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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61B 17/32	A1	(11) International Publication Number: WO 96/22738
		(43) International Publication Date: 1 August 1996 (01.08.96)

(21) International Application Number: PCT/US95/00915

(22) International Filing Date: 23 January 1995 (23.01.95)

(60) Parent Application or Grant
(63) Related by Continuation
US 07/985,329 (CIP)
Filed on 4 December 1992 (04.12.92)

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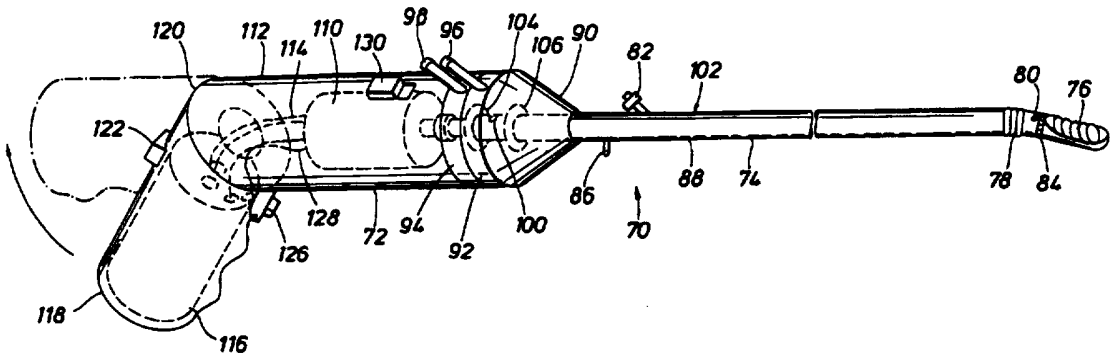
(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, US, UZ, VN, ARIPO patent (KE, MW, SD, SZ), European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: SPINAL DISC SURGICAL INSTRUMENT



(57) Abstract

The surgical instrument of the present invention includes a cannula shaft terminating in a cutting window at the distal end of the cannula shaft. The proximal end of the cannula shaft is supported by a handle having an axial bore extending therethrough. A flexible drive shaft, connected at one end to an external drive mechanism, extends through the handle and the cannula shaft. A cutting head is mounted to the distal end of the drive shaft and positioned for cooperative cutting action with the cutting window of the cannula shaft. A non-rotating idler shaft is journaled about the drive shaft. Severed tissue is removed or evacuated from the surgical site through an annular passage formed by the cannula and idler shafts. An irrigation tube through the cannula shaft provides a clean surgical site. The irrigation tube is preferably large enough to accept a fiberoptic element that may then be directed to the surgical site. The instrument further includes an ultrasonic array on the tip of the instrument to assist in directing the cutting element and to view tissue around the tip of the instrument. The handle of the instrument contains the power means, including a motor and a battery pack, and provides a swivel means to give a clear view of the surgical site.

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SPINAL DISC SURGICAL INSTRUMENT

This is a Continuation-in-Part of co-pending U.S. Application Serial No. 07/985,329, now U.S. Patent No. 5,383,884, issued January 24, 1995

FIELD OF THE INVENTION

The present invention generally relates to the field of surgical instruments and, more particularly, to a surgical instrument for performing intervertebral surgery for stabilizing the spine.

BACKGROUND OF THE DISCLOSURE

A common medical condition is chronic low back pain due to spinal disc problems. Low back pain is the most frequent cause of disability in persons under age 45 years, and the third most frequent cause in the 45-64 age group. Currently, there are 2.6 million Americans temporarily disabled and another 2.6 million Americans permanently disabled by chronic low back pain. Approximately 2 percent of all workers injure their back annually.

The need to rehabilitate these patients quickly and return them to a productive life style is obvious as studies indicate the ability to ever work again decays rapidly after six months. If an injured worker has not returned to work within two years, chances are very high that he or she will never work again.

Low back pain can be avoided if relative motion between spinal vertebra can be prevented. Intervertebral stabilization is sought in a variety of treatment methods. To abate low back pain, stabilization is directed to stabilizing contiguous vertebra in the lumbar region of the spine. A common non-surgical procedures is the use of a back brace. The brace is worn externally by the patient to restrict lumbar movement. The brace however is bulky and uncomfortable and limited in its effectiveness.

Laminotomy with discectomy is the standard treatment for patients with disc protrusion producing sciatica. The procedure is performed under general anesthesia. A surgical incision is made

and the surgeon directly visualizes the posterior disc and nerve root. The disc extrusion or free fragments are excised and removed. However, this direct approach necessitates entry into the spinal canal, thereby putting the patient at risk for epidural bleeding, perineural fibrosis and reherniation from the site of the annular fenestration.

Low back pain is associated with the degeneration of the intervertebral disc which commonly occurs with age. Surgical stabilization seeks to rigidly join the lumbar vertebra which are separated by the degenerated disc. Ideally, the surgery effectively replaces the vertebra-disc-vertebra combination with a single rigid vertebra. That is, adjacent vertebra are fused together to form a single vertebra.

Various surgical techniques have been developed for alleviating lower back pain. One surgical approach is directed to a total disc removal through a partial hemilaminectomy. This is a major surgical procedure; it is costly and the in-hospital convalescence is long.

Another procedure, chemonucleolysis, has been developed to avoid the problems associated with major surgery. The intradiscal pressure is decreased by the percutaneous introduction of chymopapain entered into the intravertebral disc to dissolve it. Such an approach is effective in the majority of patients but does have some side effects, as some patients are hypersensitive to the drug.

Arthroscopic discectomy offers an alternative method treatment for lumbar radiculopathy due to herniated disc. Several such devices are described in U.S. Patent No. 4,203,444; U.S. Patent No. 4,598,710; U.S. Patent No. 4,603,694; U.S. Patent No. 4,834,729; and U.S. Patent No. 5,062,845. However, each of these devices suffer limitations. For example known devices require time consuming removal of very small amounts of tissue via the guillotine cutting approach, the clogging of cutters and cannula due to adherent tissue fragments and, with the use of lasers, very slow canalization of the nucleus pulposus, time consuming ablation with considerable heat and char at the operative site.

Recent clinical studies have shown that patients can benefit from minimal invasive surgery utilizing the percutaneous approach. Removal of nucleus pulposus from lumbar disc, utilizing small cannula and cannulated surgical instruments, with or without endoscopic aids, thereby reducing surgical trauma, can result in immediate relief of symptoms, low morbidity and cost efficiencies.

It is therefore an object of the present invention to provide a surgical instrument for removing all or part of a intervertebrate disc employing a minimal invasive surgical technique.

It is another object of the present invention to provide a surgical instrument that eliminates all of the aforesaid problems, does not compromise future surgical procedures and offers a number of advantages including: avoidance of epidural bleeding and perineural fibrosis, elimination of reherniation through intraoperatively induced annular fenestration, preservation of spinal stability, and the establishment of a portal space for fusion.

SUMMARY OF THE INVENTION

The surgical instrument of the present invention includes a cannula shaft terminating in a cutting window at the distal end of the cannula shaft. The proximal end of the cannula shaft is mounted to a handle. A flexible drive shaft, connected at one end to a drive mechanism, extends through the handle and the cannula shaft. A cutting head is mounted to the distal end of the drive shaft and positioned for cooperative cutting action with the cutting window at the distal end of the cannula shaft. The drive shaft extends through a non-rotating idler shaft. Severed tissue is removed or evacuated from the surgical site through an annular passage defined between the cannula and idler shaft.

