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(54) **Title**: TISSUE REPAIR DEVICE

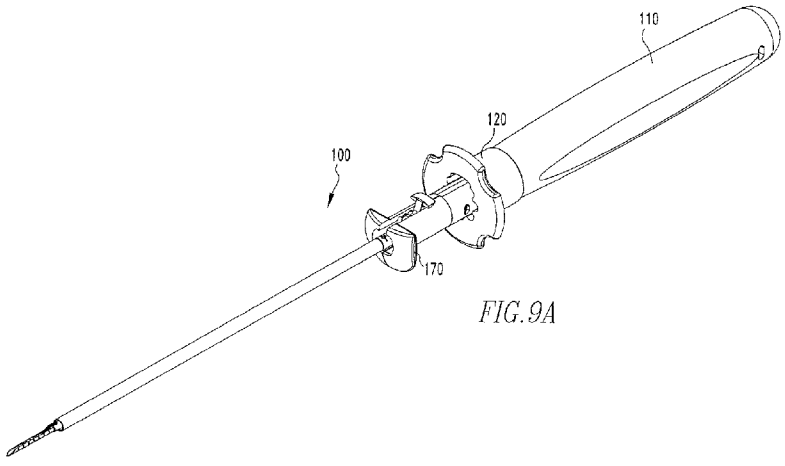

FIG. 9A

(57) **Abstract**: The present disclosure relates to a tissue repair device. The device includes a handle, a knob coupled to the handle, and a needle coupled to the handle. The needle includes a proximal end and a distal end, the distal end including a slot, wherein a first anchor is housed within the distal end and a second anchor is housed within the slot and located proximal to the first anchor. An actuator disposed within the needle and operatively coupled to the knob, wherein advancement of the knob allows for engagement of the actuator with the first anchor and subsequent advancement of the first anchor via the actuator, A method of tissue repair is also disclosed.

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TISSUE REPAIR DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a PCT International patent application claiming priority to United States Patent Application No. 61/117987, filed on November 26, 2008; United States Patent Application No. 61/166,907, filed on April 6, 2009; and United States Patent Application No. 61/255995, filed on October 29, 2009. The disclosures of all of the above-identified applications are incorporated herein by reference in their entirety.

BACKGROUND

FIELD OF TECHNOLOGY

[0002] The present disclosure relates to devices and methods for repairing tissue.

RELATED ART

[0003] Areas in the body where tissue can be surgically reattached to bone or can be surgically repaired when a tear forms in the tissue include, but are not limited to, the biceps tendon, the lateral collateral ligament in the knee, the medial collateral ligament in the knee, the meniscus in the knee, the popliteal ligament in the leg, and the labrum tendon in the knee.

[0004] Fibrous tissue wounds, such as muscle, ligament, and meniscal tears, can be repaired arthroscopically using sutures. Traditionally, to close a fibrous tissue wound, a surgeon would insert two suture needles into the tissue with sutures attached, thread the sutures across the wound, and then tie knots to fix the free ends of the sutures within the tissue.

[0005] To simplify the wound closure and to improve fixation, various types of devices, and tools for use in delivering the devices, have been developed. One example of a device is the FAST-FIX™ device, which is designed to repair tears in soft tissue, such as the meniscus. This device, and other devices for use in wound closure, is shown and described in US Patent

7,153,312, US Patent Application Publication 2003/0130694, US Patent Application Publication US 2005/0283192, and US Patent Application Publication 2005/0033363, the disclosures of which are incorporated herein by reference in their entireties.

SUMMARY

[0006] In one aspect, the present disclosure relates to a tissue repair device. The device includes a handle having a knob coupled to the handle, a needle coupled to the handle, the needle including a proximal end and a distal end, the distal end including a slot, wherein a first anchor is housed within the distal end and a second anchor is housed within the slot and located proximal to the first anchor, and an actuator disposed within the needle and operatively coupled to the knob, wherein advancement of the knob allows for engagement of the actuator with the first anchor and subsequent advancement of the first anchor via the actuator.

[0007] In another aspect, the present disclosure relates to a method of tissue repair. The repair includes providing a tissue repair device comprising a handle, a knob coupled to the handle, a needle coupled to the handle, a first anchor and a second anchor coupled to the needle, the first anchor coupled to the second anchor via a flexible member, and an actuator disposed within the needle and operatively coupled to the knob; inserting the needle through tissue, the tissue including a tear, the needle being inserted through the tissue on one side of the tear; advancing the knob of the device to engage the actuator with the first anchor and advance the first anchor out of the needle; removing the needle from the tissue and re-inserting the needle through the tissue on an opposite side of the tear; advancing the knob of the device to engage the actuator with the second anchor and advance the second anchor out of the needle; and removing the needle from the tissue and reducing a length of the flexible member between the first and second anchor to bring sides of the tear into juxtaposition.

[0008] Further areas of applicability of the present disclosure will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the disclosure, are intended for purposes of illustration only and are not intended to limit the scope of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings, which are incorporated in and form a part of the specification, illustrate the embodiments of the present disclosure and together with the written description serve to explain the principles, characteristics, and features of the disclosure. In the drawings:

[0010] Fig. 1 shows a perspective view of a first embodiment of the tissue repair device of the present disclosure.

[0011] Fig. 2 shows a side view of the tissue repair device of Fig. 1.

[0012] Fig. 3 shows a cross-sectional view of the handle of the tissue repair device of Fig. 1.

[0013] Fig. 4 shows a cross sectional view of the tissue repair device of Fig. 1.

[0014] Fig. 5 shows another cross sectional view of the tissue repair device of Fig. 1.

[0015] Figs. 6A-6B show a cross-sectional view and a perspective view of the distal end of the needle of the tissue repair device of Fig. 1.

[0016] Figs. 7A-7E show a method of tissue repair via use of the tissue repair device of the present disclosure.

[0017] Figs. 8A-8B show advancement of the knob of the tissue repair device of Fig. 1 during the method of tissue repair.

[0018] Fig. 9A shows a perspective view of an a second embodiment of the tissue repair device of the present disclosure.

[0019] Fig. 9B shows a side view of the tissue repair device of Fig. 9A.

[0020] Fig. 9C shows a cross-sectional side view of the tissue repair device of Fig. 9A.

[0021] Fig. 10 shows an isometric view of the handle of the tissue repair device of Figs. 9A-9C.

[0022] Fig. 11A shows an isometric view of the knob of the tissue repair device of Figs. 9A-9C.

[0023] Fig. 11B shows a cross-sectional view of the knob of Fig. 11A.

[0024] Fig. 12A shows an isometric view of the tubing of the tissue repair device of Figs. 9A-9C.

[0025] Fig. 12B shows a cross-sectional view of the tubing of Fig. 12A.

[0026] Fig. 13A shows an isometric view of the pusher assembly of the tissue repair device of Figs. 9A-9C.

[0027] Fig. 13B shows an isometric view of the pusher assembly of the tissue repair device of Figs. 9A-9C with the pusher disk and coiled spring.

[0028] Fig. 14 shows an isometric view of the distal end of the actuator of Figs. 13A-13B.

[0029] Fig. 15 shows an isometric view of the pusher disk of the pusher assembly of Fig. 13B.

[0030] Fig. 16A shows an isometric view of the hub of the tissue repair device of Figs. 9A-9C.

[0031] Fig. 16B shows an isometric view of a first part of the hub of Fig. 16A.

[0032] Fig. 16C shows an isometric view of a second part of the hub of Fig. 16A.

[0033] Fig. 17A shows an isometric view of the needle assembly of the tissue repair device of Figs. 9A-9C.

[0034] Fig. 17B shows an isometric view of the distal end of the needle assembly of Fig. 17A.

[0035] Figs. 18A-18B show isometric views of the distal end of the needle assembly of Fig. 9B with anchors and a transparent tube.

[0036] Fig. 19 shows an isometric view of a first anchor of the tissue repair device of Figs. 9A-9C.

[0037] Fig. 20 shows a side view of a second anchor of the tissue repair device of Figs. 9A-9C.

[0038] Fig. 21 shows an isometric view of the depth tube of the tissue repair device of Figs. 9A-9C.

[0039] Fig. 22A shows an isometric view of the depth tube of Fig. 21 with the slider coupled to the depth tube and the hub.

[0040] Fig. 22B shows a side view of the slider, depth tube, and hub of Fig. 22A.

[0041] Fig. 23 shows an isometric view of the slider of Fig. 22A.

[0042] Fig. 24A shows an isometric view of the distal end of the tissue repair device of Figs. 9A-9C with sutures.

[0043] Fig. 24B shows another isometric view of the distal end of the tissue repair device of Fig. 24A without sutures.

[0044] Fig. 24C shows a cross-sectional view of the distal end of the tissue repair device of Figs. 9A-9C

[0045] Fig. 24D shows a cross-sectional view of the tissue repair device of Figs. 9A-9C, specifically the pusher assembly prior to deployment of the first anchor.

[0046] Fig. 25 shows a cross-sectional view of the pusher assembly of the tissue repair device of the present disclosure during deployment of the first anchor.

[0047] Fig. 26A shows a cross-sectional view of the pusher disk after deployment of the first anchor.

[0048] Fig. 26B shows a cross-sectional view of the distal end of the tissue repair device of the present disclosure after deployment of the first anchor and prior to deployment of the second anchor.

[0049] Figs. 27-30 show a method of tissue repair via use of the tissue repair device of Figs. 9A-9C.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0050] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the disclosure, its application, or uses.

[0051] Figs. 1-5 show a first embodiment the soft tissue repair device **10** of the present disclosure. The device **10** includes a handle **11** and a cannula **12** coupled to the handle **11**. The handle **11** includes a body **11a** and a nose cone **11b** coupled to the body **11a**. The nose cone **11b** includes a

proximal end **11b'** and a distal end **11b''**. The body **11a** includes a cavity **11a'** and a J-shaped channel **13 (Figs. 1 & 8A-8B)**. The channel **13** includes a first portion **13a** and a second portion **13b**. A pusher **14** is housed within the cavity **11a'**. The pusher **14** includes a body **14a**, a shaft **14b** coupled to the body **14a**, and a pin **14c** coupled to the body **14a**. The pin **14c** includes a distal portion **14c'** that extends through the channel **13** and a proximal portion **14c''** that is

coupled to the body **14a**. In addition, the cavity **11a'** includes a coil **15**, wherein one end **15a** of the coil **15** is coupled to the pusher body **14a** and the other end **15b** of the coil **15** is coupled to the proximal end **11b'** of the nose cone **11b**, as shown in Fig. 3. Furthermore, a knob **16** is disposed on the body **11a** of the handle **11**. The knob **16** includes an aperture **16a** that houses the distal portion **14c'** of the pin **14c**. The coil **15**, as shown in Fig. 3, is in a released position when the knob **16** is in a starting position and becomes compressed when the knob **16** is advanced toward the nose cone **11b**, as shown in Figs. 4 & 5.

