and do not overlap each other when said inner probe tube is in said proximal position,

20

said second aperture is extended at least partially beyond the open distal end and out of said outer probe tube when said inner probe tube is in said distal position, and

a proximate end of said inner probe tube is connectable to a vacuum source;

wherein during operation:

25

a portion of the excised piece of targeted prostatic tissue is drawn into said first and second apertures by aspiration caused by a vacuum in said aspiration channel from the vacuum source when said inner probe tube is in said medial position, and is cut by said first and third cutting edges passing each other when said inner probe tube moves from said medial position to said distal position,

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another portion of the excised piece of targeted prostatic tissue is drawn into said second aperture by the

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vacuum when said inner probe tube is in said distal position, and is cut by said fourth cutting edge and open distal end passing each other when said inner probe tube moves from said distal position toward said proximal position, and

5 a further portion of the excised piece of targeted prostatic tissue is drawn into said first and second apertures when said inner probe tube is in said medial position, and is cut by said second and fourth cutting edges passing each other when said inner probe tube moves from said medial position
10 to said proximal position;

the cut portions of targeted prostatic tissue being drawn into and through said aspiration channel.

24. The method of claim 23, further comprising the step of:
pushing the excised piece of targeted prostatic tissue into the bladder
15 of the patient before the morcellation step, wherein said morcellation step is performed by said morcellation probe inside the patient's bladder.

25. The method of claim 24, further comprising the steps of:
retrieving the excised piece of targeted prostatic tissue within the
patient's bladder with the morcellation probe; and
20 positioning the retrieved piece of prostatic tissue away from the walls of the patient's bladder before the morcellating step.

26. The method of claim 24, wherein the incisional device includes an electrosurgical cutting loop for performing the incising step.

27. The method of claim 24, wherein the incisional device
25 includes an optical fiber having an input end connected to a laser system that generates an optical output and an output end for delivering the optical

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output through the patient's urethra to the targeted prostatic tissue, wherein said incising step is performed by said optical output exiting said output end.

28. The method of claim 27, wherein said laser system is one of an erbium laser system, a holmium laser system, an Nd:Yag laser system and a KTP laser system.

5

29. The method of claim 23, wherein said incising step and said morcellating step are performed substantially simultaneously.