A flexible joint in the cannula shaft near the cutting window is provided to permit the operator to adjust the angle at which the cutting action is performed. Adjacent the flexible joint, an irrigation port flushes the surgical site, allowing the operator to keep the surgical site free of removed tissue. The distal end of

the instrument is also provided with two means of viewing, an ultrasonic array for viewing through tissue and a fiberoptic viewing means for a clear view of the surgical site.

The handle of the instrument is also provided with a swivel joint to provide the operator with a clear view. Similarly, the cannula shaft may be rotated about a 360 degree angle so that the operator may cut on the underside of a vertebra as easily as the upper side.

The instrument of the present invention is a fully contained unit, other than the fiberoptic and ultrasonic viewing features. That is, the cutting element is driven by a motor that is powered by a battery pack contained within the handle of the instrument.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the above recited features, advantages and objects of the present invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended drawings.

It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

Figure 1 is a partially broken away, sectional view of a preferred embodiment of the invention;

Figure 2 is a partial, sectional view showing the distal end of the surgical instrument of a preferred embodiment of the invention;

Figure 3 is a partial, sectional view showing an alternate embodiment of the distal end of the surgical instrument of a preferred embodiment of the invention; and

Figure 4 is a partial, sectional view of the distal end of the surgical instrument of the invention showing a guide wire extending through the drive shaft and cutting head of a preferred embodiment of the invention.

Figure 5A is a perspective view of a complete dissector instrument, including the cutting head and the power/drive system, of a preferred embodiment of the invention.

Figure 5B is a detail view of an articulated section of the cutting head of the invention. Figure 5C is a detail view of the articulated section of Figure 5C, shown in an actuated position.

Figure 6A is a side view of the cutter head of the invention; Figures 6B through 6E are detail views of the cutter head of Figure 6A.

Figure 7A is a side view of the cutter head of the invention; Figures 7B through 7D are detail view of the cutter head of Figure 7A.

Figure 8A is a side view of the cutter head of the invention; Figure 8B is partially a section view and partly a detail view of the cutter head of Figure 8A.

Figure 9A is a side view of the cutter head, including a scope port. Figure 9B is a top view of the cutter head of Figure 9A and Figure 9C is a bottom view.

Figure 10A is an enlarged view of a cutting element or bit of the invention; Figure 10B is a left-end view of the cutting element and Figure 10C is a right-end view.

Figure 11 is a further enlarged view of a cutting element within its enclosure, particularly preferred assembly relationships of the various parts of the cutter head.

Figures 12A through 12D are detail views of cutters with varying blade pitch and window angles.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Figure 1 depicts the surgical instrument **10** of the present invention. The surgical instrument **10** comprises a handle **12**, a cannula shaft **14** and an external drive mechanism (Figure 5A, for example). The cannula shaft **14** of Figures 1-4 is a substantially rigid, hollow tubular member approximately 10 to 12 inches in length. However, the cannula shaft preferably includes a malleable or articulated section near an end or tip **20**, as described below in greater detail.

The cannula shaft **14** is mounted to the end **16** of the handle **12**. The proximal end of the cannula shaft **14** is received in a bore formed in the handle **12** which terminates at a shoulder **18**. The cannula shaft **14** is press fit into the end **16** of the handle **12** so that the proximal end thereof engages the shoulder **18** formed in the handle **12**.

The distal end of the cannula shaft **14** terminates in an end **20**. The end **20** is slotted to form a cutting window. The end **20** may be integrally formed with the cannula shaft **14**, however, for ease of manufacture, the end **20** is preferably formed as a separate component and is welded or otherwise secured to the distal end of the cannula shaft **14** as shown in greater detail in Figure 2.

The handle **12** includes a through-bore **22** axially extending through the handle **12**. The proximal end of the bore **22** is closed by an end cap **24** which is press fit into the end **26** of the handle **12**. An evacuation port **28** angularly extends through the body of the handle **12**. The port **28** opens into the bore **22** thereby forming an evacuation passage for tissue removed at the surgical site. The port **28** provides a connection for connecting an aspirating device to the handle **12**. Alternatively, the port **28** may be utilized as an injection port for delivery of medication to the surgical site.

Referring now to Figure 2, the cutting end of the surgical instrument **10** is shown in greater detail. The end **20** is slotted on one side to provide a cutting window for progressively shaving

away the herniated disc. The cutter **30** is mounted on the drive shaft **32**. It is welded or otherwise secured to the end of the drive shaft **32** and positioned within the end **20** of the surgical instrument **10** so that each rotation of the cutter **30** shaves off a segment of the herniated disc. The auger-like profile of the cutter **30** transports the shaved segments backward to the annulus **34**. The shavings are then aspirated to a collection vessel connected to the evacuation port **28**. Alternatively, the drive shaft **32** may be hollow, as shown in Figure 4. The hollow shaft **32** extends through cutter **30** and cannula end **20**, allowing a guide wire **64** to pass through the entire assembly, as best shown in Figure 3 and Figure 4, to facilitate passage and positioning of the cannula shaft **14** for removal of tissue at the surgical site.

Removal of the herniated disc is accomplished by shaving away bits of the disc. Each pass of the cutter **30**, however, does not always sever and separate discrete portions of the disc. In addition, the suction of the aspirating device may draw tissue into the cutting chamber which will be severed by the cutter **30**. Therefore, relatively long and stringy shavings or cuttings may be cut by the cutter **30**. Long and stringy shavings have a tendency to wrap around a rotating drive shaft and thereby tend to block the evacuation passage. The present surgical instrument avoids this problem by incorporating an idler shaft **36** about the drive shaft **32**. The idler shaft **36** does not rotate with the drive shaft **32**. However, it does tend to vibrate slightly in response to the rotating action of the drive shaft **32**. The vibrating action of the idler shaft **36** agitates and dislodges shavings which might otherwise adhere to the surface of the idler shaft **36**. Thus, shavings removed by the cutter **30** are quickly aspirated from the surgical site through the annulus **34** and into a collection receptacle.

Referring again to Figure 1, it will be observed that the idler shaft **36** terminates at a coupling **38** located in the passage **22** of the handle **12**. The idler shaft **36** is secured to the coupling **38** by a set screw **40** or the like. A seal **42** is journaled about the idler shaft **30** for sealing the evacuation passage. The seal **42** seals the passage **22** extending through the handle **12** so that

shavings are directed through the evacuation port **28** to a collection vessel (not shown in the drawings).

The drive cable **32** extends through the end cap **24** and connects to a drive motor (Figure 5A). Stabilization of the flexible drive shaft **32** is provided by a stabilizer **44** which extends from the coupler **38** and into the end cap **24**. The stabilizer **44** is secured to the coupler **38** by a set screw **46**. The stabilizer **44** confines the flexible drive shaft **32** so that it does not whip about within the handle **12** thereby causing severe vibration of the handle **12**.

Referring now to Figures 3 and 4, alternate embodiments of the cutting head of the surgical instrument **10** are shown. As shown in Figure 3, the cutter **50** defines a substantially cylindrical cutting element. The cutter **50** is open at the proximal end thereof. The forwardmost or distal end of the cutter **50** is closed and defines a rounded profile substantially corresponding to the profile of the tip **52** of the cutter housing **54** which is mounted on the end of the cannula shaft **14**. The cutter **50** is provided with a pair of slots **56** formed in the sidewall thereof. The slots **56** substantially correspond to the size of the cutting window **58** formed in one side of the cutter housing **54**. The slots **56** are diametrically opposite each other and extend longitudinally along the sidewall of the cutter **50**. The drive shaft **32** extends to the distal end of the cutter **50** and is welded or otherwise fixedly secured to the cutter **50**. Likewise, the idler shaft **36** extends into the cutter **50** terminating adjacent the distal end thereof. To aid in the positioning and stabilization of the cutter **50**, a guide wire **64** extends through the drive shaft **32** and the cutter **50**.