[0052] The cannula **12** includes a proximal end **12a** and a distal end **12b**. The proximal end **12a** is partially housed within a through hole **11b'''** of the nose cone **11b** and includes areas of reduced diameter **12a'**. A needle **17** is disposed within the cannula **12** and includes a proximal end **17a** and a distal end **17b**. The proximal end **17a** is partially housed within the through hole **11b'''** of the nose cone **11b** and the distal end **17b** includes a beveled, pointed tip **17c** and a slot **17b'**. As shown in Figs. 6A and 6B, a first anchor **20** is housed within the distal end **17b** of the needle **17** and a second anchor **30** is housed within the slot **17b'** and located proximal to the first anchor **20**. The anchors **20,30** are coupled via a flexible member **40**, such as a suture, that includes a slip knot **41** located between the anchors **20,30**. The suture **40** is coupled to the anchors **20,30** and the slip knot **41** is formed via the methods described in the above incorporated US patents and published applications. A free end **42** extends from the slip knot **41** and the suture length between the anchors **20,30** is reduced upon pulling the free end **42** in one direction, but not in another direction, as will be further described below.

[0053] The distal end **17b** also includes laser marks **17b''** that are used during repair to indicate the depth of the needle **17**, as will be further described below. An actuator **18** is disposed within the needle **17** and includes a distal end **18a** engaged with the first anchor **20** and

a proximal end **18b** coupled to the pusher shaft **14b**. A depth indicator **19** is disposed over the cannula **12** and the needle **17**. The indicator **19** includes a proximal end **19a** and a distal end **19b**. The proximal end **19a** includes at least two tabs **19a'** that engage the areas of reduced diameter **12a'** and couple the indicator **19** to the cannula **12**. Prior to repair, the indicator **19** is coupled to the cannula **12** such that the distal end **19b** covers the distal end **17b** of the needle **17**. Fig. 6A shows the distal ends **17b,19b** of the needle **17** and the indicator **19**. As shown, the first anchor **20** is within the distal end **17b** of the needle **17** and the second anchor **30** is within the opening **17b'**, such that the actuator **18** is located below the second anchor **30** and the distal end **18a** is in engagement with the first anchor **20**.

[0054] Referring to Figs. 7A-7E, in use, preferably under arthroscopic guidance, the user inserts the device **10** into, for example, the knee joint, until the distal end **19b** of the indicator **19** is in contact with the superior surface of the meniscus **50**, as shown in Fig. 7A. The indicator **19** is then moved proximally toward the nose cone **11b** to uncover the distal end **17b** of the needle **17**, and determine the appropriate needle insertion depth, as shown in Fig. 7B. In practice, enough of the needle **17** should be exposed to allow for insertion of the needle **17** through the meniscus and subsequent delivery of the anchor **20**, but not so much that the needle **17** will extend into areas behind the meniscus, such as neurovascular areas, where it could cause damage. Insertion of the end **17b** through the meniscus **50** occurs until the appropriate laser mark **17b''** is reached and the knob **16** is then moved distally toward the nose cone **11b** to deploy the first anchor **20**, as shown in Fig. 7C. Before deployment of the first anchor **20**, the pin **14c** is located in the first portion **13a** of the channel **13**, as shown in Fig. 8A. However, after deployment of the first anchor **20**, the pin **14c** is located in the second portion **13b** of the channel **13**, as shown in Fig. 8B.

[0055] Once the first anchor **20** has been deployed, the needle **17** is removed from the meniscus **50** and re-inserted across the tear **51**, as shown in Fig. 7D. The knob **16** is, once again, moved distally toward the nose cone **11b** to deploy the second anchor **30**. The device **10** is subsequently removed from the knee joint and the free end **42** is pulled in the direction of arrow **60**. This shortens the length of suture between anchors **20,30**, bringing sides of tear **51** into juxtaposition, as shown in Fig. 7E. Depending on the length of suture between anchors **20,30**, the slip knot **41** will either be on the tissue surface or move within the tissue **50**. Slip knot **41** allows the suture **40** to slide in the direction of arrow **61**, but does not allow the suture **40** to slide in the opposite direction **60**. The tension placed on suture **40** by pulling on the suture **40** relative to anchors **20,30** acts to turn the anchors **20,30** such that their long sides are in contact with tissue surface. Excess suture **40** can then be cut off. Further manipulation of suture **40** is not needed to secure anchors **20,30**, although the surgeon may wish to provide additional fastening as a back-up securement measure.

[0056] For the purposes of this disclosure, the handle **11**, nose cone **11b**, pusher **14**, shaft **14b**, knob **16**, actuator **18**, cannula **12**, and depth indicator **19** are of a non-metal material, but may be made from a metal material. In addition, the coil **15**, pin **14c**, and needle **17** are of a biocompatible metal material, such as stainless steel. The anchors **20,30** and suture **40** are of a non-metal material, such as a polymer material, and may or may not be absorbable. The handle **11** and nose cone **11b** may be coupled via mechanical means, adhesive means, such as a non-toxic, biocompatible, adhesive glue, or other means known to one of skill in the art. In addition, the cannula **12** and needle **17** are coupled to the nose cone **11b**, the actuator **18** is coupled to the shaft **14b**, and the coil **15** is coupled to the nose cone **11b** and the pusher **14** via similar means. The device **10** and its components are all made via a method known to one of skill in the art.

[0057] Figs. 9A-9C show an alternative embodiment of the soft tissue repair device **100** of the present disclosure. The components of the device **100** will be described with reference to Figs. 10, 11A-11B, 12A-12B, 13A-13B, 14, 15, 16A-16C, 17A-17B, 18A-18B, 19, 20, 21A-21B, 22A-22B, and 23. The device **100** includes a handle **110** which, as shown in Fig. 10, includes a closed-ended proximal portion **110a**, an open distal portion **110b**, a cannulation **110c**, and an outer surface **110d** including holes **110e** on opposite sides of the handle **110**. The purpose of the holes **110e** will be further described below. Disposed within the handle **110** is a knob **120**. As shown in Figs. 11A-11B, the knob **120** includes a shaft **121**, a head **122** coupled to the shaft **121**, and a cannulation **123**. The head **122** includes a flange **122a** and a neck **122b**, both of which have a larger diameter than the shaft **121**. The flange **122a** includes depressions **122a'**. The inner wall **122c** of the head **122** includes several grooves **122c'**. The shaft **121** includes an outer wall **121a** having slots **121b** and an inner wall **121c**. Coupled to the inner wall **121c** is a rod **121d** having a cannulation **121d'**. The cannulation **121d'** has a "D" shape, such that a portion of the cannulation **121d'** is flat and the rest of the cannulation is rounded. The rod **121d** includes a first portion **121e** and a second portion **121f**. The first portion **121e** includes a face **121e'** having spikes **121e''** and divots **121e'''** located between the spikes **121e''**. An end **121f'** of the second portion **121f** includes legs **121g** that extend between an outer surface **121f''**of the second portion **121f** to an inner wall **121c** of the shaft **121**.

[0058] Disposed within the cannulation **123** of the knob **120** and, therefore the handle **110**, is a tubing **130**. As shown in Figs. 12A-12B, the tubing **130** includes a proximal portion **131**, a distal portion **132**, an outer surface **133**, an inner surface **134**, and a cannulation **135**. The proximal portion **131** of the tubing **130** includes slots **136** that divide the proximal portion **131** into two sides **131a,131b**. Both sides **131a,131b** of the proximal portion **131** include tabs **137**

that extend outward from the outer surface **133** of the tubing **130**. When the tubing **130** is disposed within the handle **110**, the tabs **137** are disposed within the holes **110e** of the handle **110**, thereby coupling the tubing **130** to the handle **110**. The distal portion **132** of the tubing **130** includes channels **132a** located on opposite sides of the distal portion **132**. A hole **138** is located at an end **132a'** of each channel **132a**. The purpose of the channels **132a** and the holes **138** will be further described below. The distal portion **132** also includes rails **139** and slots **132b,132c** located between the rails **139**. Slots **132b,132c** both extend an entire length of the rails **139**. However, slot **132b** includes two regions **132b',132b''** having different depths, such that a stepped region **132b'''** is present along the slot **132b**, as is more clearly shown in Fig. 12B.

[0059] Also disposed within the handle **110** is a pusher assembly **140**. The pusher assembly **140** is shown in Fig. 13B. Fig. 13A shows the pusher assembly **140** without the coiled spring **150** or the pusher disk **160**. The assembly **140** includes a shaft **141** and an actuator **142** coupled to the shaft **141**. The shaft **141** includes a proximal portion **141a** and a distal portion **141b**. The proximal portion **141a** includes a flat portion **141a'**, such that the proximal portion **141a** is in the shape of a "D". As mentioned above, the cannulation **121d'** of the rod **121d** also has a "D" shape. As is shown in Fig. 9C, the proximal portion **141a** of the shaft **141** is housed within the cannulation **121d'** of the rod **121d**, such that the flat portions of the cannulation **121d'** and the proximal portion **141a** are adjacent to each other, thereby coupling the pusher assembly **140** to the knob **120**. As will be further described below, during operation, the "D" shapes of the cannulation **121d'** and the proximal portion **141a** allow for axial movement of the proximal portion **141a** within the cannulation **121d'** and restrict rotational movement of the proximal portion **141a** within the cannulation **121d'**.

[0060] The distal portion **141b** includes a flanged cap **141c** located on the distal portion **141b** and an inner channel **141b'**. The flanged cap **141c** includes a cap **141c'** and a flange **141c''**. The flanged cap **141c** is located on the distal portion **141b** such that there is an area of reduced diameter **141d** located between the proximal portion **141a** and the flange **141c''**. The distal portion **141b** is configured for attachment of a pusher disk **160** as will be further described below with regard to Fig. 15.

[0061] The actuator **142** includes a proximal portion **142a** and a distal portion **142b**. The proximal portion **142a** is housed within the inner channel **141b'**, thereby coupling the actuator **142** to the shaft **141**. As shown in Fig. 14, the distal portion **142b** of the actuator **142** includes a flat top portion **142b'**, a rounded bottom portion **142b''**, and a beveled end portion **142b'''**. The top portion **142b'** and the end portion **142b'''** are shaped to engage a tissue anchor, as will be further described below. A coiled spring **150** is disposed on the actuator **142** such that an end **150a** of the spring **150** rests against the cap **141c'**, as shown more clearly in Fig. 13B. As will be further described below, it is important that the end **150a** of the spring **150** rest against the cap **141c'** rather than the pusher disk **160** so as to not restrict rotation of the pusher disk **160** during operation of the device **100**.