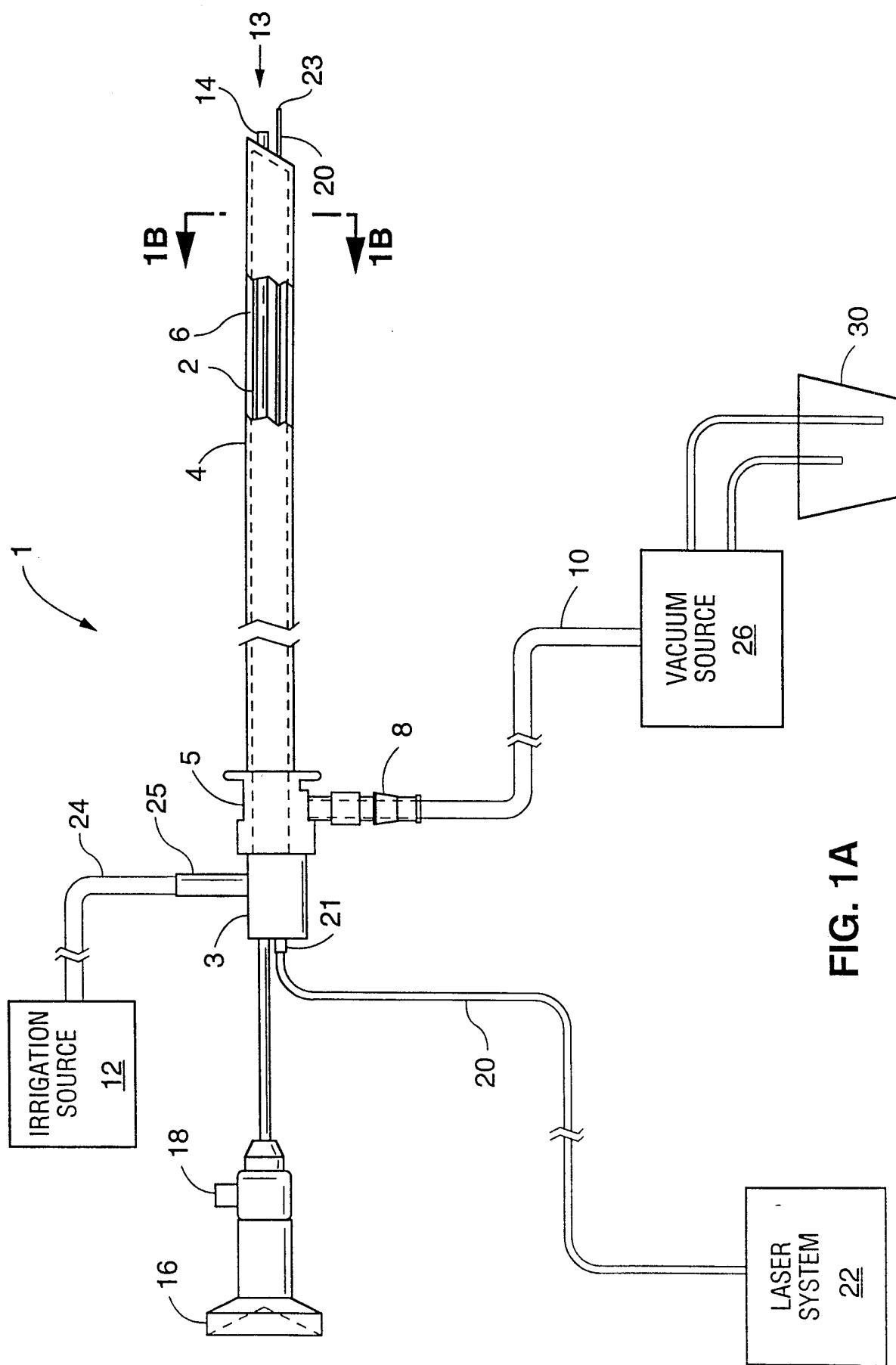


FIG. 1A

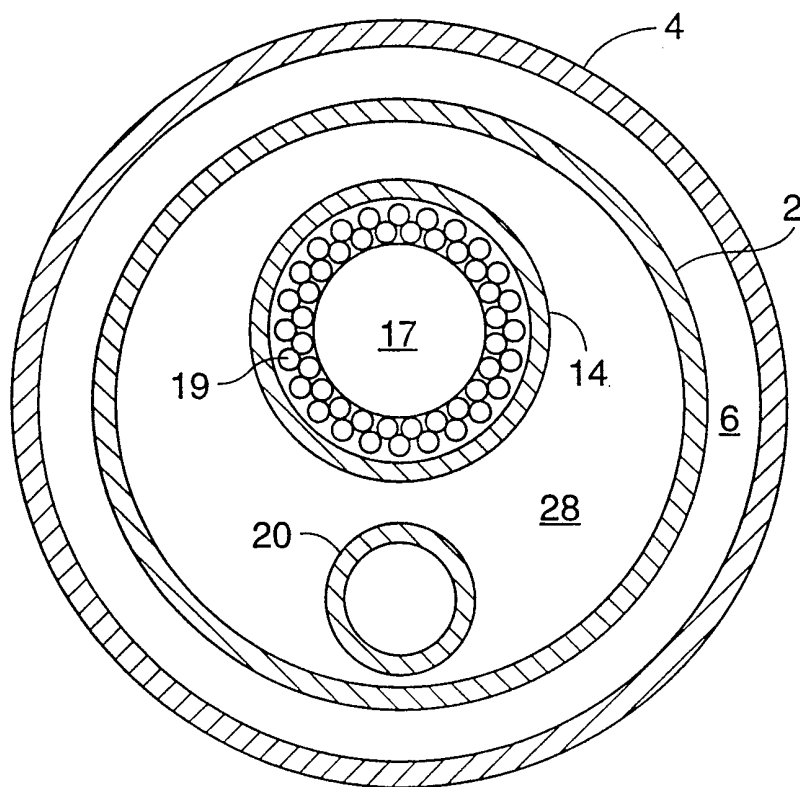


FIG. 1B

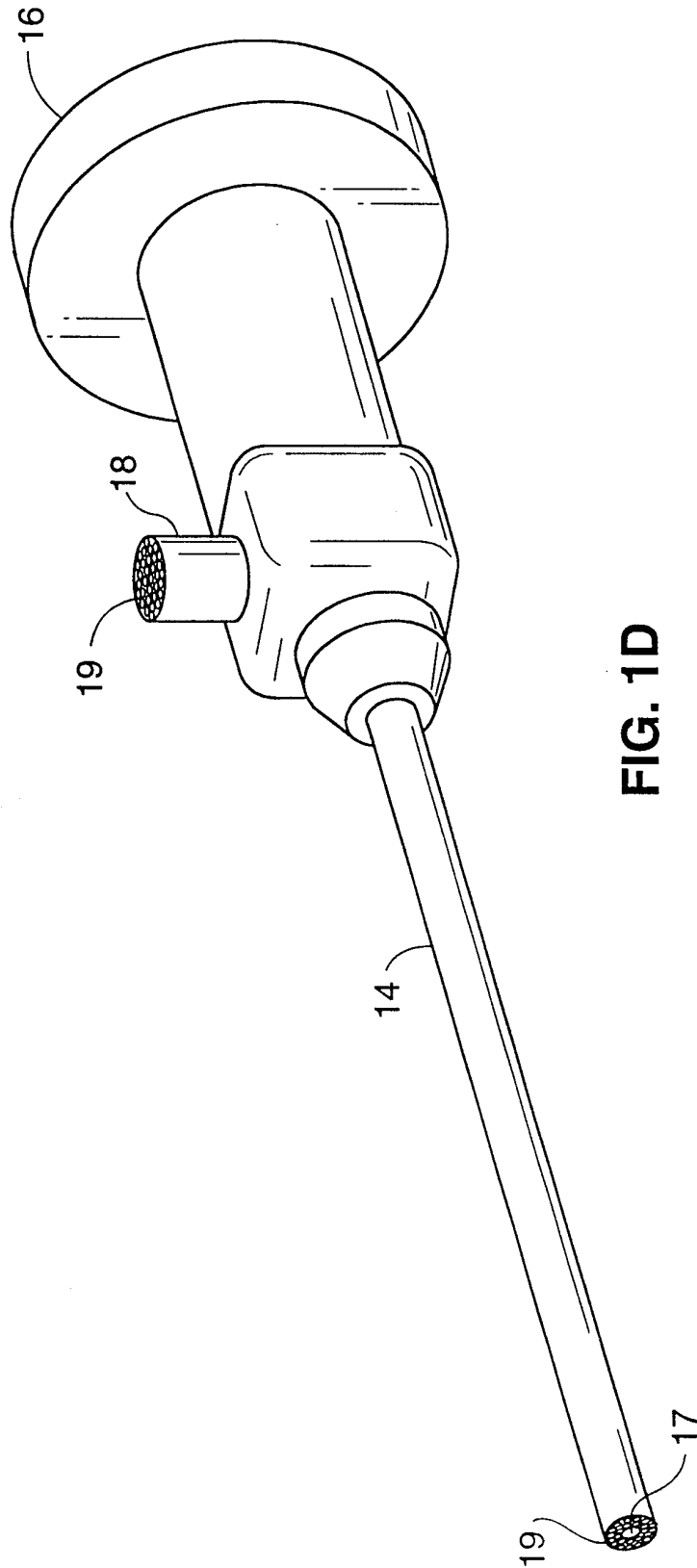


FIG. 1D

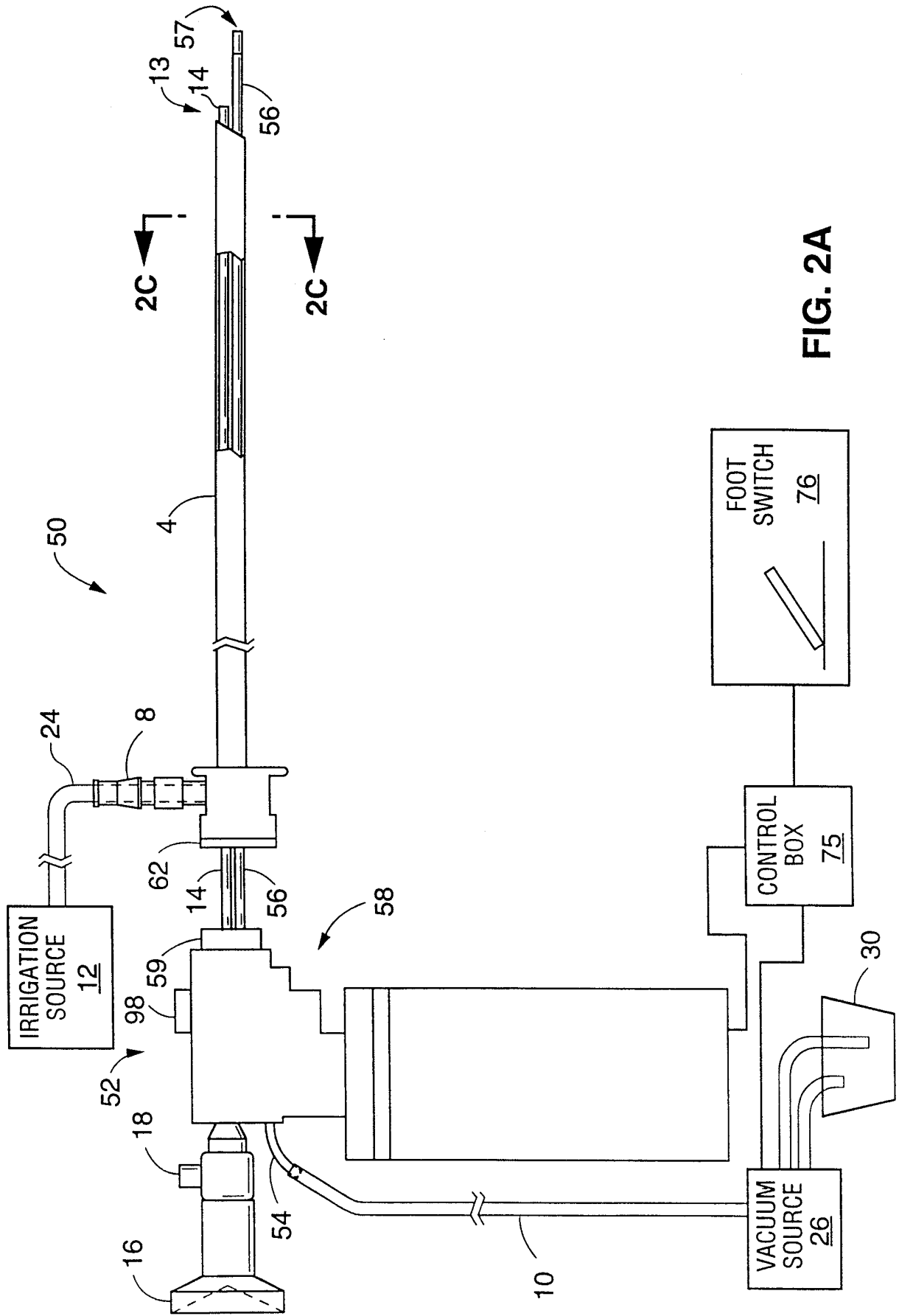


FIG. 2A

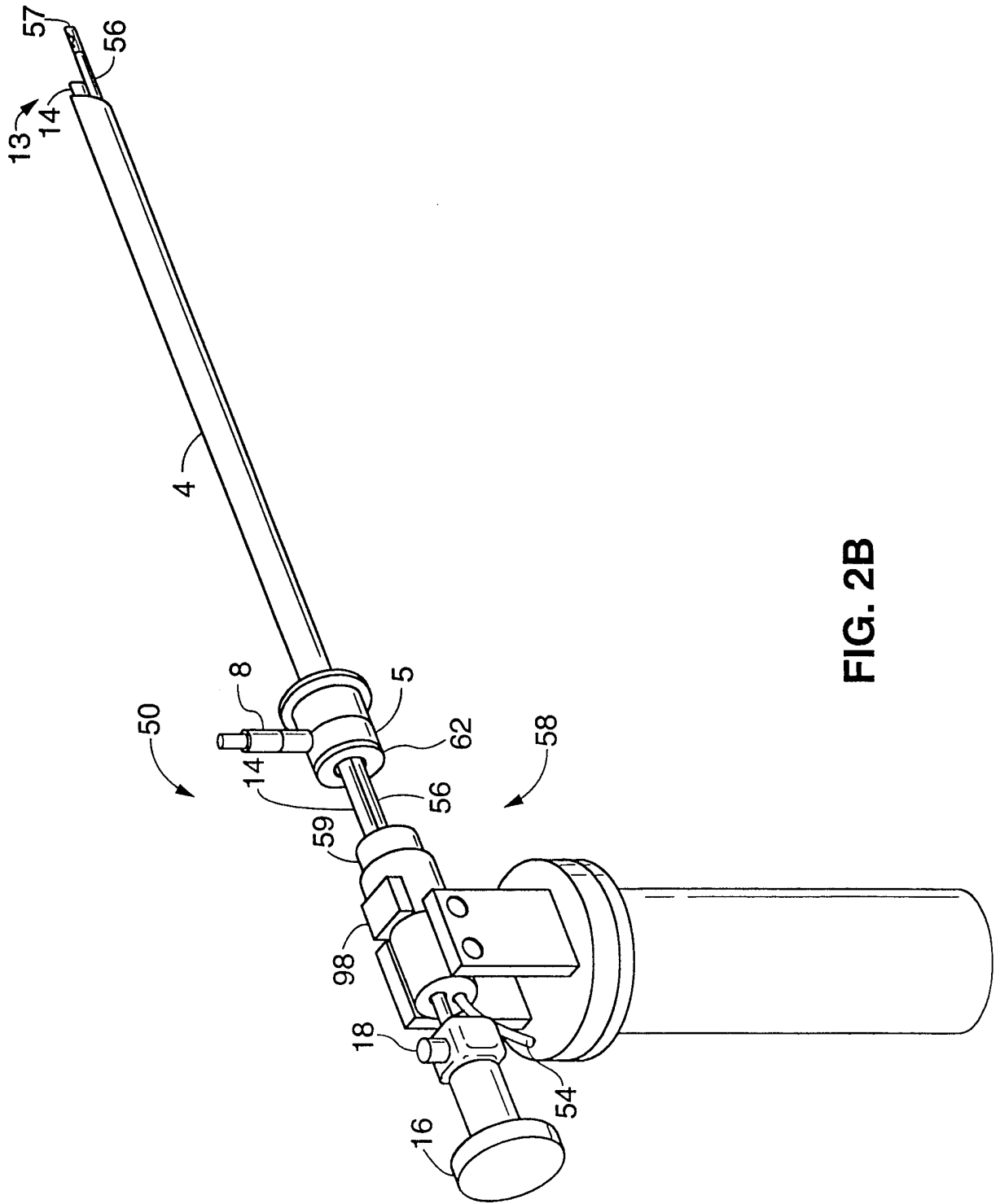


FIG. 2B

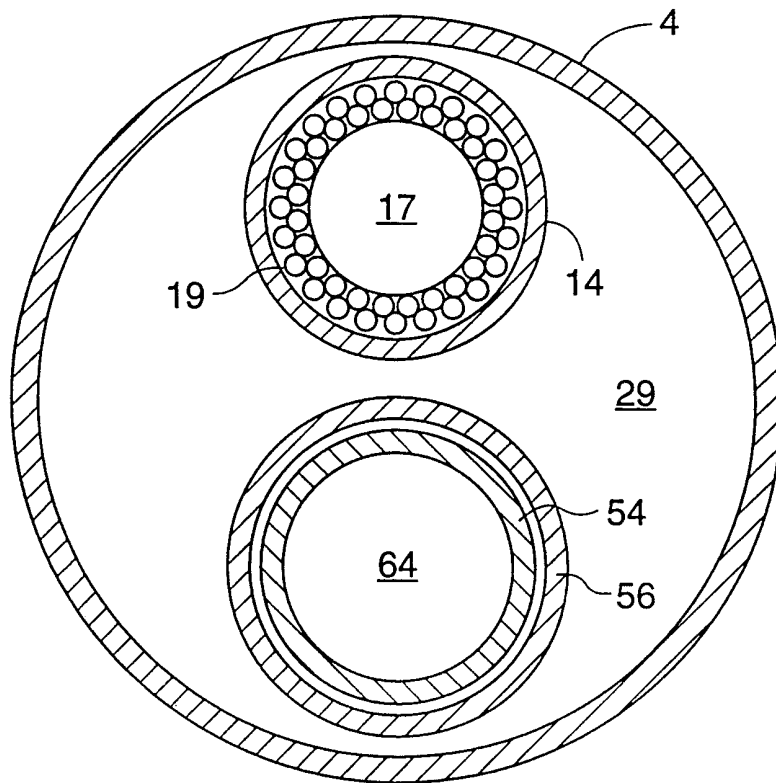


FIG. 2C

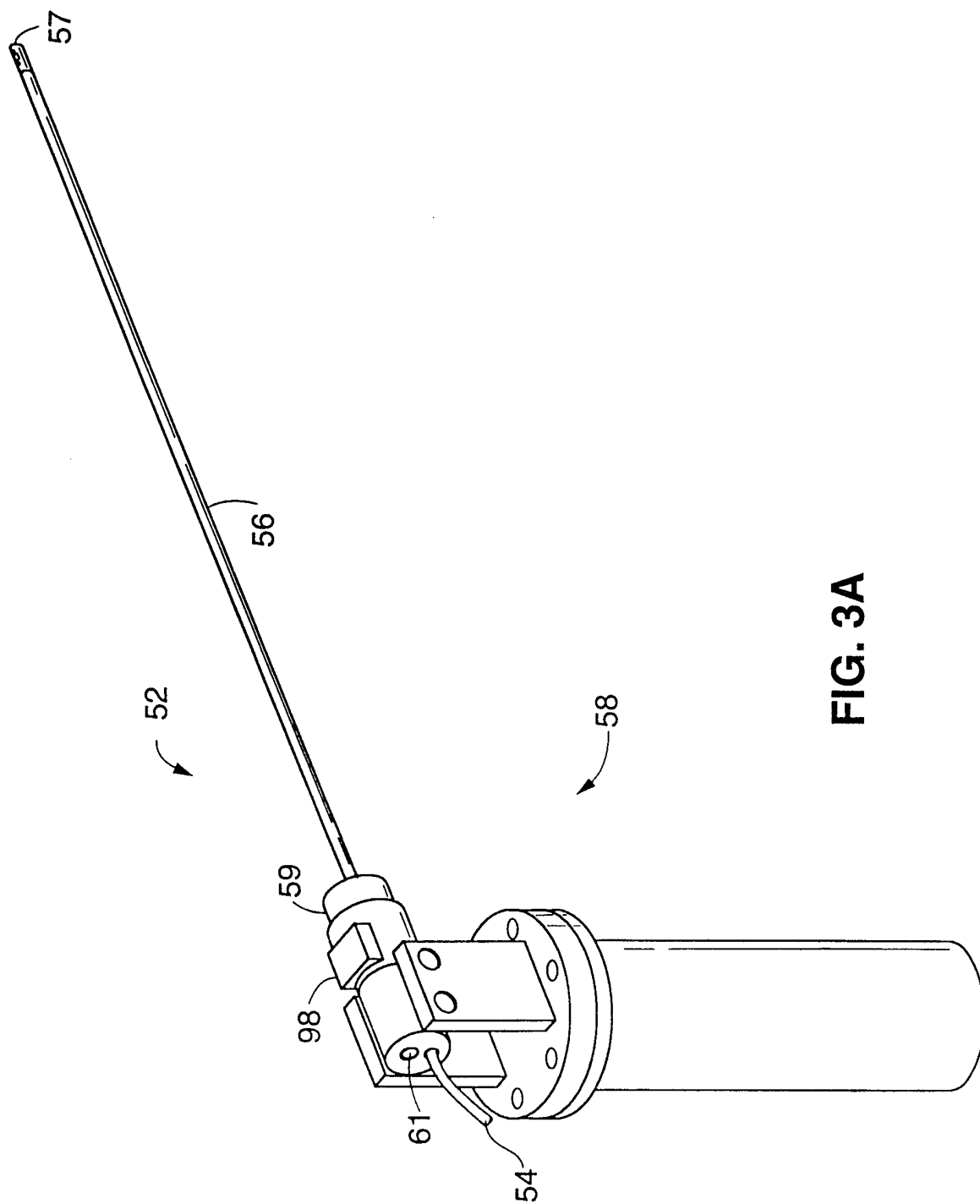


FIG. 3A

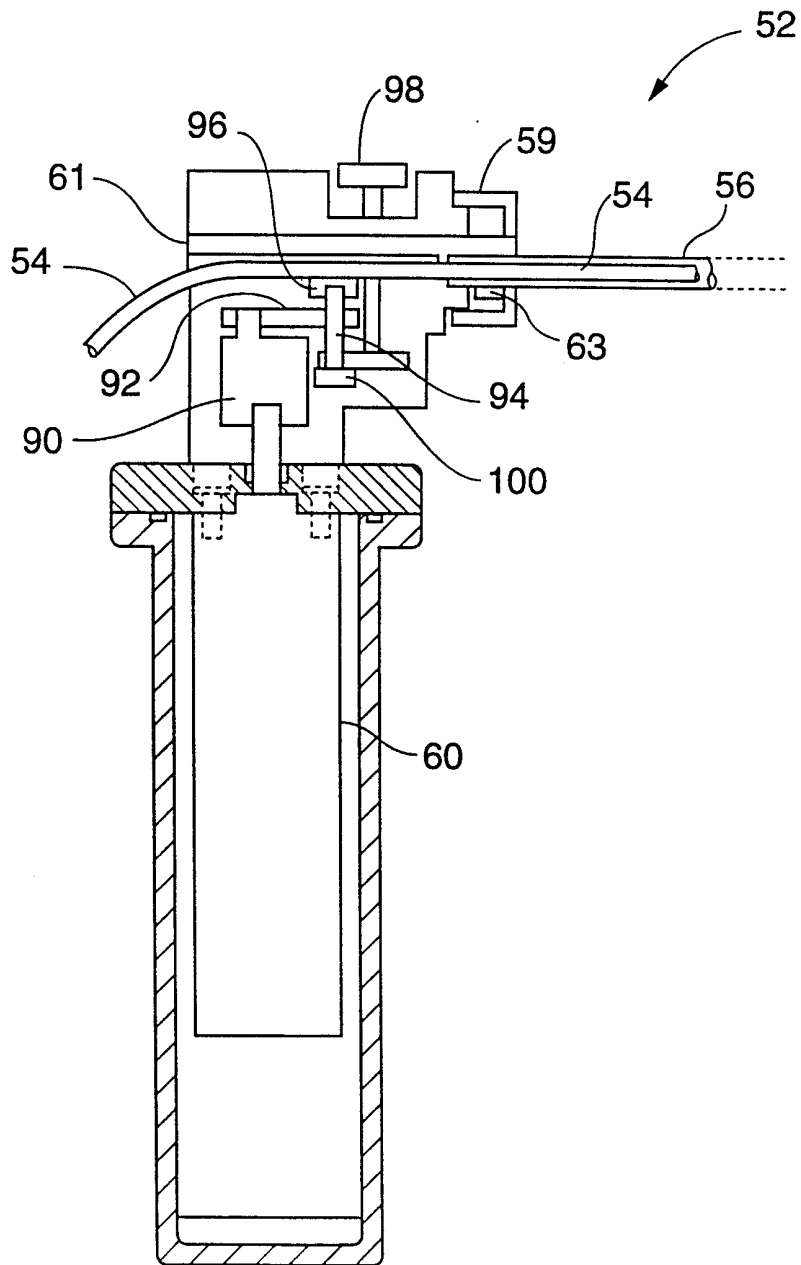


FIG. 3B

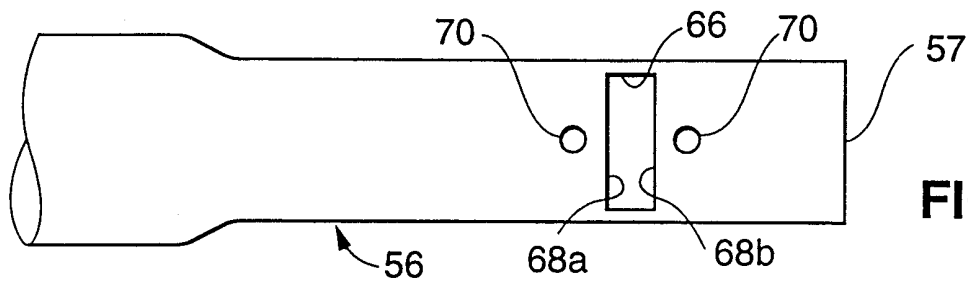


FIG. 4A

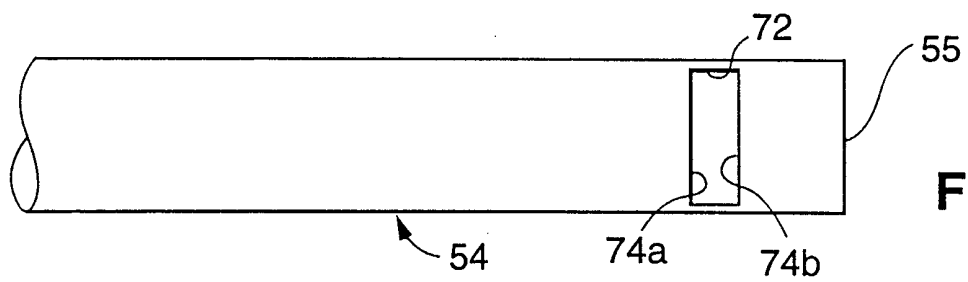


FIG. 4B

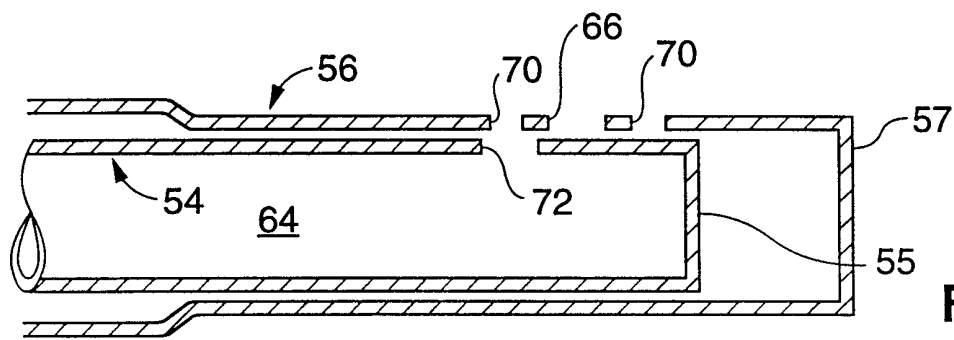


FIG. 5A