The alternate embodiment of Figure 4 depicts a cutter **60** defining a substantially conical profile. The cutter **60** includes a plurality of blades **62** spaced about the conical body of the cutter **60**. The blades **62** of the cutter **60** are particularly suited for boring through or chipping away calcified matter. To aid in the positioning and stabilization of the cutter **60**, a guide wire **64** extends through the drive shaft **32** and the cutter **60**.

Removal of a herniated disc is accomplished with the present surgical instrument by making a small incision in the back of the patient to access the spine. The cannula shaft **14** is inserted through the incision and the cutting tip of the instrument **10** is positioned to engage the herniated disc. The cutter is rotated and by contacting the disc with the cutting tip, the surgeon may progressively shave away the herniated disc. The process is repeated until the herniated disc is completed removed.

Figure 5A depicts a currently preferred embodiment of the surgical instrument **70** of the present invention. Generally, the instrument **70** comprises a handle **72**, a cannula shaft **74**, and a cutter **76**. The cutter **76** may comprise any of the previously described cutter elements.

Adjacent the cutter **76**, and near the distal end of the cannula shaft **74**, the instrument **70** includes a flexible joint **78**. The flexible joint **78** may be constructed by any of a number of techniques, but is preferably malleable or articulated. The flexible joint enable the operator of the instrument to deflect the cutter **76**. This deflection directs the cutter to cut on a different plane and provides greater functionality to the surgeon.

Also adjacent the cutter, and preferably between the cutter and the joint **78**, the instrument includes an irrigation port **80**. The irrigation provides a means of irrigating the region that is being cut, thereby flushing removed tissue and assisting in the removal of the material through aspiration. The irrigation port **80** further serves as an exit port for a fiber optic viewing system, as described below, to enable the surgeon to directly view the area being cut. The fiber optic viewing system may be coupled to a fiberoptic port **82** or any appropriate means.

Also adjacent the cutter, and preferably between the irrigation port **80** and the cutter, is an ultrasonic array **84**. The ultrasonic array **84** may be built into the cannula shaft **74**, or it too may be fed by wire through the irrigation port **80**.

Attached to and protruding from the cannula shaft is a deflector lever **86**. The deflector lever **86** is attached to the distal

end of the cannula shaft by a wire or rod **88** to permit the operator to adjust the precise angle of deflection of the flex joint **78**.

The handle **72** joins to the cannula shaft **74** at a shoulder **90**, as previously described with regard to Figures 1-4. Immediately behind the shoulder **90** the handle includes an irrigation chamber **92** and immediately behind the irrigation chamber **92** is an aspiration chamber **94**. The irrigation chamber **92** is provided with a supply port **96** and the aspiration chamber **94** communicates with a suction port **98**. Each of the ports **96** and **98** is provides with a connector means of any appropriate type, preferably to enable quick connect and disconnect.

Within the irrigation chamber **92** is an irrigation orifice **100**. The irrigation orifice **100** provides communication between the chamber **92** and a irrigation tube **102**. Aspiration from the aspiration chamber **94** through the suction port **98** is carried out as previously described. Furthermore, the chambers **92** and **94** are sealed off between the handle and the cannula shaft by O-ring seals **104** and **106** in a conventional manner.

The drive shaft of the instrument **70**, like the drive shaft **32** of Figure 1, is coupled via a coupling **108** like the coupling **38** as previously described. The coupling **108** couples to a drive means **110**, preferably a 4.5 volt DC motor. The motor **110** is firmly mounted within a motor shell **112** and is powered through power cables **114**. Power is provided by a battery pack **116** and the cables **114** provide the electrical connection to the motor **110**. The battery pack **116** is firmly mounted within a battery shell **118**.

Referring to Figures 5B and 5C, a handle swivel feature of the present invention is disclosed. Between the battery shell **118** and the motor shell **112** is a swivel joint **120**. Rotation of the swivel joint **120** is enabled by a swivel lock **122**. The swivel lock **112** also serves to lock the shells in place in the swivelled position. When the swivel lock **122** is depressed, a latch is released permitting rotation of the battery shell **118** relative to the motor shell **112**. The shells are coupled to one another

through a rotating flange **124** and the rotating flange also encloses the cables **114** which connect the battery pack to the motor. This feature of the present invention permits adjustment of the handle to improve the field of view for the operator when he is operating from an anterior approach.

Mounted on the battery shell is a control switch **126**. The control switch **126** controls operation of the motor through connecting wires **128**.

The present invention also permits rotation of the cannula shaft through a key lock **130**.

Figures 6A through 6E provide details of the construction of the flex joint **78** and its controls. It should be understood that the side view of Figure 6A is turned over from the perspective view of Figure 5A. Figure 6B provides details of the flex joint **78** itself. As shown, the flex joint is preferably formed of an accordion-like construction, to give flexibility while remaining sealed. Figures 6A to 6E also show the structural relationship between the irrigation tube **102** and an aspiration tube, as previously described, and shown in section in Figure 8B. Also, Figure 6E illustrates that the end of the irrigation tube **102** is sealed at one end within the cannula shaft and is penetrated by the orifice **100**.

Figures 7A through 7D depict details of the ultrasonic array feature of the present invention. An array **84** of piezoelectric crystals is placed about the tip **20** of the cannula shaft **74** to provide as assembly of ultrasonic transmitters and receivers which may be serially activated to ultrasonically scan a preselected pattern about the surgical field. The ultrasonic signal is generated by a set of transducers and receivers, typically operating at a frequency range of 5 to 50 megahertz. The transmitted and received signals are preferably conducted through a set of leads **132**. The electric wire leads are embedded or encapsulated in the length of the cannula to transmit the signal to and from the ultrasonic transducer crystals. These crystals act in response to excitation of an external voltage pulse (typically 5-50 volt range) or in response to sonic vibration return from body

tissue onto a receiver crystal and thereby converted to an electric signal.

Figures 8A and 8B illustrate the structural relationship between various elements within the cannula shaft **74**. Coaxial within the cannula shaft **74** are a drive shaft **134** which rotates within an idler shaft **136**. These shaft elements operate in a manner as previously described. Within the cannula shaft **74** and running axially parallel with the shaft is the irrigation tube **102**. Recall that the irrigation tube **102** also serves as the access tube for a fiber optic instrument that may be inserted through the instrument. The tube **102** may be attached to an inner wall **138** of the cannula shaft by any appropriate means, preferably by spot welding.

Also within the cannula shaft, and perhaps opposite the tube **102**, is the deflector wire or rod **88**. The wire or rod **88** is attached to the deflector lever **86**. The lever **86** may be mounted upon a pedestal **140** which provides a pivot axis **142**, as through a pin **144**.

Figure 9A depicts a side view of the cannula shaft **74** of the invention. Figure 9B provides a top view and Figure 9C provides a bottom view. These figures depict the preferred structural relationship of the cannula shaft, the deflection wire **88** (*i.e.*, preferably on the upper portion of the cannula shaft **74**), and the irrigation and scope tube **102** (*i.e.*, preferably on the bottom portion of the cannula shaft).