[0062] As shown in Fig. 15, the pusher disk **160** includes a cannulation **161**, a front portion **162**, a back portion **163**, an inner surface **164**, and an outer surface **165**. Protrusions **166** are located on the outer surface **165** of the disk **160**. The cannulation **161** includes a first portion **161a**, a second portion **161b**, and a third portion **161c**. The second portion **161b** has a smaller diameter than both of the first and third portions **161a,161c**, such that coupling of the pusher disk **160** to the distal portion **141b** results in the second portion **161b** being disposed within the area of reduced diameter **141d**. In addition, the first and third portions **161a,161c** are of a diameter

such that during operation of the device **100** the disk **160** is capable of rotating without restriction from either the flange **141c''** or the proximal portion **141a**. The back portion **163** of the disk **160** includes spikes **163a** and divots **163b** located between the spikes **163a**. During operation of the device **100**, the spikes **163a** and divots **163b** engage the spikes **121e''** and divots **121e'''** of the rod **121d** and the rails **139** of the tubing **130**, as will be further described below. In addition, during operation, the protrusions **166** slide within the slots **132b,132c** of the tubing **130**, as will be further described below.

[0063] Figs. 16A-16C show a two-part hub **170**. The hub **170** includes a first part **171**, as more clearly shown in Fig. 16B, and a second part **172**, as more clearly shown in Fig. 16C. Both the first part **171** and the second part **172** include a first section **171a,172a** and a second section **171b,172b**. The first sections **171a,172a** include a depression **171a',172a'** and grooves **171a'',172a''**. The second sections **171b,172b** include a channel **171b',172b'** and at least two bosses **171b'',172b''** located within each channel **171b',172b'**. The first part **171** also includes pins **171c** that, upon coupling of the first part **171** and the second part **172** to form the hub **170**, are disposed within holes **172c** on the second part **172**. Each part **171,172** also includes tabs **171d, 172d** located on an outer surface **171b''',172b'''** of the second sections **171b,172b**. As shown in Fig. 9C, the second section **171b,172b** is housed within the cannulation **135** of the tubing **130** such that the tabs **171d,172d** are disposed within the holes **138** of the tubing **130**, thereby coupling the hub **170** to the tubing **130**.

[0064] Figs. 17A and 17B show a needle assembly **180**. The assembly **180** includes a disposal rod **181** and a needle **182** disposed within the rod **181**. The rod **181** includes a proximal portion **181a**, a distal portion **181b**, and an inner channel **181c**. The proximal portion **181a** includes depressions **181a'** on opposite sides of the proximal portion **181a**. As shown in Fig.

9C, the needle assembly **180** is disposed within the hub **170**, such that the bosses **171b'',172b''** for both parts **171,172** are disposed within the depressions **181a'**, thereby coupling the assembly **180** to the hub **170**. The distal portion **181b** includes a flange **181b'**. It is within the scope of this disclosure that the distal portion **181b** includes more than one flange **181b'**. The needle **182** includes a proximal portion **(not shown)** housed within the inner channel **181c** of the rod **181** and a distal portion **182b** including a beveled tip **182b'**, a slot **182b''** extending from the beveled tip **182b'** and including a front portion **182d**, a back portion **182e**, and two sides **182f**, and laser marks **182b'''**. The laser marks **182b'''** are used during repair to indicate the depth of the needle **182**, as will be further described below.

[0065] As shown in Figs. 18A and 18B, anchors **190,1000**, which are more clearly shown in Figs. 19 and 20, are coupled to the distal portion **182b** of the needle **182**. Both anchors **190,1000** include holes **190a,1000a** and slots **190b,1000b**. The second anchor **1000** includes channels **1000c** on opposite sides of the anchor **1000** and a protrusion **1010**. The second anchor **1000** is coupled to the needle **182**, such that the sides **182f** of the slot **182b''**are housed within the channels **1000c** and the back portion **182e** of the slot **182b''** is within slot **1000b**. Also shown in Figs. 18A-18B is a cannulated, transparent tube **200**. The tube **200** includes a proximal portion **200a**, which is disposed over the distal portion **181b** of the rod **181** such that the flange **181b'** engages an inner wall **200c** of the tube **200**, and a distal portion **200b** is disposed over the protrusion **1010** of the second anchor **1000**. The protrusion **1010** allows for an increased amount of interference between the distal portion **200b** of the tube **200** and the anchor **1000** when the distal portion **200b** is disposed over the protrusion **1010** of the anchor **100**. This increased amount of interference increases the retention of the anchor **1000** to the needle **182**.

[0066] The actuator **142** is disposed within needle **182** such that the end portion **142b'''** of the actuator **142** is located proximal to the first anchor **190** and distal to the second anchor **1000**.

[0067] Fig. 21 shows a depth tube **300**, which includes a first portion **300a**, a second portion **300b**, and a cannulation **300c**. As shown in Figs. 1C and 22A-22B, a slider **400**, which is more clearly shown in Fig. 23, is coupled to the depth tube **300** such that a shaft **401** of the slider **400** is housed within the second portion **300b** of the depth tube **300**. The slider **400** includes the shaft **401**, a housing **402** coupled to the shaft **401**, and a cannulation **403**. The shaft **401** includes a distal portion **401a** and a proximal portion **401b** having a diameter such that the shaft **401** engages an inner wall **300b'** of the second portion **300b**, thereby coupling the slider **400** to the depth tube **300**. The housing **402** includes a top portion **402a**, a bottom portion **402b**, and an opening **402c**. The top portion **402a** includes tabs **402a'**. As shown in Fig. 22B, the housing **402** is located within the hub **170** such that the tabs **402a'** are located within the grooves **171a'',172a''**. The needle assembly **180** is housed within the cannulation **300c** of the depth tube **300**. Longitudinal movement of the depth tube **300** occurs via pressing on the top portion **402a** of the housing **402** in a direction towards the bottom portion **402b**, so as to remove the tabs **402a'** from one of the grooves **171a'',172a''**, moving the housing **402** longitudinally in a proximal direction towards or away from the handle **110**, and then releasing the top portion **402a** such that the tabs **402a'** are deposited into other one of the grooves **171a'',172a''**.

[0068] As shown in Fig. 24A, the anchors **190,1000** are coupled via a flexible member **500**, such as a suture, that includes a slip knot **501** located between the anchors **190,1000**. The suture **500** is coupled to the anchors **190,1000** and the slip knot **501** is formed via the methods described in the above incorporated US patents and published applications. A free end **502**

extends from the slip knot **501** and the suture length between the anchors **190,1000** is reduced upon pulling the free end **502** in one direction, but not in another direction, as will be further described below.

[0069] Referring to Figs. 27-30, in use, preferably under arthroscopic guidance, the user inserts the device **100** into, for example, the knee joint, until the beveled tip **182b'** of the needle **182** is in contact with the superior surface of the meniscus **700**, as shown in Fig. 27. At this time, the device **100**, and especially the starting position of its components, is as shown in Figs. 24B-24D. Namely, as stated above, the end portion **142b'''** of the actuator **142** is located proximal to the first anchor **190** and distal to the second anchor **1000** and a distal portion **200b** of the tube **200** is disposed over at least a portion of the second anchor **1000**. The first portions **171a, 172a** of the hub **170**, and specifically the fronts **(Fig. 22A, 171a'',172a'')** of portions **171a,172a** are aligned with the markings **300d** of the second portion **300b**. Similarly, as can be seen in Fig. 27, the front **300a'** of the depth tube **300** is aligned with the markings **182b'''** of the needle **182**. During repair, as the depth tube **300** is moved longitudinally along the needle **182**, the fronts **171a'', 172a'', 300a'** of the hub **170** and the depth tube **300** will continue to align with the markings **300d, 182b'''**such that the markings **300d, 182b'''** that the fronts **171a'', 172a'', 300a'** are aligned with will be equivalent to each other. For example, when fronts **171a'', 172a''** are aligned with marking **300d** that corresponds to 1 mm, front **300a'** is aligned marking **182b'''** that corresponds with 1mm.

[0070] Optionally, the depth tube **300** is disposed over the needle assembly **180** and, after insertion of the device **100** into the joint, the tube **300** is moved proximally, in a manner as described above, toward the knob **120** to uncover the distal end **182b** of the needle **182**, and determine the appropriate needle insertion depth, which the laser marks **182b''', 300d** may be

used for. In practice, enough of the needle **182** should be exposed to allow for insertion of the needle **182** through the meniscus and subsequent delivery of the anchor **190**, but not so much that the needle **182** will extend into areas behind the meniscus, such as neurovascular areas, where it could cause damage.

[0071] In addition to the starting position of the beveled tip **182b'** of the needle **182**, the starting position of the disk **160** is shown in Fig. 24D. The disk **160** is located such that the protrusions **166** are located in slots **132b**, specifically region **132b'**, and the spikes **163a** of the protrusions **166** rest against stepped region **132b'''**.

[0072] Insertion of the end **182b** through the meniscus **700** occurs until the depth tube **300** prevents the needle **182** from being inserted any further or the user decides to discontinue insertion of the needle **182**. The knob **120** is then moved distally over the hub **170** to deploy the first anchor **190**, as shown in Fig. 28. At this time, the position of the pusher disk **160** is shown in Fig. 25. Specifically, movement of the knob **120** in a distal direction pushes the disk **160** out of slot **132b**. In addition, knob movement causes engagement to occur between spikes **163a** of disk **160** and spikes **121e''** of rod **121d''**, thereby causing the disk **160** to partially rotate. After deployment of the first anchor **190**, the knob **120** is moved proximally toward the handle **110**. Upon movement of the knob **120** in a proximal direction, the protrusions **166** of the knob **120** engage the rails **139**, which cause another partial rotation of the disk **160**, thereby locating the protrusions **166** in slots **132c**. Once the protrusions **166** are located in slots **132c**, the disk **160** continues to move in the proximal direction until the head **122** of the knob **120** rests against the handle **110**, as shown in Fig. 26A. Fig. 26A also shows the back portion **163** of the disk **160** resting against the face **121e'** of the rod **121d''**. As shown in Fig. 26B, when the disk **160** is

positioned as shown in Fig. 26A, the end portion **142b'''** of the actuator **142** is located proximal to the second anchor **1000**.