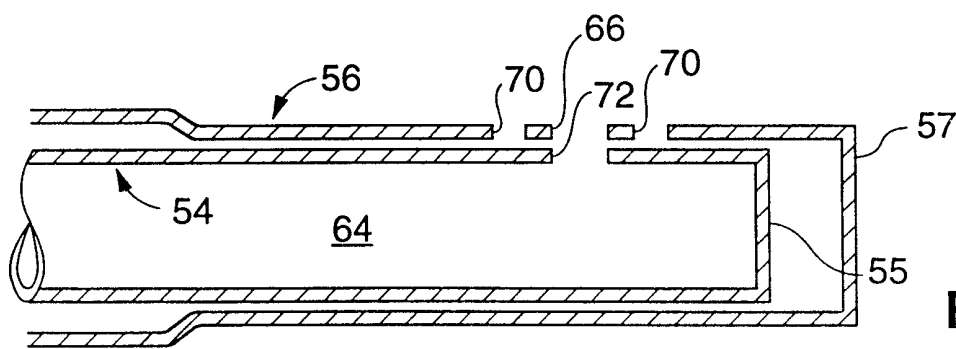


FIG. 5B

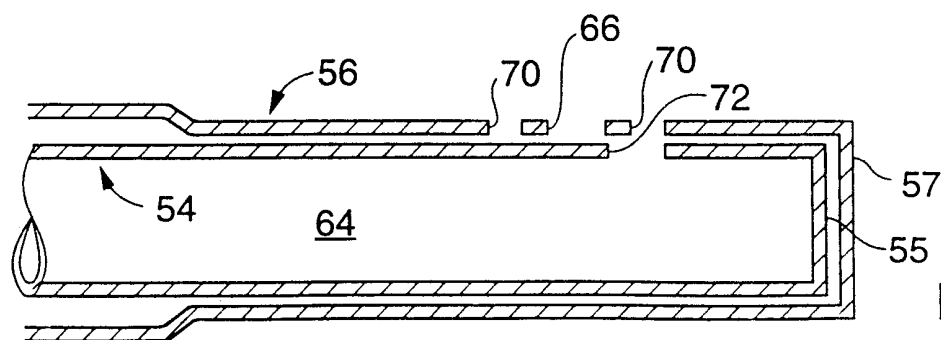


FIG. 5C

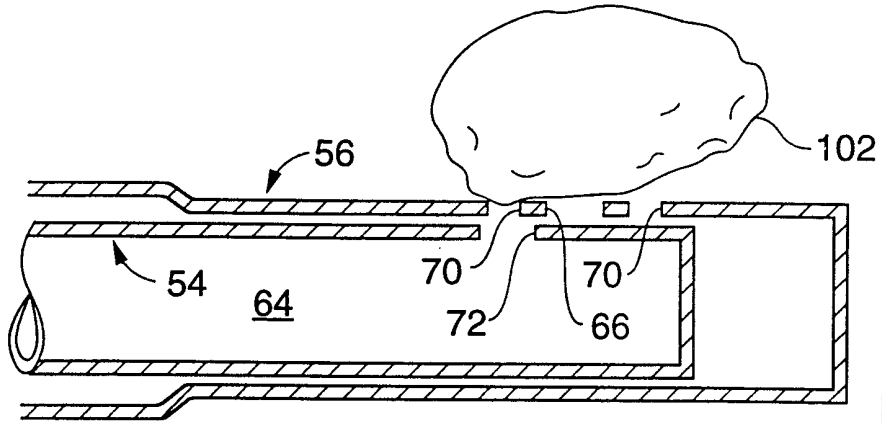


FIG. 6A

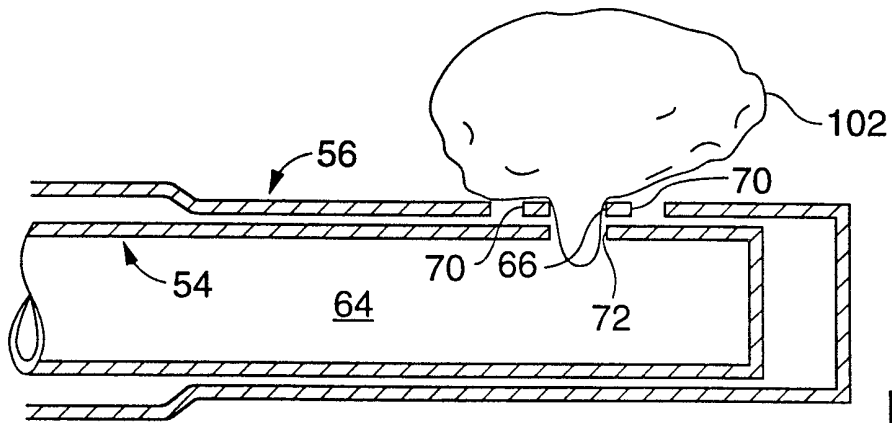


FIG. 6B

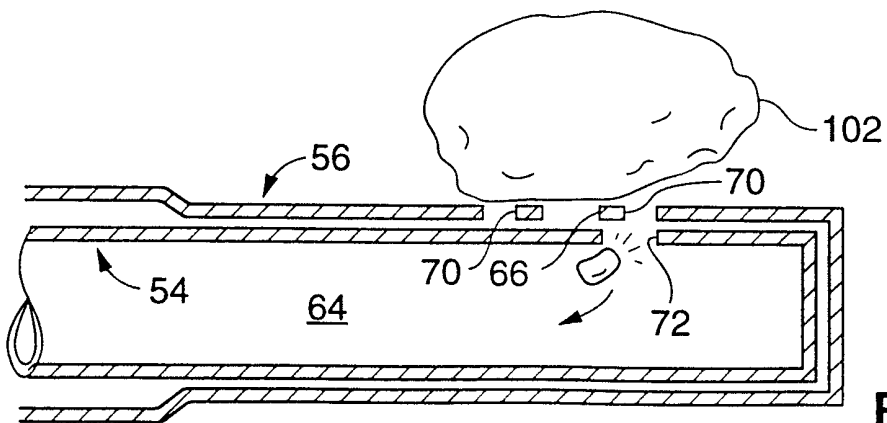


FIG. 6C

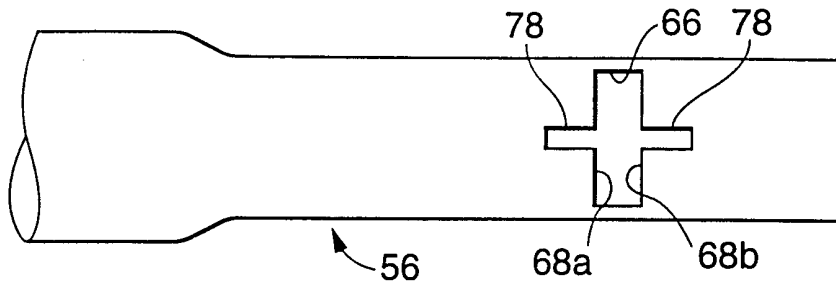


FIG. 7A

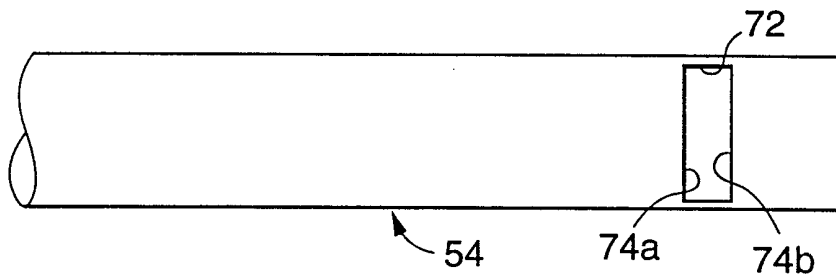


FIG. 7B

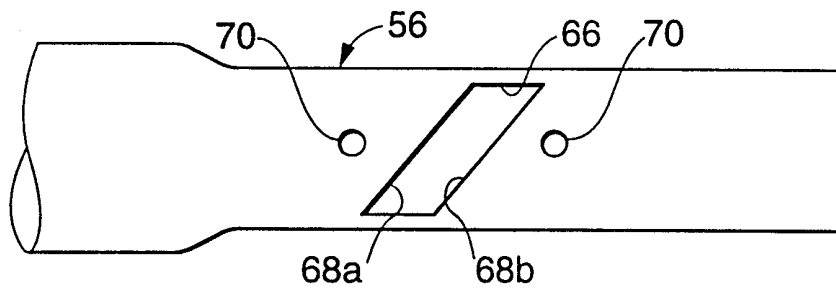


FIG. 8A

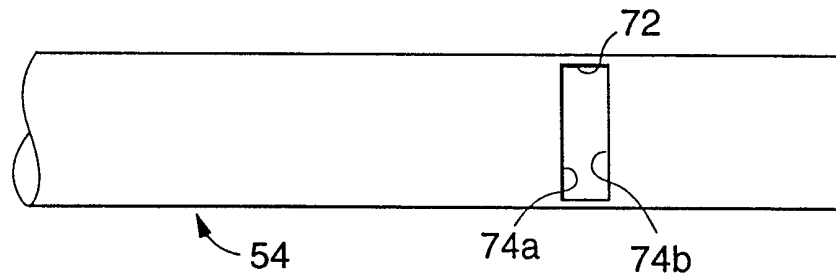


FIG. 8B

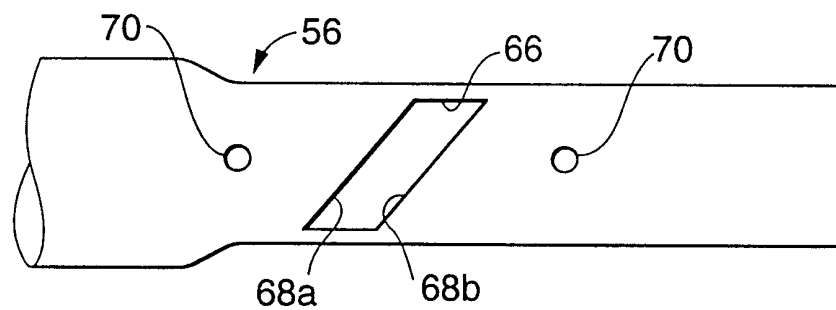


FIG. 9A

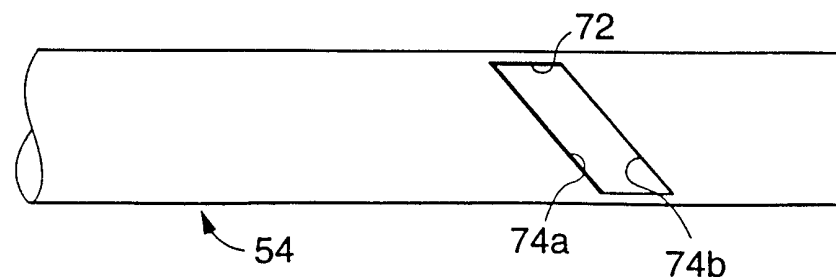


FIG. 9B

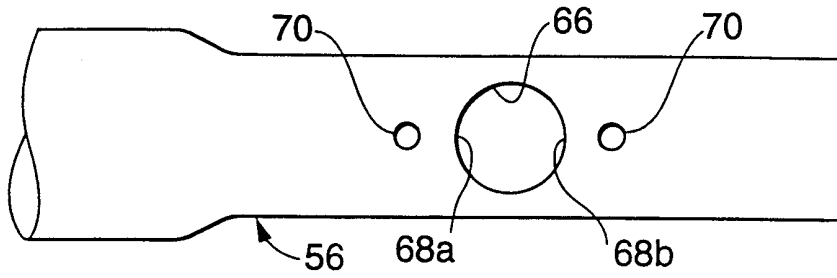