Finally, Figures 10A through 10C, 11, and 12A through 12D depict another feature of the present invention. It has been found that the cutter element and the window through which the cutter element have two parameters that may be varied to tailor specific performance of the instrument, depending on the application and the type of tissue that is to be removed. Specifically, the operator should have the option to select a particular cutter window angle β, the angle being determined from the centerline at the tip, for example, depending on the tissue of interest. An angle of 5° as defined by Figure 11, has been found to be more aggressive in drawing desired tissue into the instrument because more of the

blade is exposed. Thus, where the particular tissue of interest is, for example, hard calcified deposits, a greater angle β is preferred because a steeper window angle has been found to provide greater "bite" for the cutter element. Thus, the window angle is preferably from about 5° to about 10°.

The other parameter that may be varied is referred to herein as the blade pitch α. Conceptually, the blade pitch α may be thought of as the angle between the edge of the blade and the axis of rotation of the cutter element, as viewed from the side. The blade pitch α is preferably between about 14° and about 20°. Angles significantly less than about 14° present too flat an aspect to the tissue being cut and the blades lose the shear force in the cutting motion. On the other hand, angles significantly greater than about 20° tend to pull the instrument and such blades introduce an unnecessary instability in the operation.

The principles, preferred embodiments, and modes of operation of the present invention have been described in the foregoing specification. This invention is not to be construed as limited to the particular forms disclosed, since these are regarded as illustrative rather than restrictive. Moreover, variations and changes may be made by those skilled in the art without departing from the scope of the invention, as defined in the following claims.

I claim:

1. A surgical instrument comprising:

a cannula shaft, the cannula shaft including a lateral cutting port formed on the distal end thereof;

a handle supporting the cannula shaft at one end thereof, the handle including an axial bore extending therethrough;

a drive shaft extending through the handle and the cannula shaft, the drive shaft including a cutter mounted on the distal end thereof, the cutter cooperating with the cutting port for severing body tissue;

an idler shaft journaled about the drive shaft and enclosing the drive shaft within the cannula shaft, the idler shaft providing a non-rotating surface for evacuation of severed tissue from the surgical site; and

power means within the handle, the power means connected to the drive shaft for rotating the cutter means.

2. A surgical instrument comprising:

a cannula shaft, the cannula shaft including a lateral cutting port formed on the distal end thereof;

an articulated swivel handle supporting the cannula shaft at one end thereof, the handle including an axial bore extending therethrough;

a drive shaft extending through the handle and the cannula shaft, the drive shaft including a cutter mounted on the distal end thereof, the cutter cooperating with the cutting port for severing body tissue;

an idler shaft journaled about the drive shaft and enclosing the drive shaft within the cannula shaft, the idler shaft providing a non-rotating surface for evacuation of severed tissue from the surgical site; and

means connected to the drive shaft for rotating the cutter means.

3. A surgical instrument comprising:

a cannula shaft, the cannula shaft including a lateral cutting port formed on the distal end thereof;

a handle supporting the cannula shaft at one end thereof, the handle including an axial bore extending therethrough;

a drive shaft extending through the handle and the cannula shaft, the drive shaft including a cutter mounted on the distal end thereof, the cutter cooperating with the cutting port for severing body tissue;

an idler shaft journaled about the drive shaft and enclosing the drive shaft within the cannula shaft, the idler shaft providing a non-rotating surface for evacuation of severed tissue from the surgical site;

means connected to the drive shaft for rotating the cutter means; and

an irrigation tube within the cannula shaft.

4. The surgical instrument of Claim 3 wherein the irrigation tube provides a means for directing a fiberoptic viewing means adjacent the cutting port.

5. A surgical instrument comprising:

a cannula shaft, the cannula shaft including a lateral cutting port formed on the distal end thereof;

a user operable flexible joint on the cannula shaft;

a handle supporting the cannula shaft at one end thereof, the handle including an axial bore extending therethrough;

a drive shaft extending through the handle and the cannula shaft, the drive shaft including a cutter mounted on the distal end thereof, the cutter cooperating with the cutting port for severing body tissue;

an idler shaft journaled about the drive shaft and enclosing the drive shaft within the cannula shaft, the idler shaft providing a non-rotating surface for evacuation of severed tissue from the surgical site; and

means connected to the drive shaft for rotating the cutter means.

6. The surgical instrument of Claim 5 further comprising a lever mounted on the cannula shaft and connected to the flexible joint for directing the cutter at a user selectable angle.

7. A surgical instrument comprising:

a cannula shaft, the cannula shaft including a lateral cutting port formed on the distal end thereof;

a handle supporting the cannula shaft at one end thereof, the handle including an axial bore extending therethrough;

a drive shaft extending through the handle and the cannula shaft, the drive shaft including a cutter mounted on the distal end thereof, the cutter cooperating with the cutting port for severing body tissue;

an idler shaft journaled about the drive shaft and enclosing the drive shaft within the cannula shaft, the idler shaft providing a non-rotating surface for evacuation of severed tissue from the surgical site;

means connected to the drive shaft for rotating the cutter means; and

an ultrasonic array mounted on the cannula shaft.

8. A surgical instrument comprising:

a cannula shaft;

a handle supporting the cannula shaft at one end thereof, the handle including an axial bore extending therethrough;

a drive shaft extending through the handle and the cannula shaft, the drive shaft including a cutter mounted on the distal end thereof, the cutter comprising a dual-fluted helical blade having a pitch of between about 14 degrees and about 20 degrees;

an idler shaft journaled about the drive shaft and enclosing the drive shaft within the cannula shaft, the idler shaft providing a non-rotating surface for evacuation of severed tissue from the surgical site;

means within the axial bore in the handle and connected to the drive shaft for rotating the cutter; and

wherein the cannula shaft and the idler shaft define an annular evacuation passage therebetween for evacuation of severed tissue from the surgical site.

9. A surgical instrument comprising:

a cannula shaft, the cannula shaft including a lateral cutting port formed on the distal end thereof;

a first handle portion supporting the cannula shaft at one end thereof, the first handle portion including an axial bore therethrough;

a second handle portion, the second handle portion including an axial bore therethrough;

a flexible joint between the first and second handle portions;

a drive shaft extending through the first handle portion and the cannula shaft, the drive shaft including a cutter mounted on the distal end thereof, the cutter cooperating with the cannula shaft port for severing body tissue;

an idler shaft journaled about the drive shaft and enclosing the drive shaft within the cannula shaft, the idler shaft providing a non-rotating surface for evacuation of severed tissue from the surgical site; and

power means within the handle, the power means connected to the drive shaft for rotating the cutter means.

10. A surgical instrument comprising:

a cannula shaft, the cannula shaft including a lateral cutting port formed on the distal end thereof;

a user operable flexible joint on the cannula shaft;

a lever mounted on the cannula shaft and connected to the flexible joint for directing the distal end of the cannula shaft at a user selectable angle;

an ultrasonic array mounted on the cannula shaft;

an articulated swivel handle supporting the cannula shaft at one end thereof, the handle including an axial bore extending therethrough;

a drive shaft extending through the handle and the cannula shaft, the drive shaft including a cutter mounted on the distal end thereof, the cutter cooperating with the cutting port for severing body tissue, the cutter comprising a dual-fluted helical blade having a pitch of between about 14 degrees and about 20 degrees;

an idler shaft journaled about the drive shaft and enclosing the drive shaft within the cannula shaft, the idler shaft providing a non-rotating surface for evacuation of severed tissue from the surgical site;

power means within the handle and connected to the drive shaft for rotating the cutter means;

an irrigation tube within the cannula, the irrigation tube further providing means for directing a fiberoptic viewing means adjacent the cutting port.