[0073] Once the first anchor **190** has been deployed, the needle **182** is removed from the meniscus **700** and re-inserted across the tear **701**, as shown in Fig. 29. The knob **120** is, once again, moved distally over the hub **170** to deploy the second anchor **1000**. Specifically, when the end portion **142b'''** of the actuator **142** is located proximal to the second anchor **1000**, the end portion **142b'''** is flipped upward, as shown in Fig. 26B, which allows the end portion **142b'''** to engage the anchor **1000** and be inserted into the slot **1000b** upon movement of the knob **120** in a distal direction. Further movement of the actuator **142** pushes the anchor **1000** out of the needle **182**. In addition, knob movement in a distal direction causes the disk **160** to be dispelled from the slot **132b**, thereby causing the disk **160** to partially rotate. After deployment of the second anchor **1000**, the knob **120** is moved proximally toward the handle **110**. Upon movement of the knob **120** in a proximal direction, the protrusions **166** of the disk **160** engage the rails **139**, which cause another partial rotation of the disk **160**, thereby locating the protrusions **166** in slots **132b**. Once the protrusions **166** are located in slots **132b**, the disk **160** continues to move in the proximal direction until the spikes **163a** of the protrusions **166**, once again, rest against stepped region **132b'''**, as shown in Fig. 24D.

[0074] The device **10** is subsequently removed from the knee joint and the free end **502** is pulled in the direction of arrow **600**. This shortens the length of suture between anchors **190,1000**, bringing sides of tear **701** into juxtaposition, as shown in Fig. 30. Depending on the length of suture between anchors **190,1000**, the slip knot **501** will either be on the tissue surface or move within the tissue **700**. Slip knot **501** allows the suture **500** to slide in the direction of arrow **601**, but does not allow the suture **500** to slide in the opposite direction **600**. The tension

placed on suture **500** by pulling on the suture **500** relative to anchors **190,1000** acts to turn the anchors **190,1000** such that their long sides are in contact with tissue surface. Excess suture **500** can then be cut off. Further manipulation of suture **500** is not needed to secure anchors **190,1000**, although the surgeon may wish to provide additional fastening as a back-up securement measure.

[0075] For the purposes of this disclosure, the needle **182**, rod **181**, actuator **142**, and spring **150** are of a biocompatible metal material, such as stainless steel, but may be made from a non-metal material. All of the other components are made from a non-metal material. The anchors **190,1000** and suture **500** are of a polymer material, which may or may not be an absorbable polymer material. The actuator **142** may be coupled to the shaft **141** and the needle **182** may be coupled to the rod **181** via mechanical means, adhesive means, such as a non-toxic, biocompatible, adhesive glue, or other means known to one of skill in the art. The device **100** and its components are all made via a method known to one of skill in the art, including, but not limited to injection molding.

[0076] As various modifications could be made to the exemplary embodiments, as described above with reference to the corresponding illustrations, without departing from the scope of the disclosure, it is intended that all matter contained in the foregoing description and shown in the accompanying drawings shall be interpreted as illustrative rather than limiting. Thus, the breadth and scope of the present disclosure should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims appended hereto and their equivalents.

CLAIMS

What is claimed is:

1. A tissue repair device comprising:

a handle including a knob coupled to the handle;

a needle coupled to the handle, the needle including a proximal end and a distal end, the distal end including a slot, wherein a first anchor is housed within the distal end and a second anchor is housed within the slot and located proximal to the first anchor; and

an actuator disposed within the needle and operatively coupled to the knob, wherein advancement of the knob allows for engagement of the actuator with the first anchor and subsequent advancement of the first anchor via the actuator.

2. A method of tissue repair comprising:

providing a tissue repair device comprising a handle, a knob coupled to the handle, a needle coupled to the handle, a first anchor and a second anchor coupled to the needle, the first anchor coupled to the second anchor via a flexible member, and an actuator disposed within the needle and operatively coupled to the knob;

inserting the needle through tissue, the tissue including a tear, the needle being inserted through the tissue on one side of the tear,;

advancing the knob of the device to engage the actuator with the first anchor and advance the first anchor out of the needle;

removing the needle from the tissue and re-inserting the needle through the tissue on an opposite side of the tear;

advancing the knob of the device to engage the actuator with the second anchor and advance the second anchor out of the needle; and

removing the needle from the tissue and reducing a length of the flexible member between the first and second anchor to bring sides of the tear into juxtaposition.