FIG. 10A

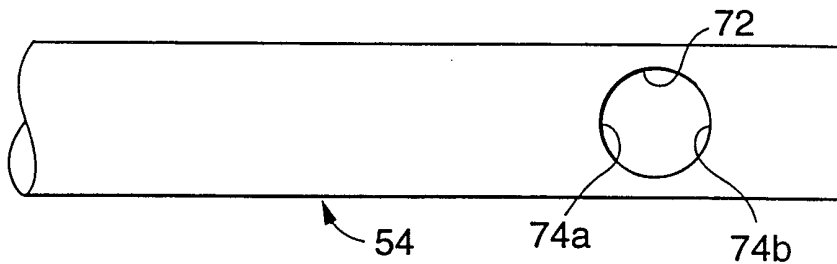


FIG. 10B

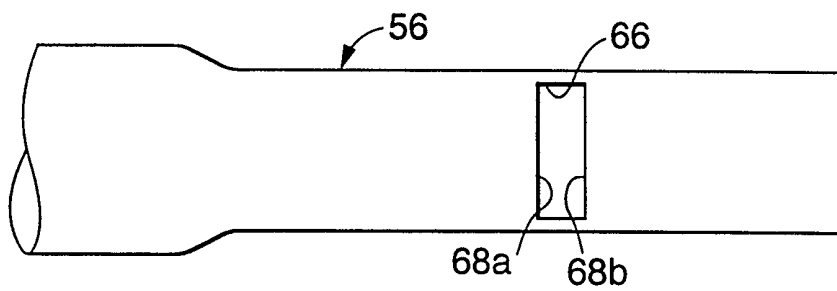


FIG. 11A

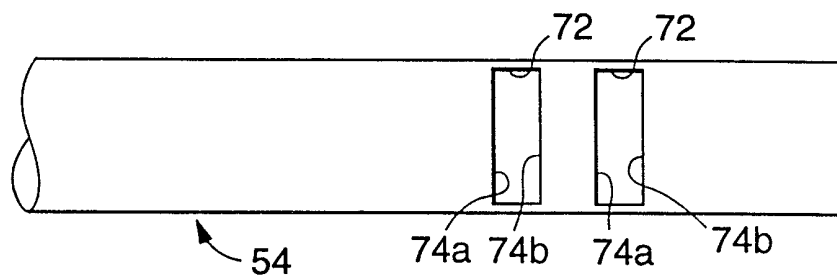


FIG. 11B

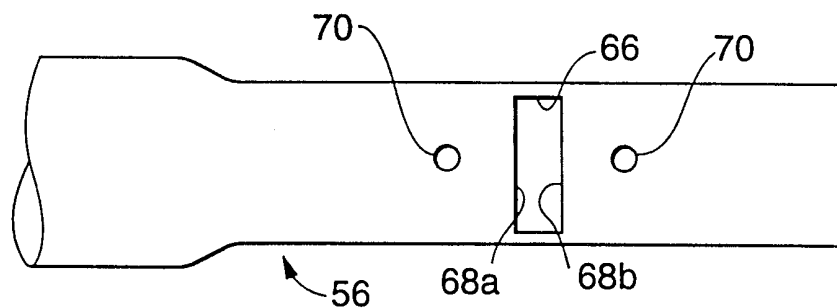


FIG. 12A

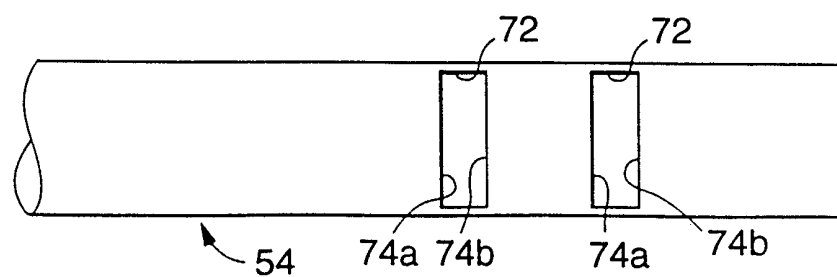


FIG. 12B

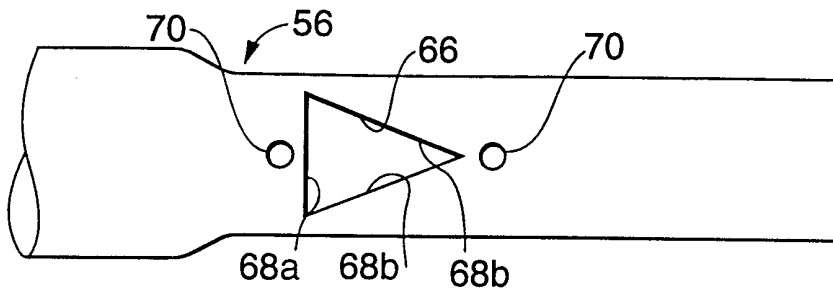


FIG. 13A

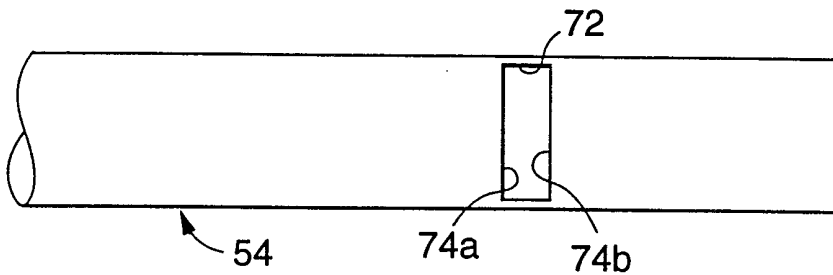


FIG. 13B

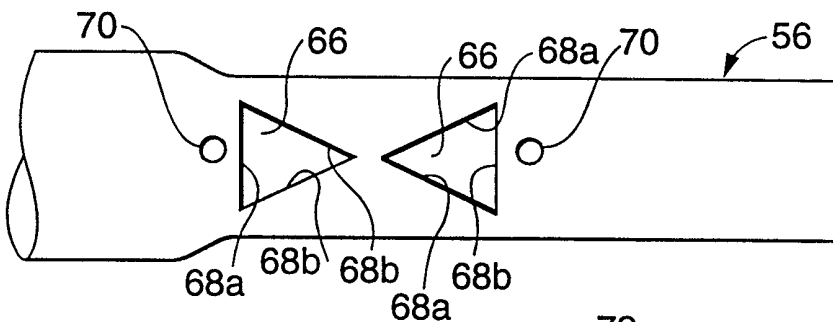


FIG. 14A

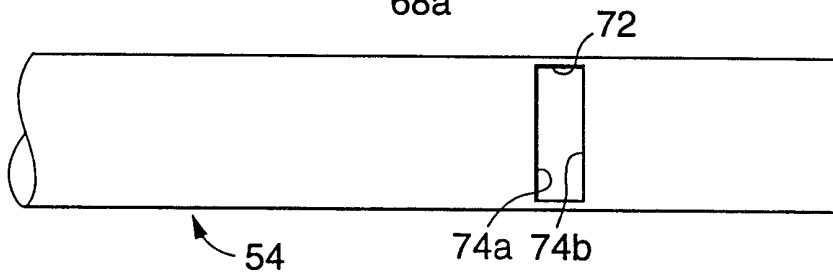


FIG. 14B

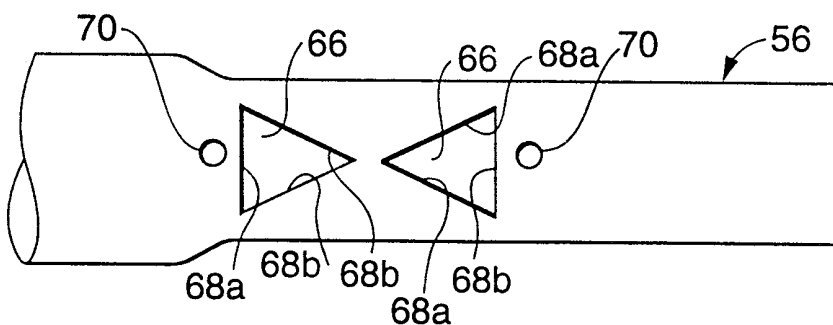


FIG. 15A

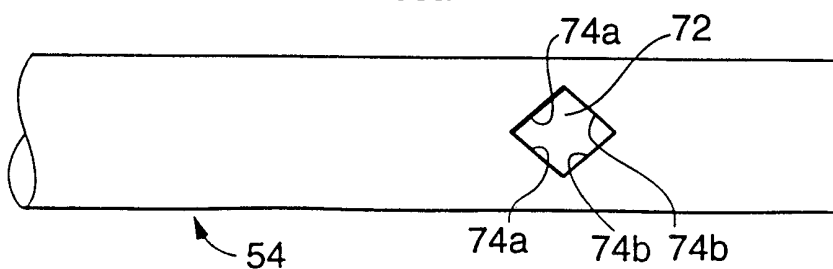


FIG. 15B