FIG.1

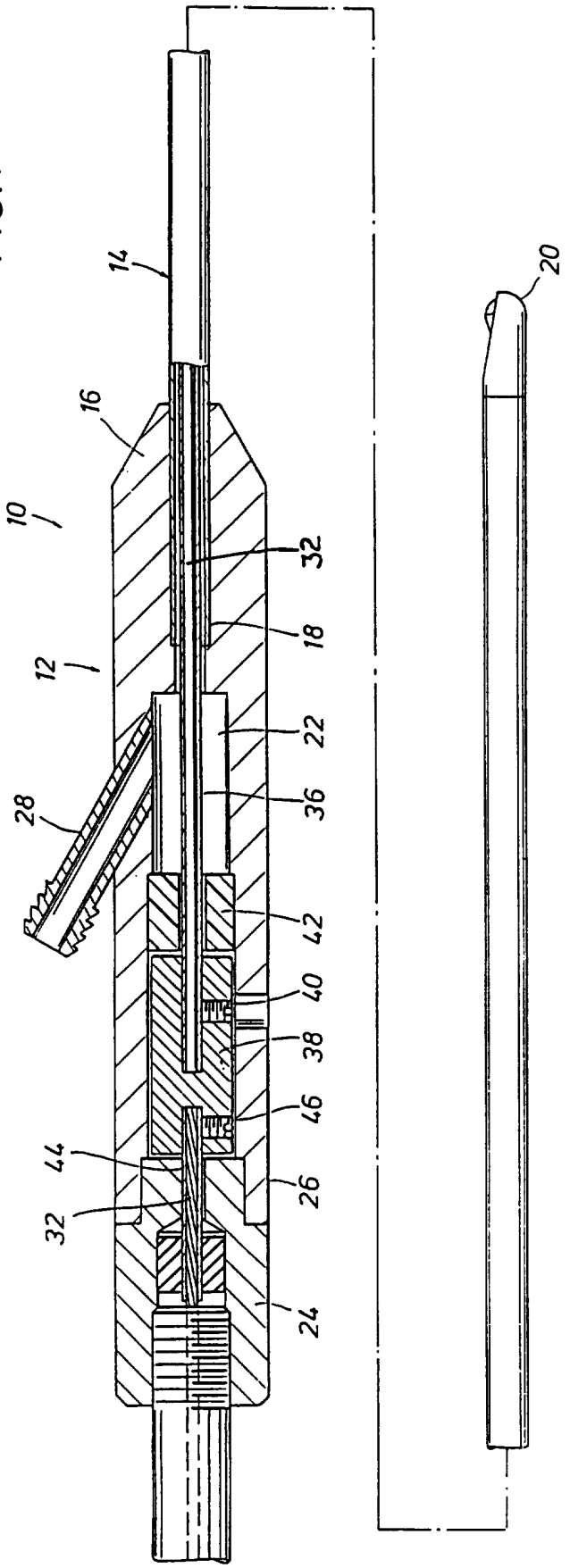


FIG.2

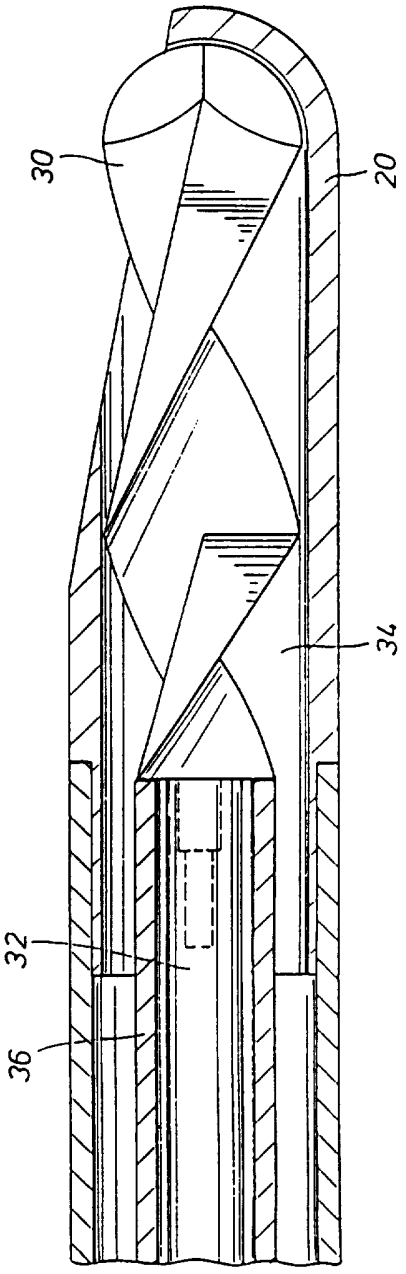


FIG. 3

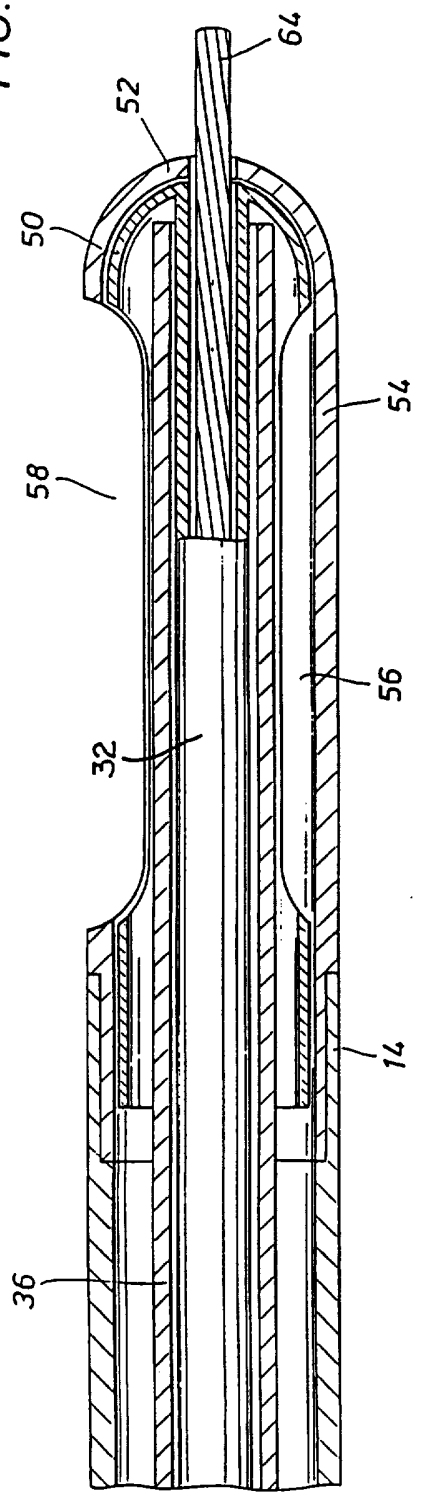


FIG. 4