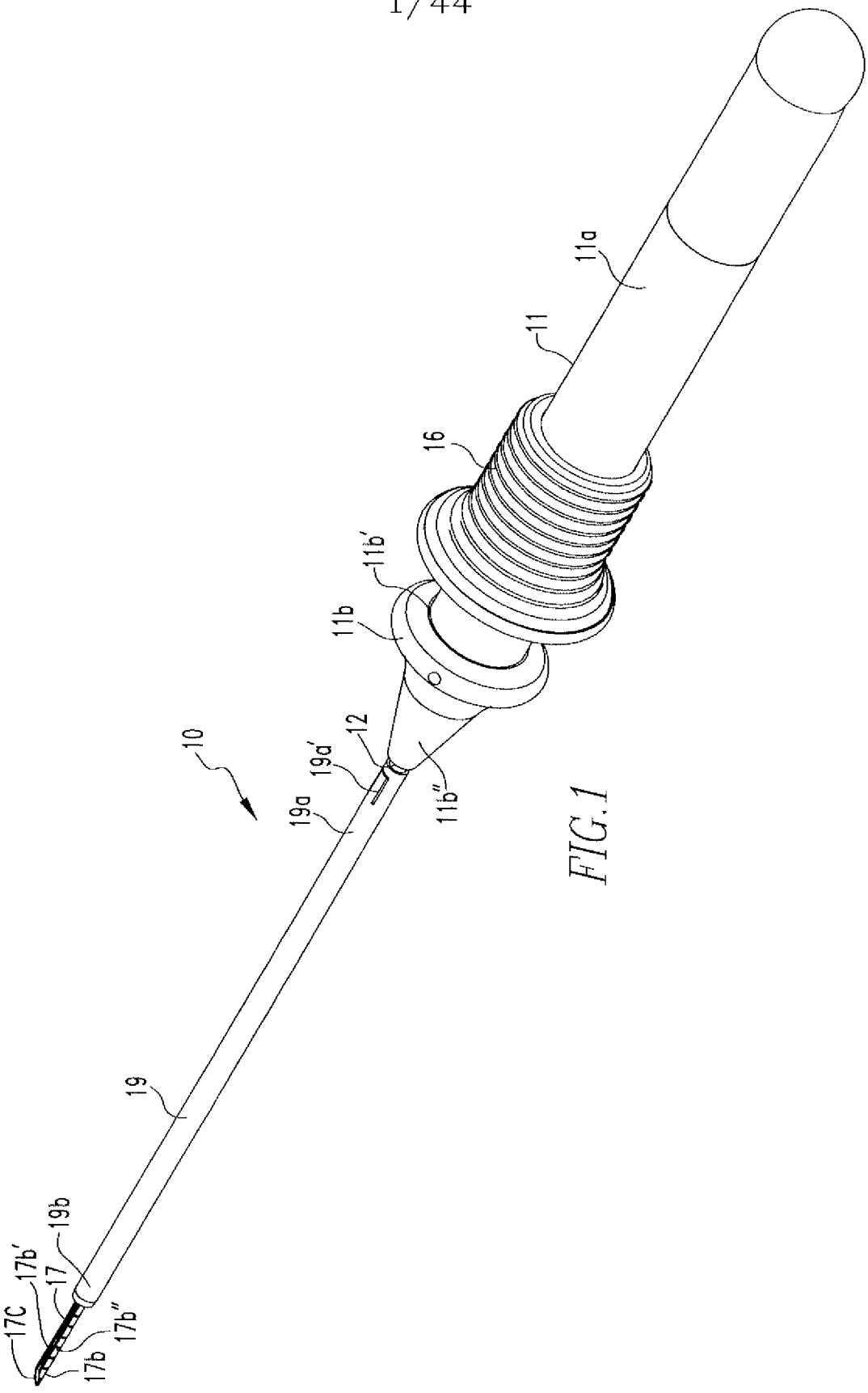

FIG. 1

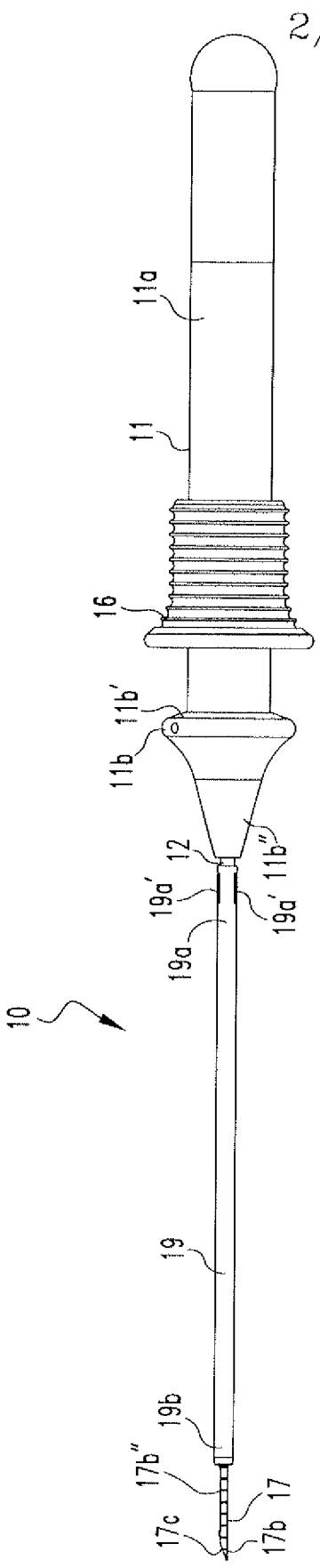

FIG.2

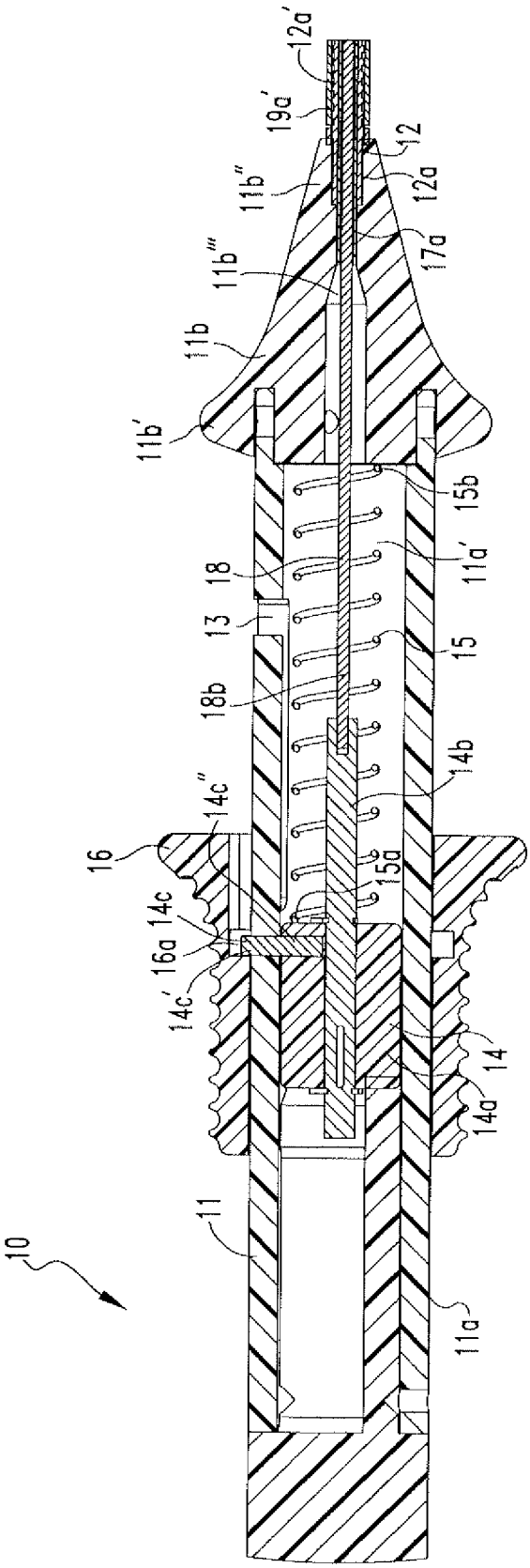
12a'
19a'
12
11b''
12a
17a
11b'''
11b
11b'
15b
18
11a'
13
15
18b
14b
14c''
16
15a
14c
16a
14c'
14
14a
11
10
11a

FIG. 3

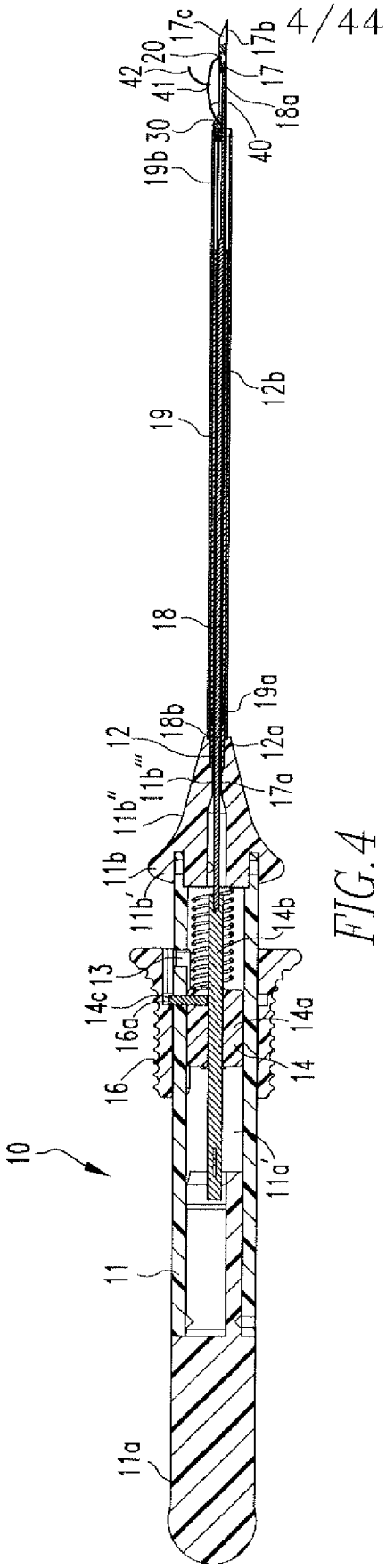
17c
17b
20
42
41
17
18a
19b
30
40
12b
19
18
19a
18b
12
12a
11b''
11b'''
17a
11b
11b'
14b
13
14c
16a
14a
16
14
10
11a'
11
11a

FIG. 4

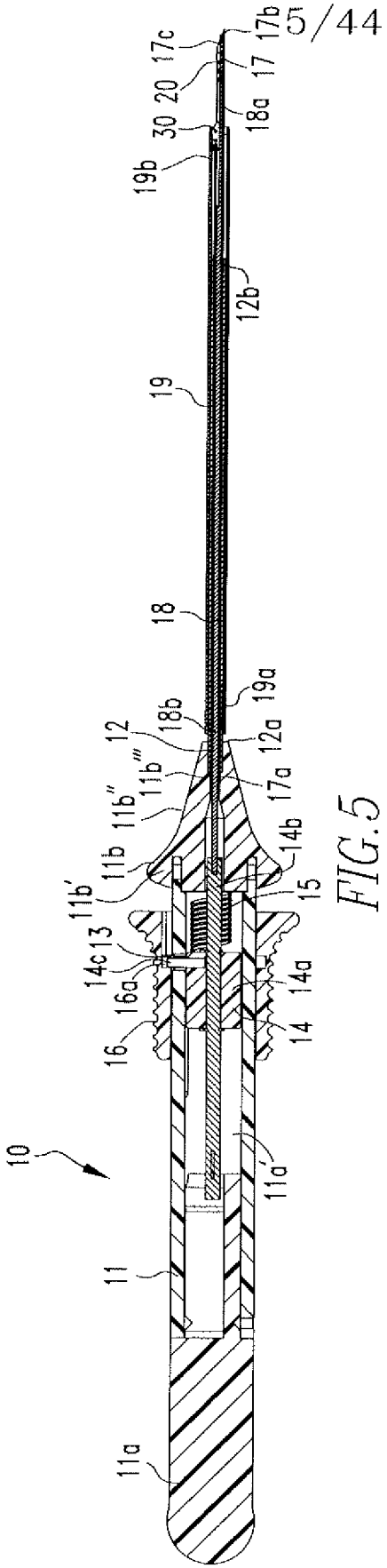
17c
17b
17
20
30
18a
19b
12b
19
18
19a
18b
12
12a
11b‴
11b″
17a
11b
14b
11b′
15
13
14c
16a
14a
16
14
10
11a′
11
11a