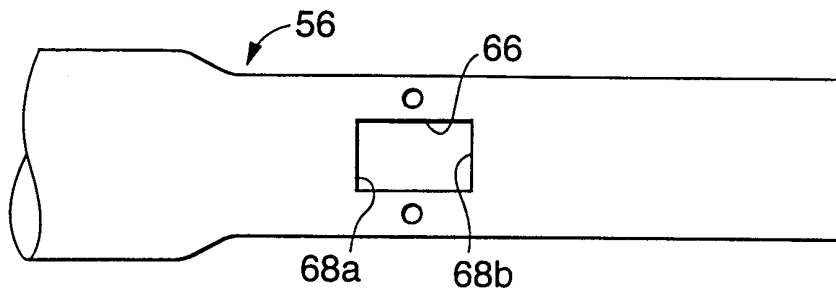


FIG. 16A

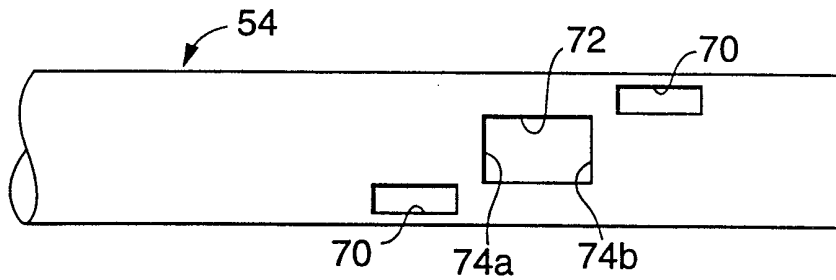


FIG. 16B

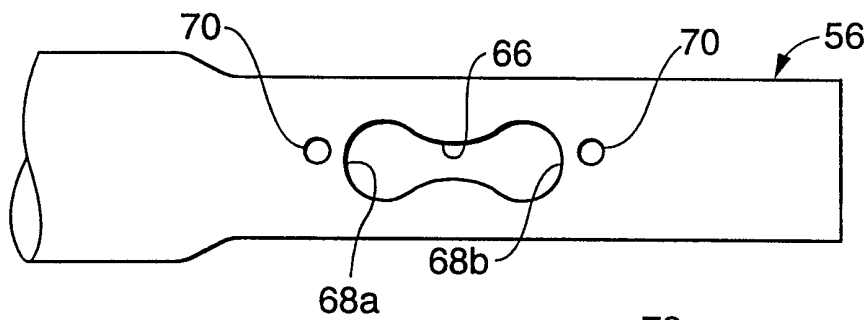


FIG. 17A

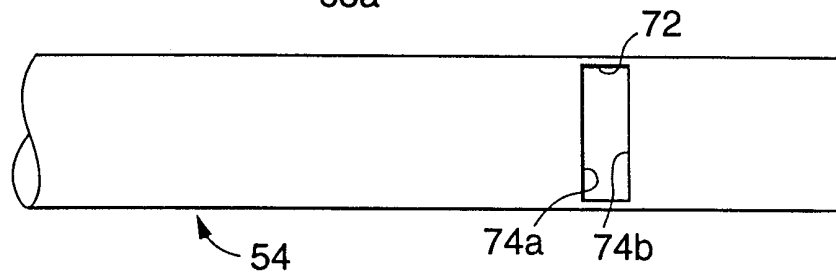


FIG. 17B

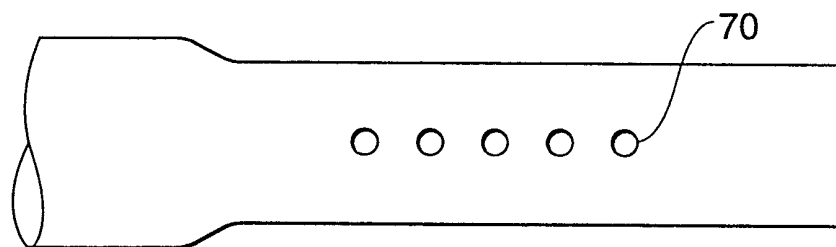


FIG. 18A

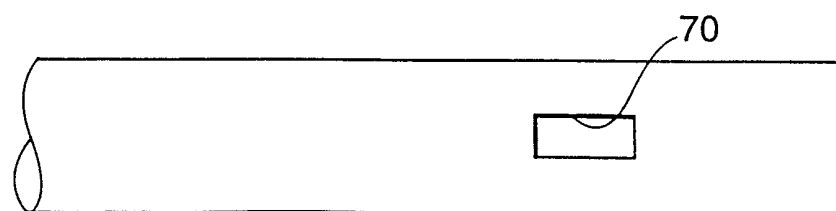


FIG. 18B

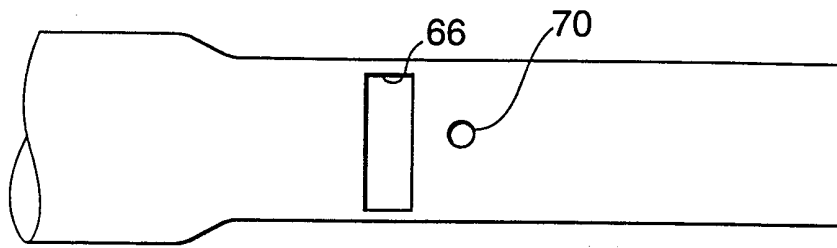


FIG. 19A

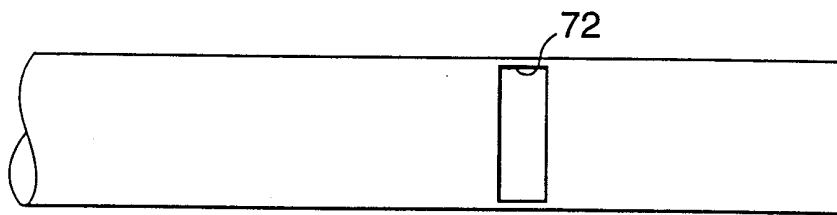


FIG. 19B

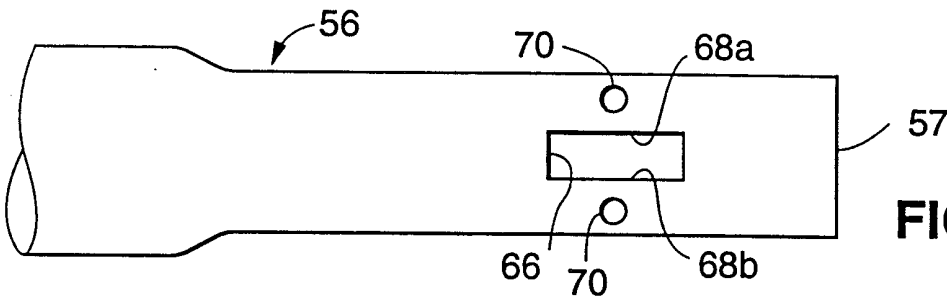


FIG. 20A

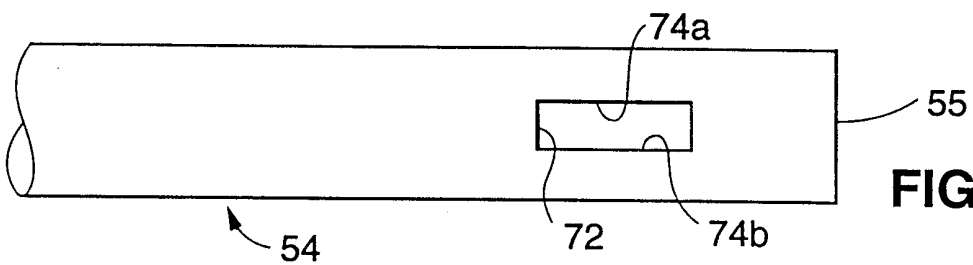


FIG. 20B

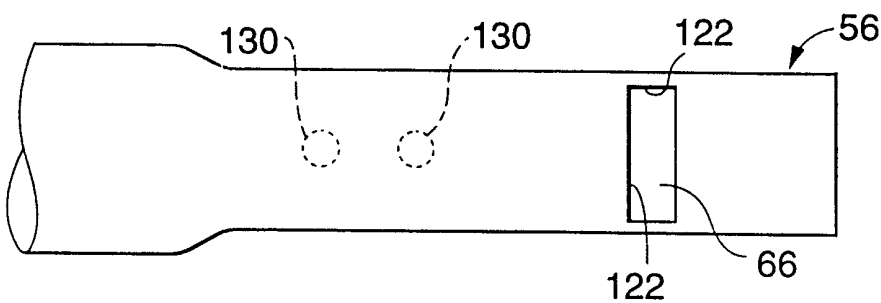


FIG. 21A