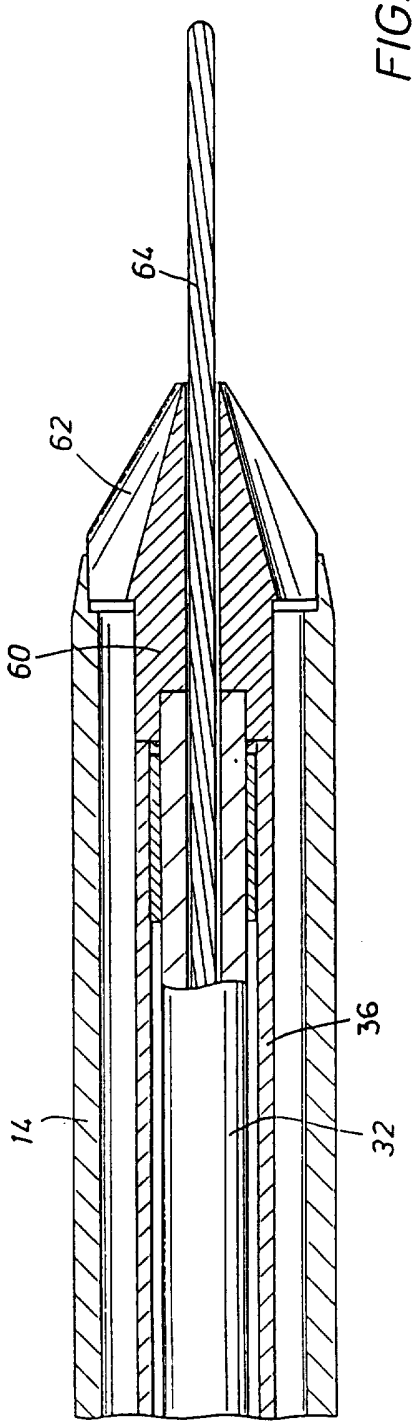


FIG. 5A

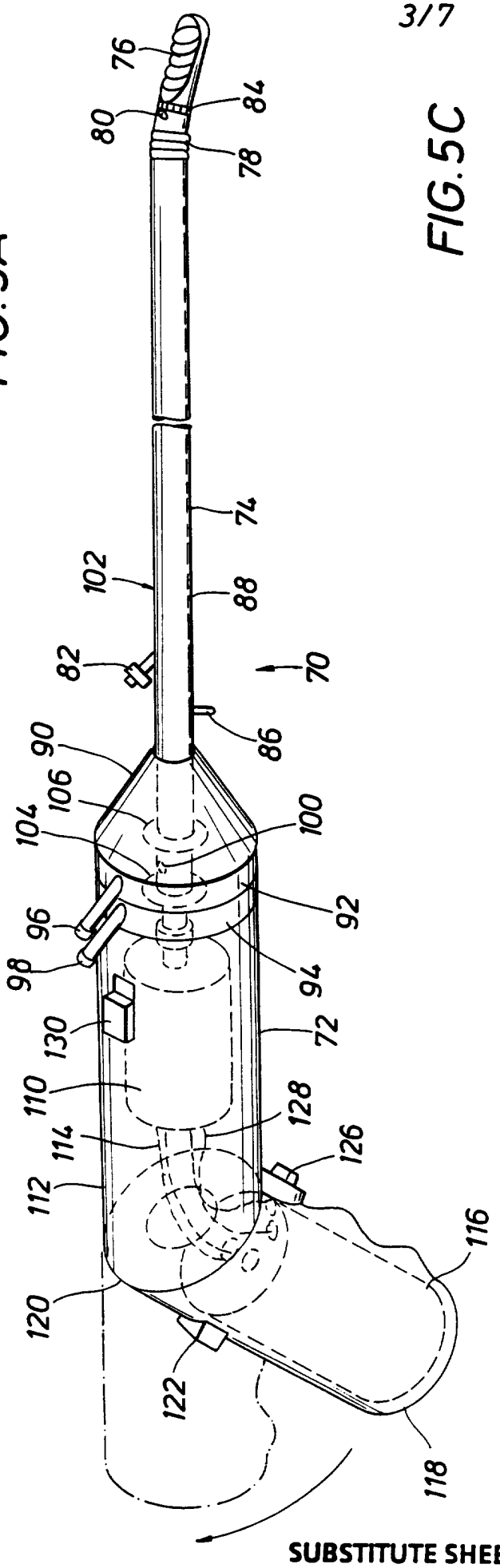


FIG. 5C

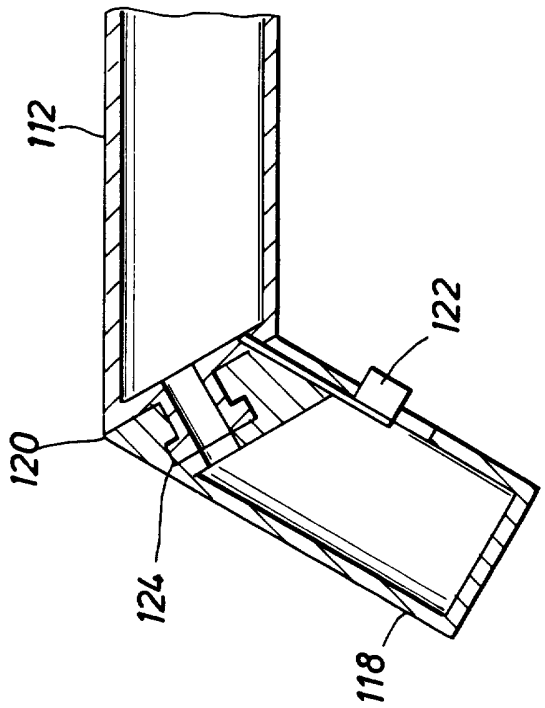
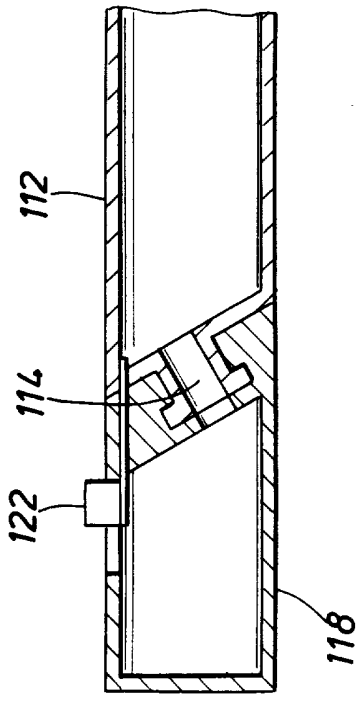