FIG.5

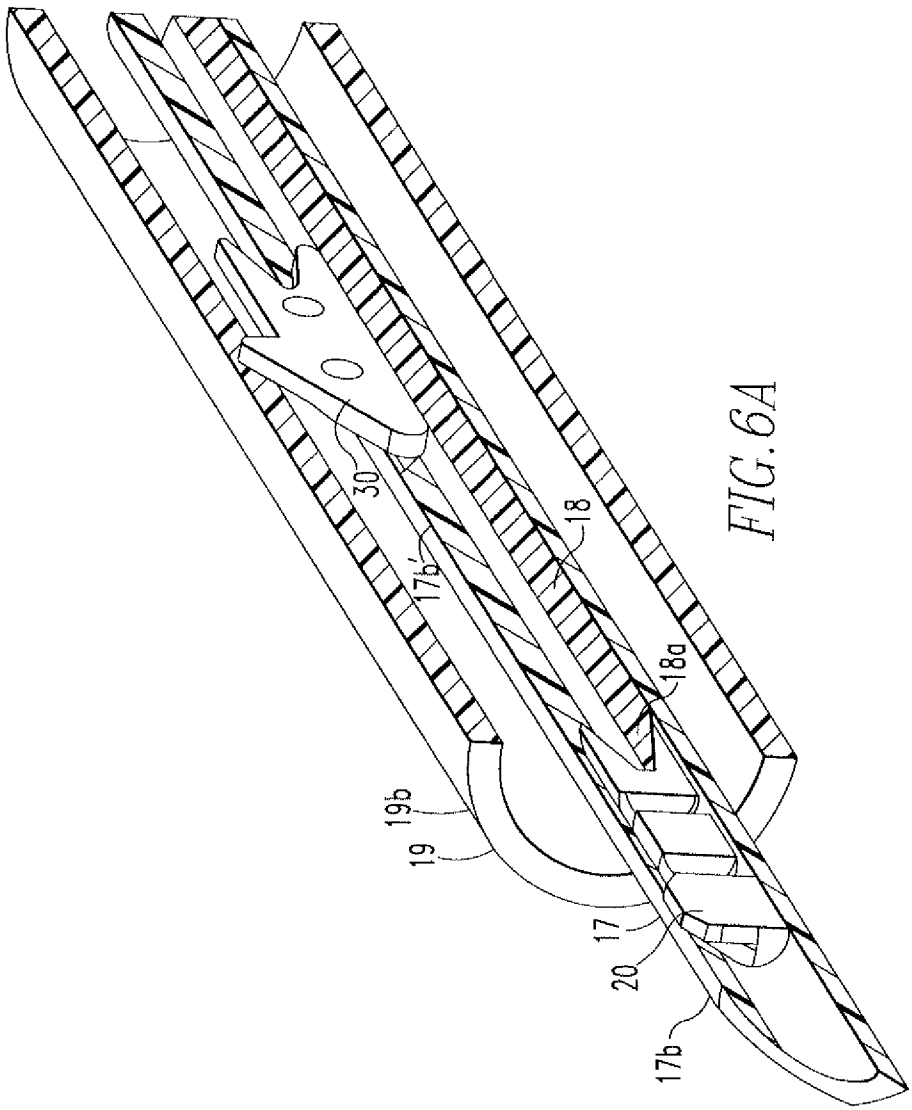

FIG.6A

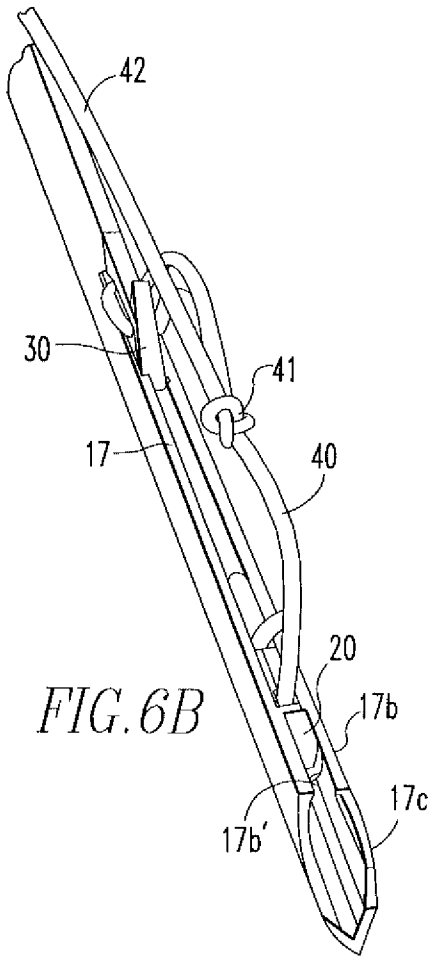

FIG. 6B

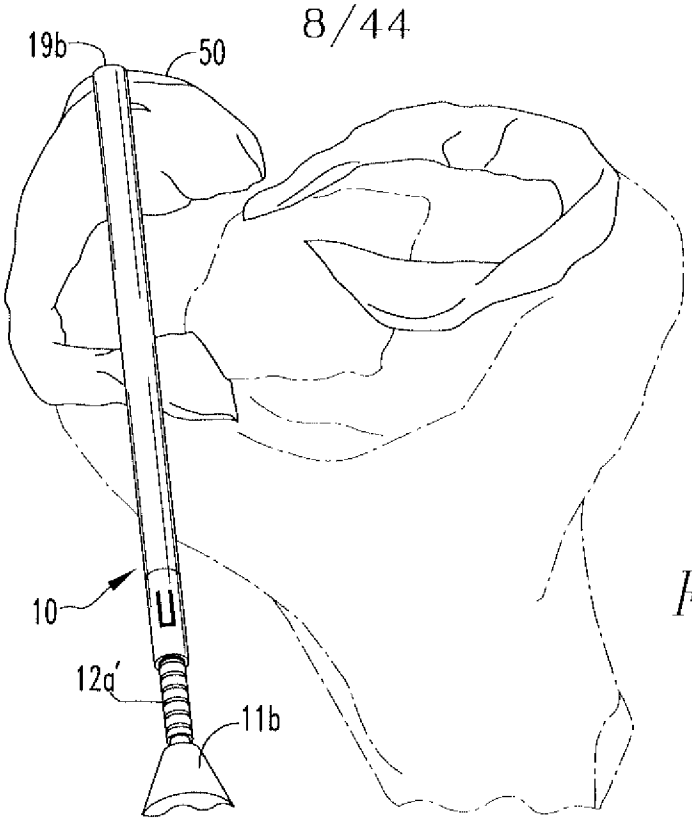

FIG. 7A

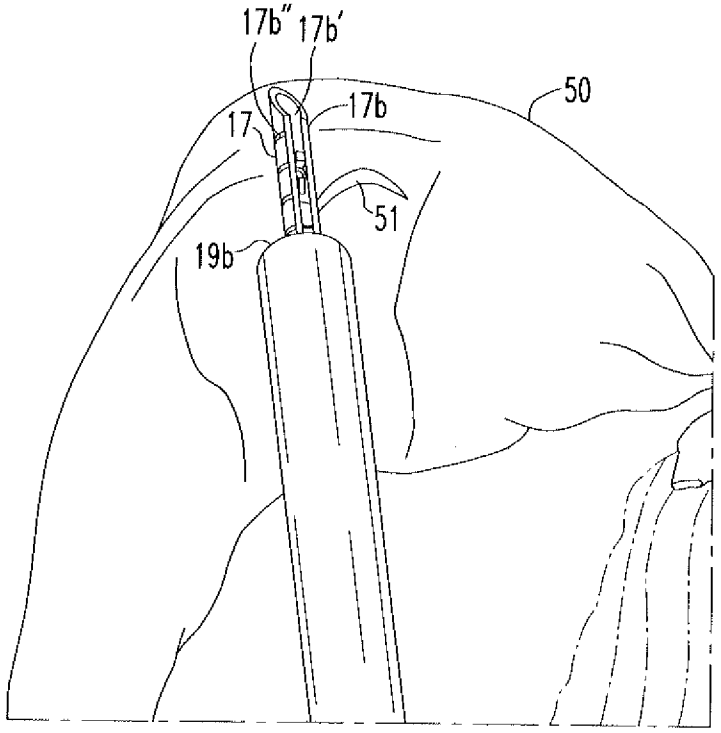

FIG. 7B

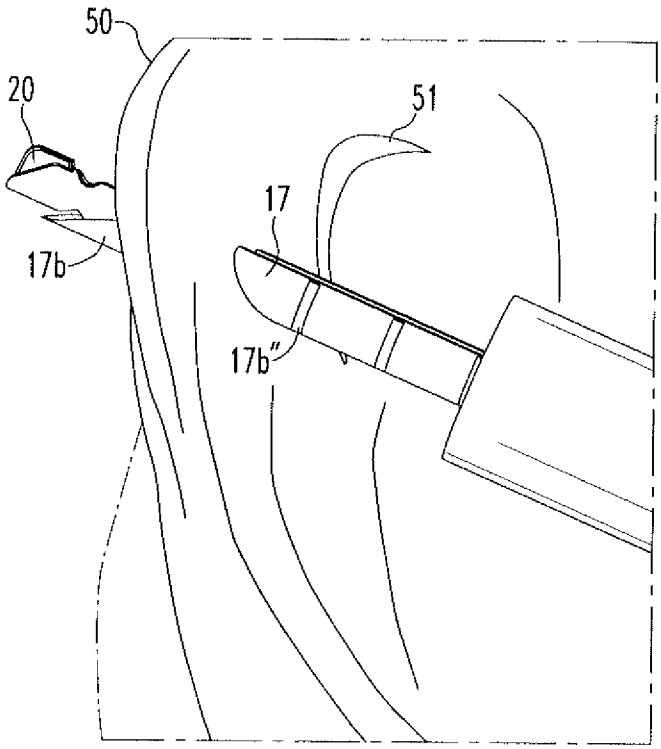

FIG. 7C

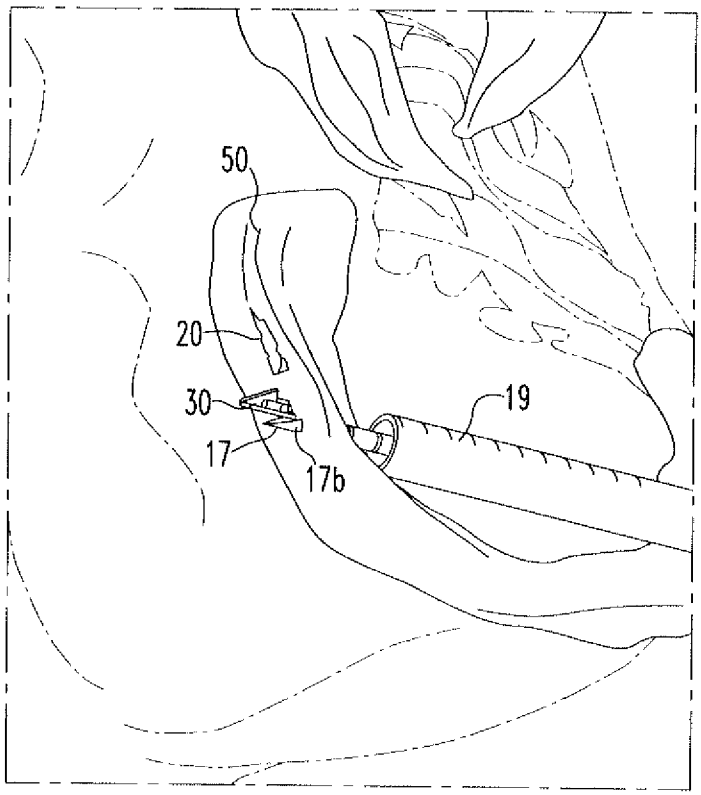