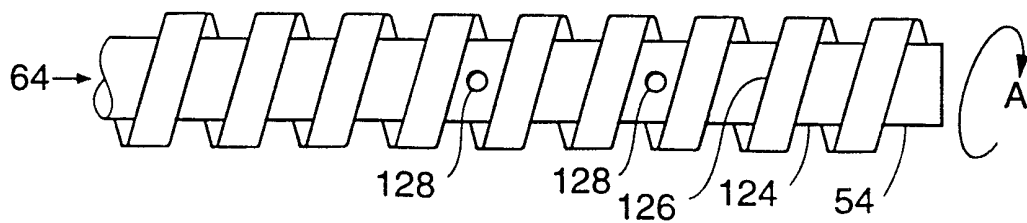


FIG. 21B

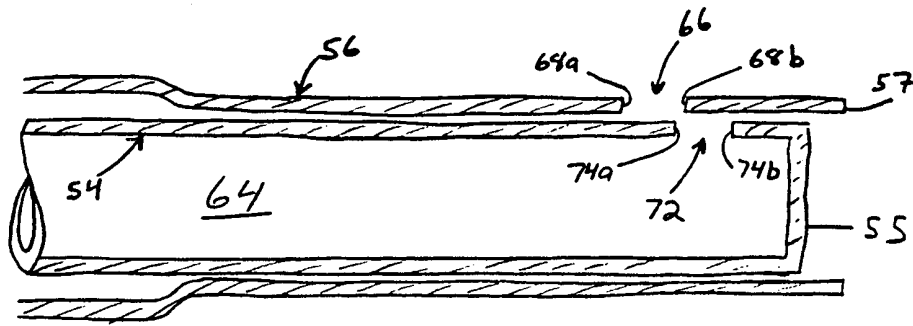


Fig 22A

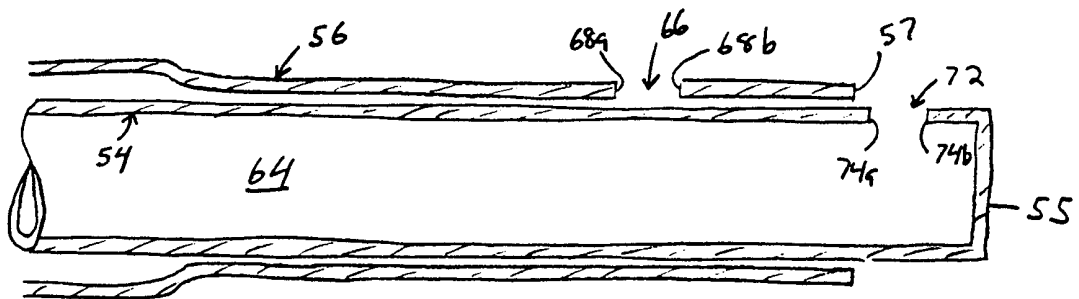


Fig 22B

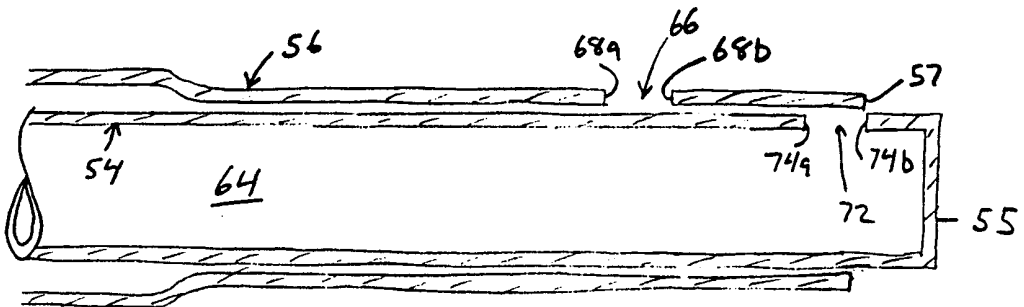


Fig 22C

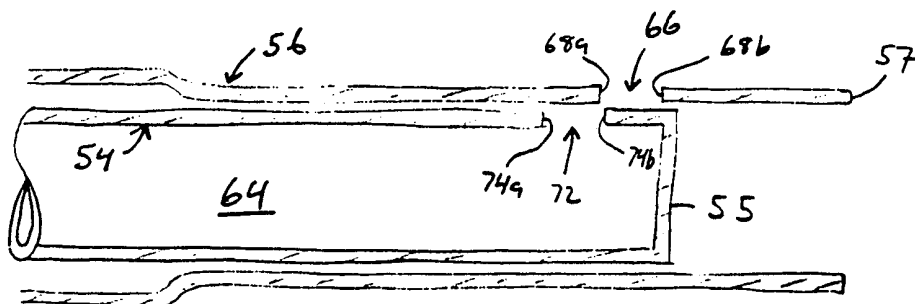


Fig 22D

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/02667

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B17/32

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 7 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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 98 46147 A (COHERENT INC) 22 October 1998 (1998-10-22) the whole document ---	1-22
Y	US 5 458 112 A (WEAVER GEORGE W) 17 October 1995 (1995-10-17) column 7, line 66 -column 8, line 23; figures 8,9 ---	1-22
A	US 5 106 364 A (HAYAFUJI MINEKI ET AL) 21 April 1992 (1992-04-21) column 2, line 24 - line 51; figures 1-5 --- -/--	1,2,5, 11-13,17

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search

19 June 2000

Date of mailing of the international search report

29/06/2000

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Ducreau, F

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/02667

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 5 403 276 A (STAVE FREDERICK R ET AL) 4 April 1995 (1995-04-04)</p> <p>column 3, line 33 - line 49 column 7, line 17 - line 30 figures 1,3</p> <p style="text-align: center;">----</p>	<p>1,2, 8-13, 20-22</p>
A	<p>US 4 620 547 A (BOEBEL MANFRED) 4 November 1986 (1986-11-04) column 2, line 18 - line 66; figures 1,2</p> <p style="text-align: center;">----</p>	<p>1,2,12, 13</p>
A	<p>US 5 527 332 A (CLEMENT THOMAS P) 18 June 1996 (1996-06-18) abstract; figures 4-7</p> <p style="text-align: center;">-----</p>	<p>1,2,12, 13</p>

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