FIG. 5B



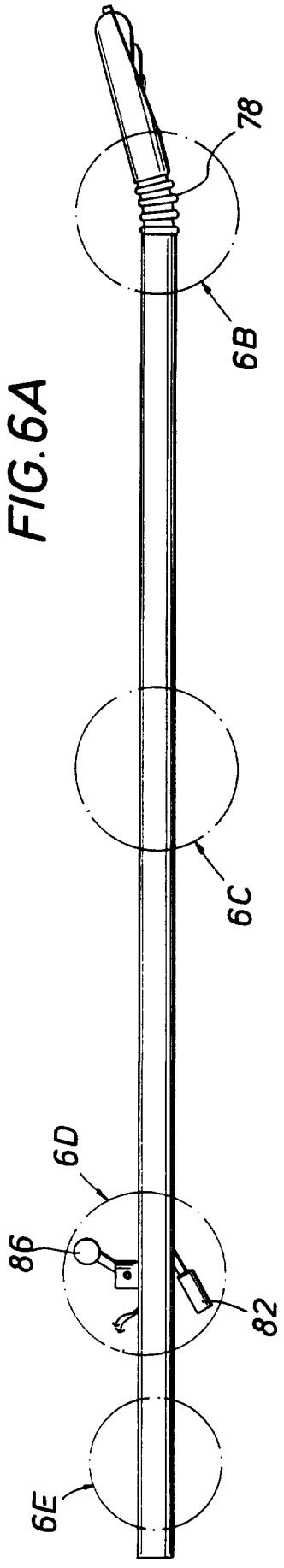


FIG.6A

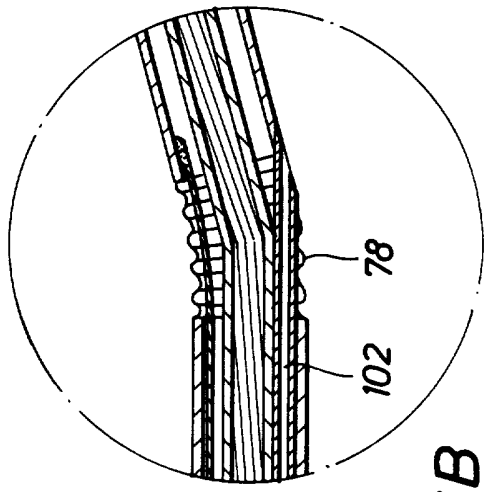


FIG.6B

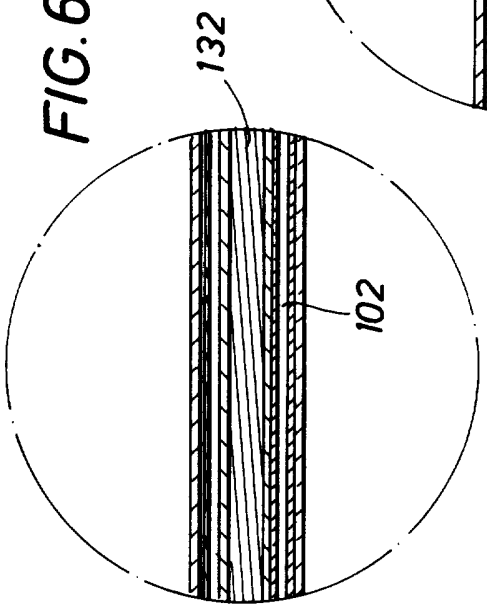


FIG.6C

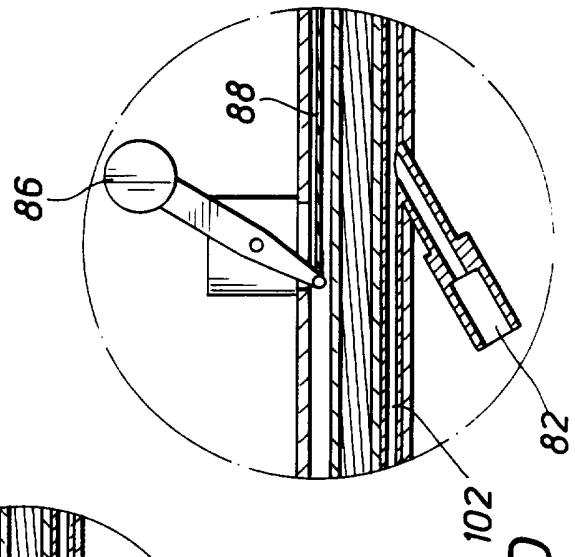


FIG.6D

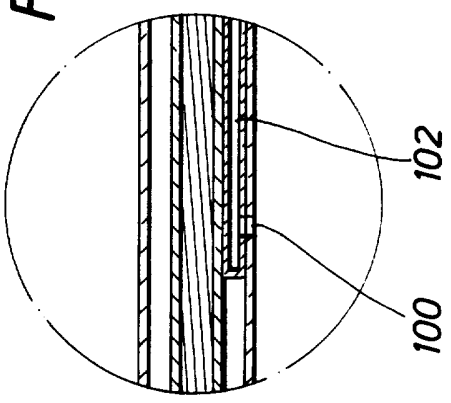


FIG.6E

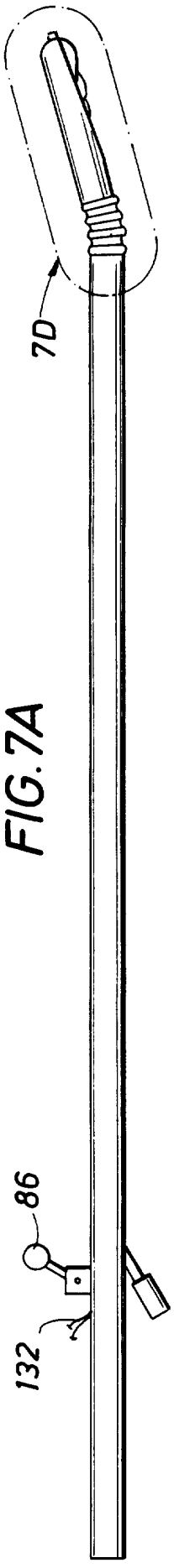


FIG. 7A

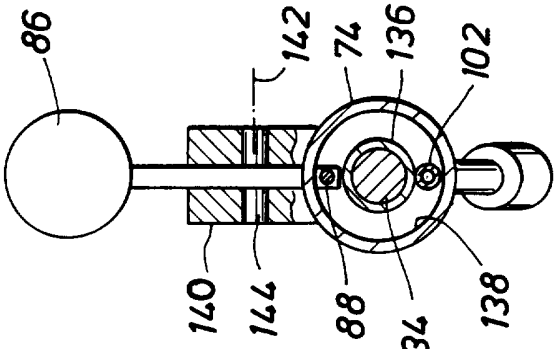


FIG. 8B

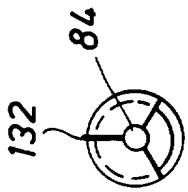


FIG. 7C

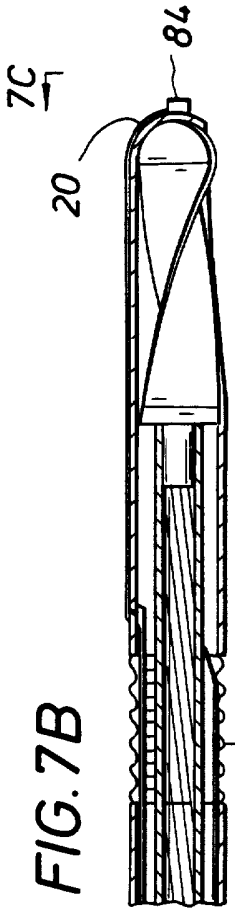


FIG. 7B

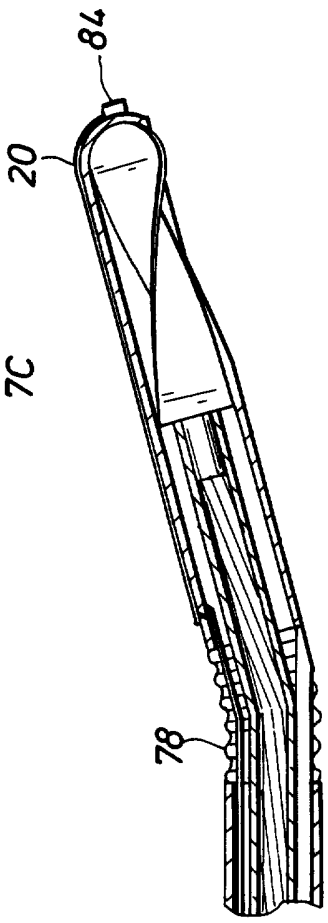


FIG. 7D

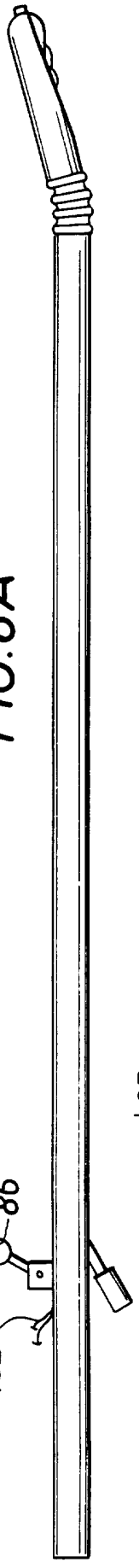


FIG. 8A

FIG. 9B

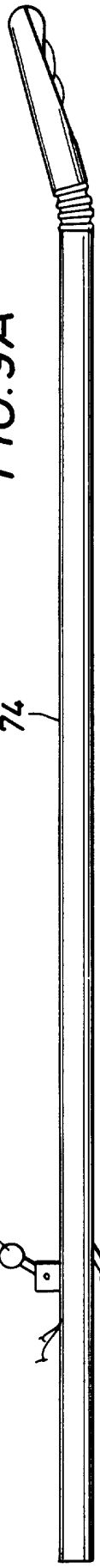


FIG. 9A

FIG. 9C

FIG. 10C

FIG. 10A

FIG. 10B

FIG. 11

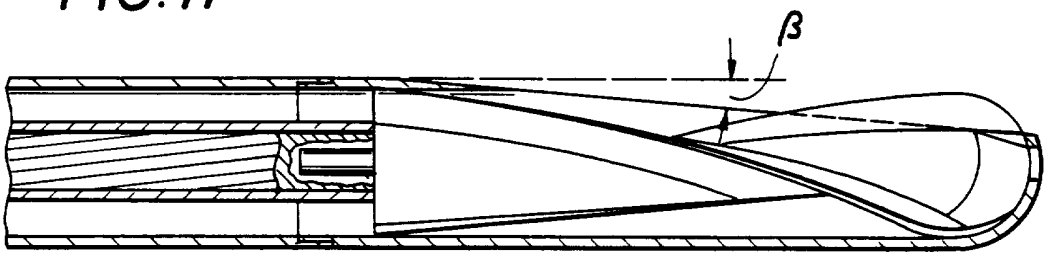


FIG. 12A

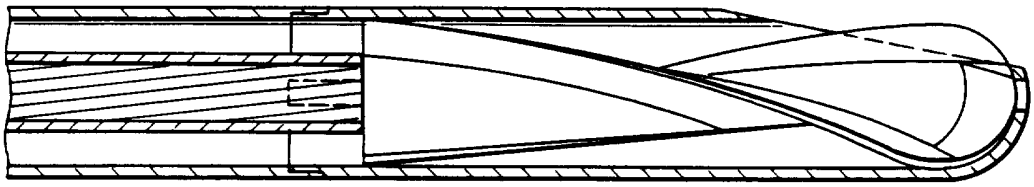


FIG. 12B

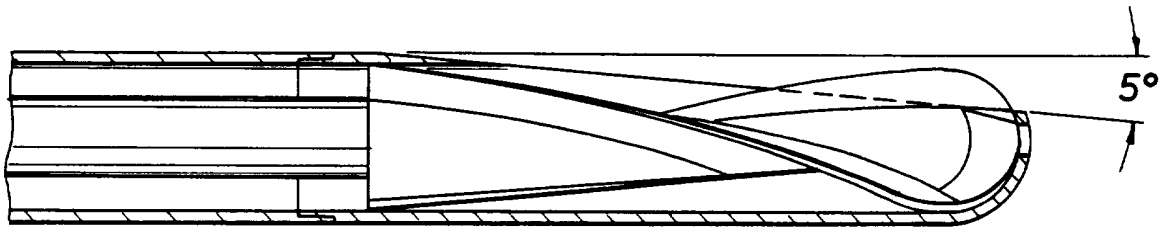


FIG. 12C

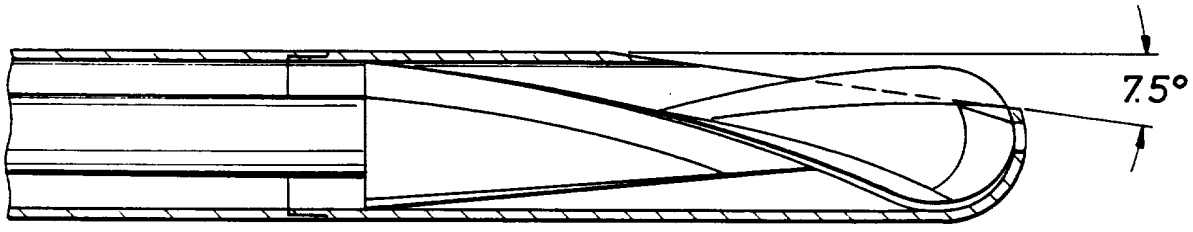
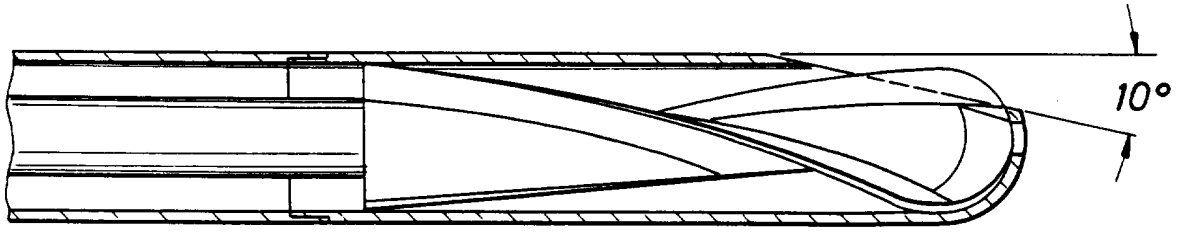


FIG. 12D



INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/US 95/00915

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 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 6 A61B A61F

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 582 533 (LABORATOIRES DOMILENS S.A.) 9 February 1994 see abstract; claims; figures	1,8
A	US,A,4 955 882 (HAKKY) 11 September 1990 see abstract; claims; figures 1-4,13-17	1,3,4,8
A	EP,A,0 442 263 (MICROCISION INC.) 21 August 1991 see claims; figures	1,3,8
A	US,A,5 226 909 (EVANS ET AL.) 13 July 1993 see column 6, line 29-46; claims; figures	1
A	US,A,3 976 077 (KERFOOT, JR.) 24 August 1976 see abstract; figures	1

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

☒ Patent family members are listed in annex.

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

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

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

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"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
25 October 1995	07-11-95
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Authorized officer Giménez Burgos, R

INTERNATIONAL SEARCH REPORT

Inte nal Application No
PCT/US 95/00915

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0582533	09-02-94	FR-A-	2696924	22-04-94
US-A-4955882	11-09-90	US-A-	5061266	29-10-91
		US-A-	5201731	13-04-93
EP-A-0442263	21-08-91	US-A-	5074841	24-12-91
		AU-B-	6943891	01-08-91
US-A-5226909	13-07-93	US-A-	5312425	17-05-94
		US-A-	5403334	04-04-95
US-A-3976077	24-08-76	NONE		