FIG. 7D

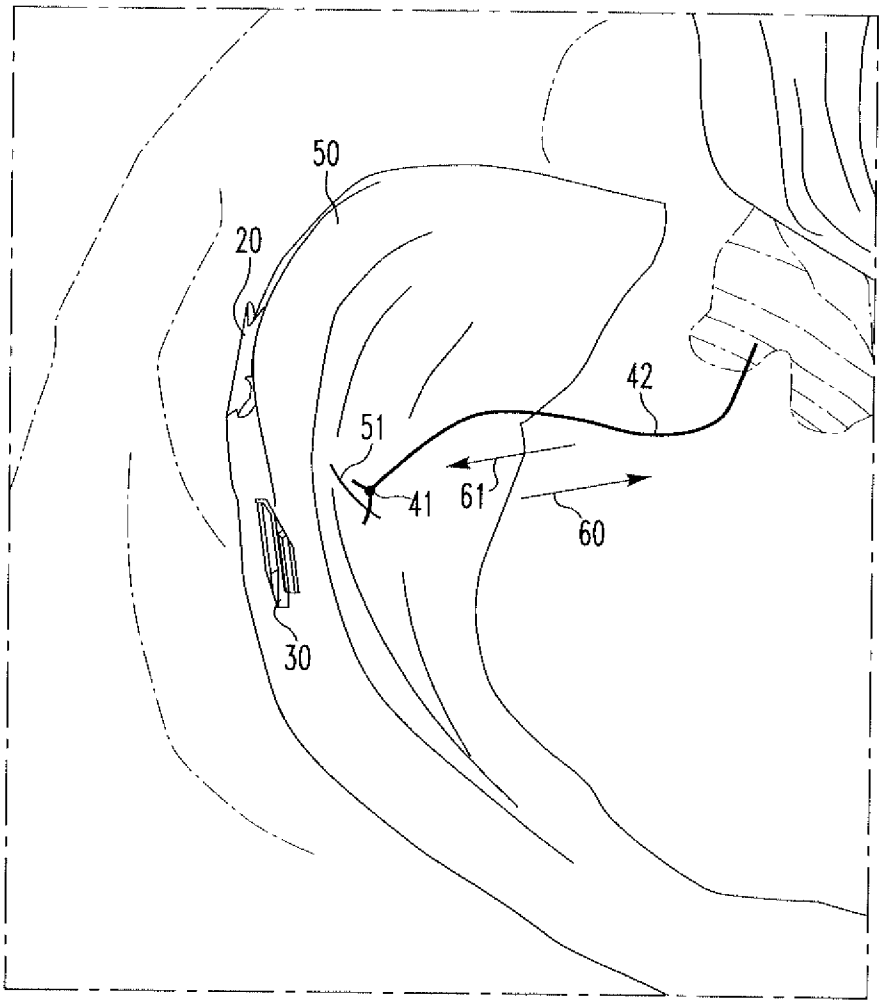

FIG. 7E

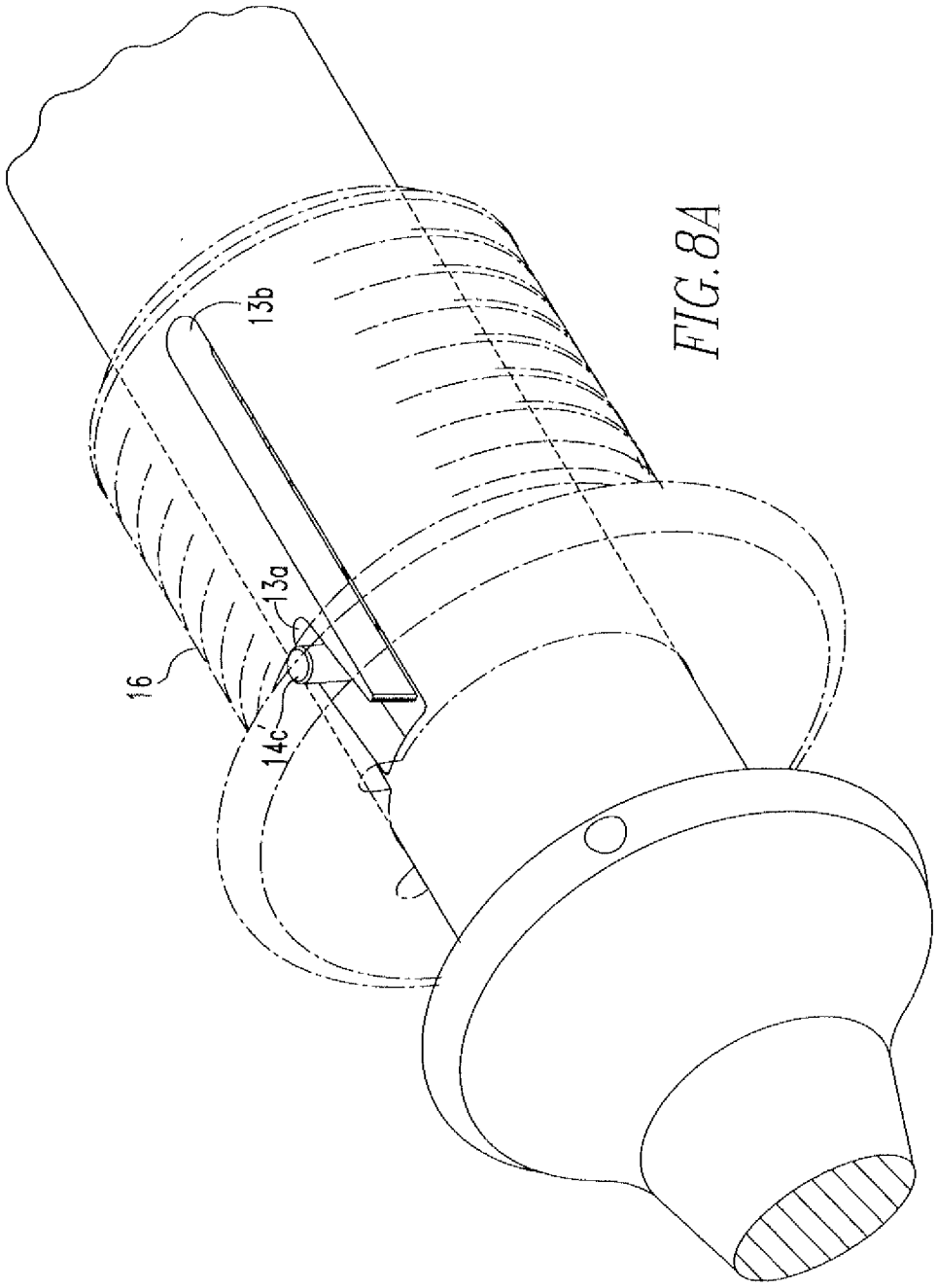

FIG. 8A

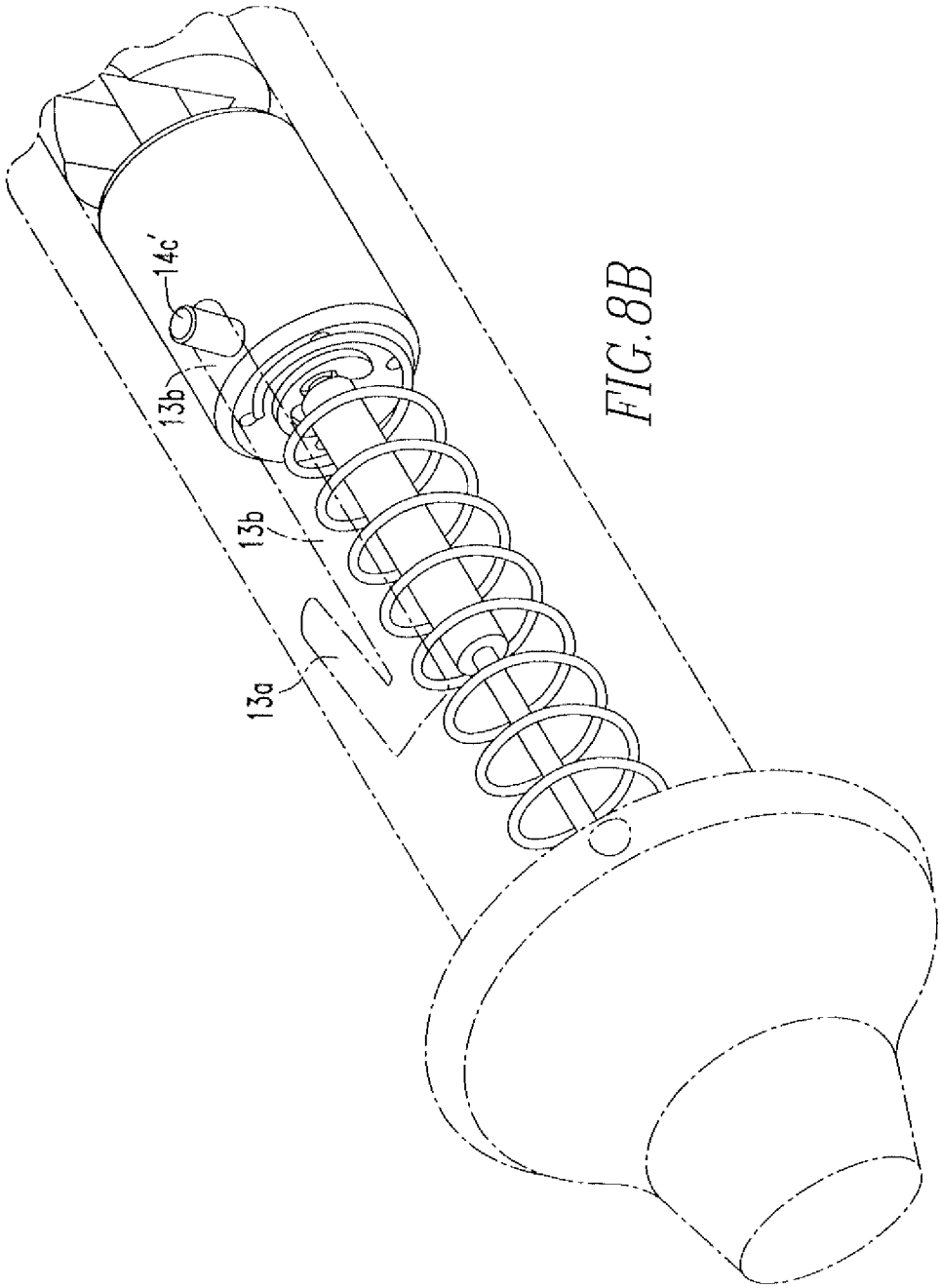

FIG.8B

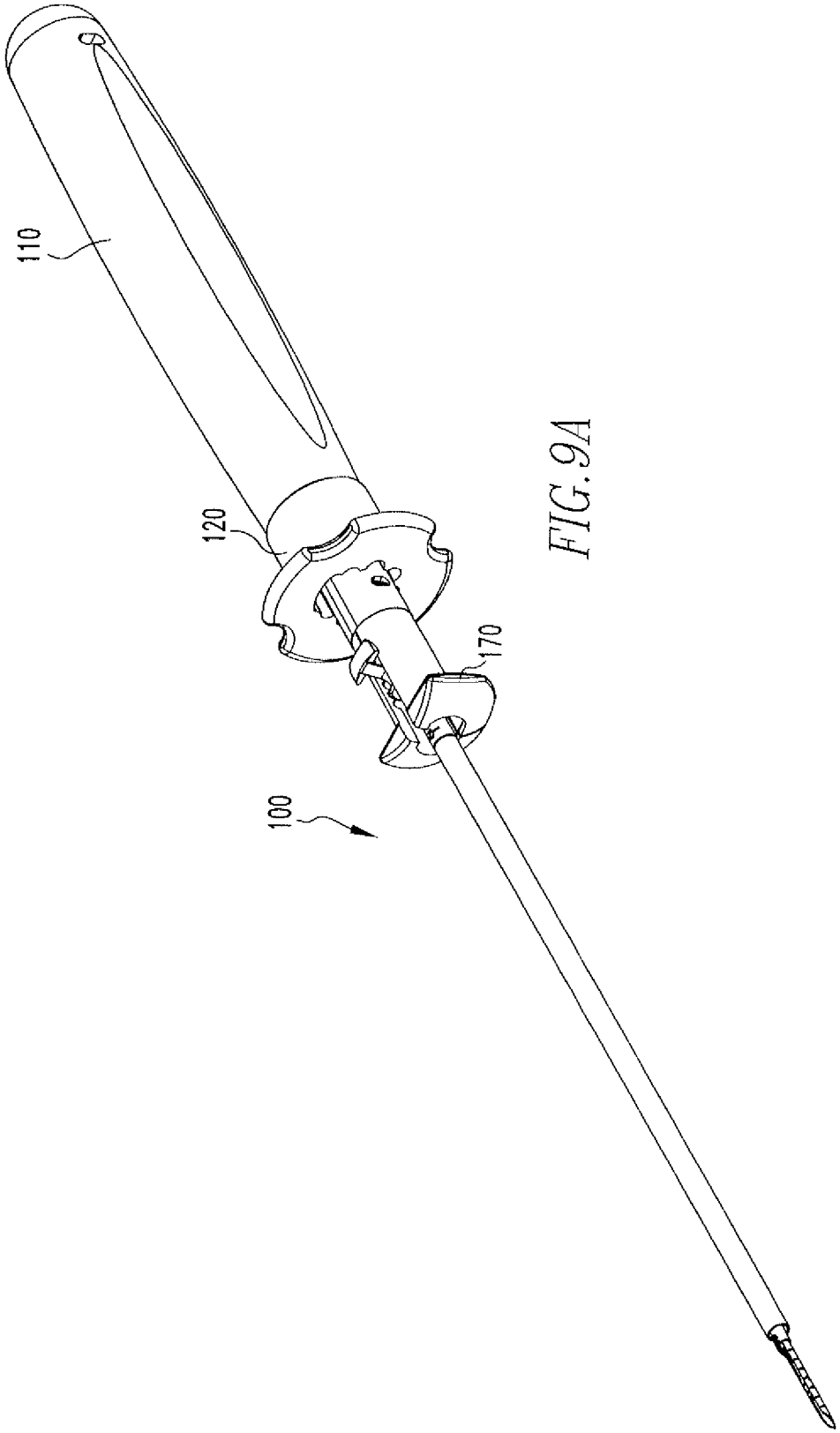

FIG. 9A

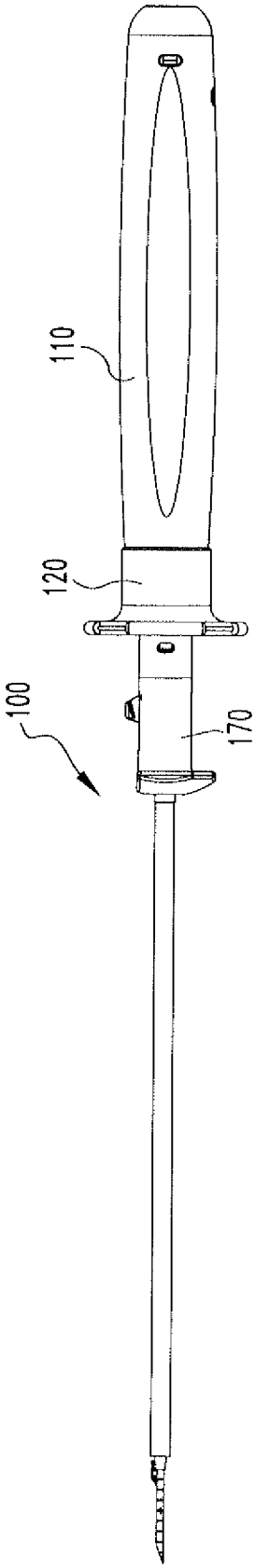

FIG. 9B

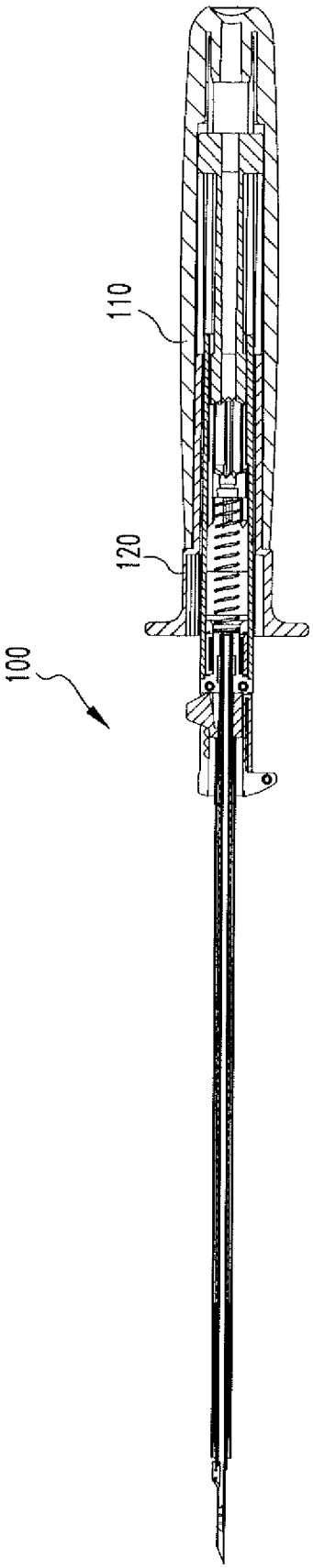

FIG. 9C

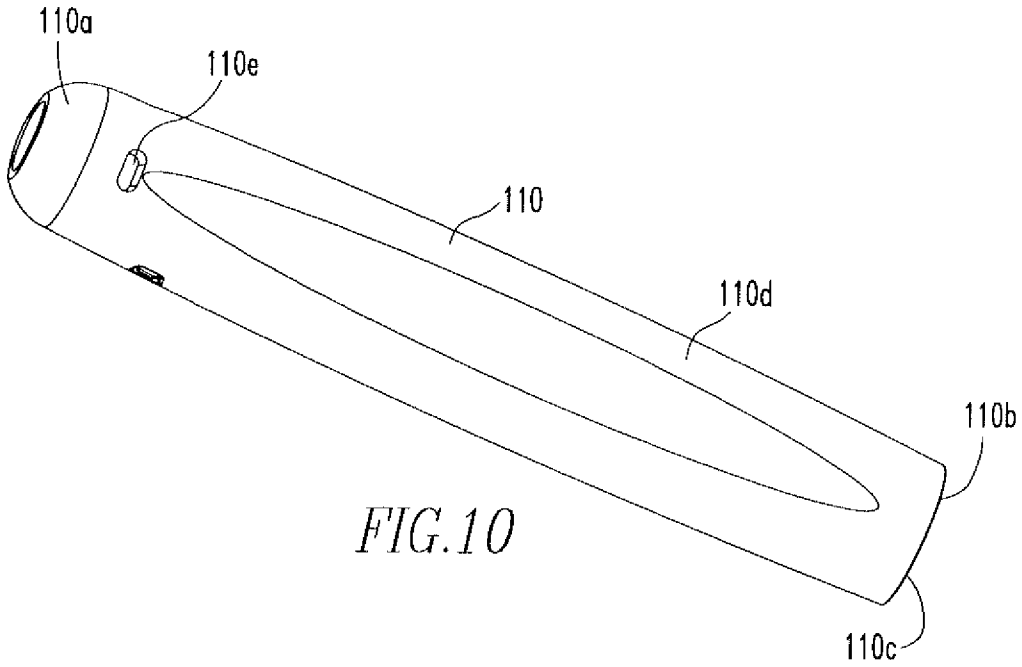

FIG.10

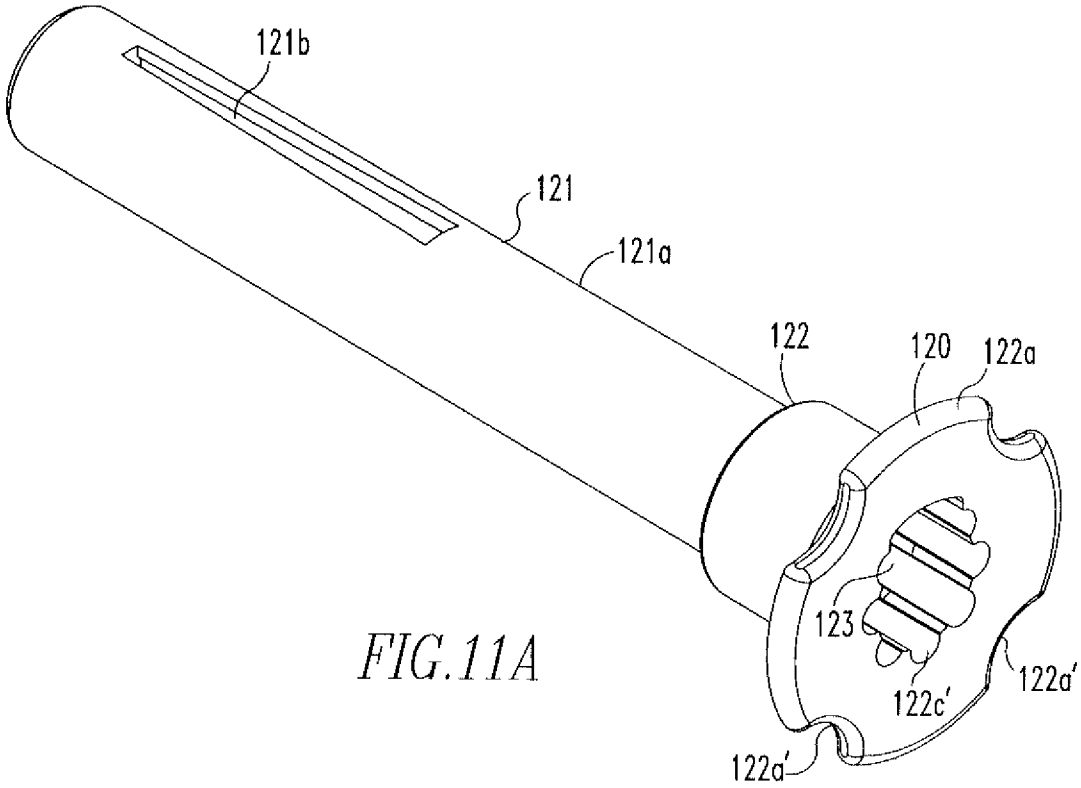

FIG.11A

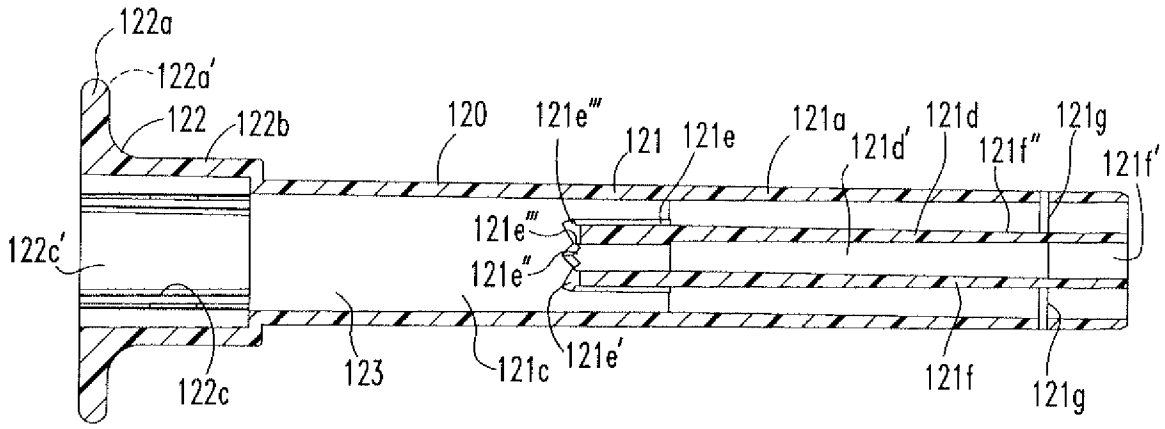
122a
122a'
122
122b
120
121e'''
121
121e
121a
121d'
121d
121f''
121g
121f'
122c'
121e'''
121e''
122c
123
121c
121e'
121f
121g

FIG.11B

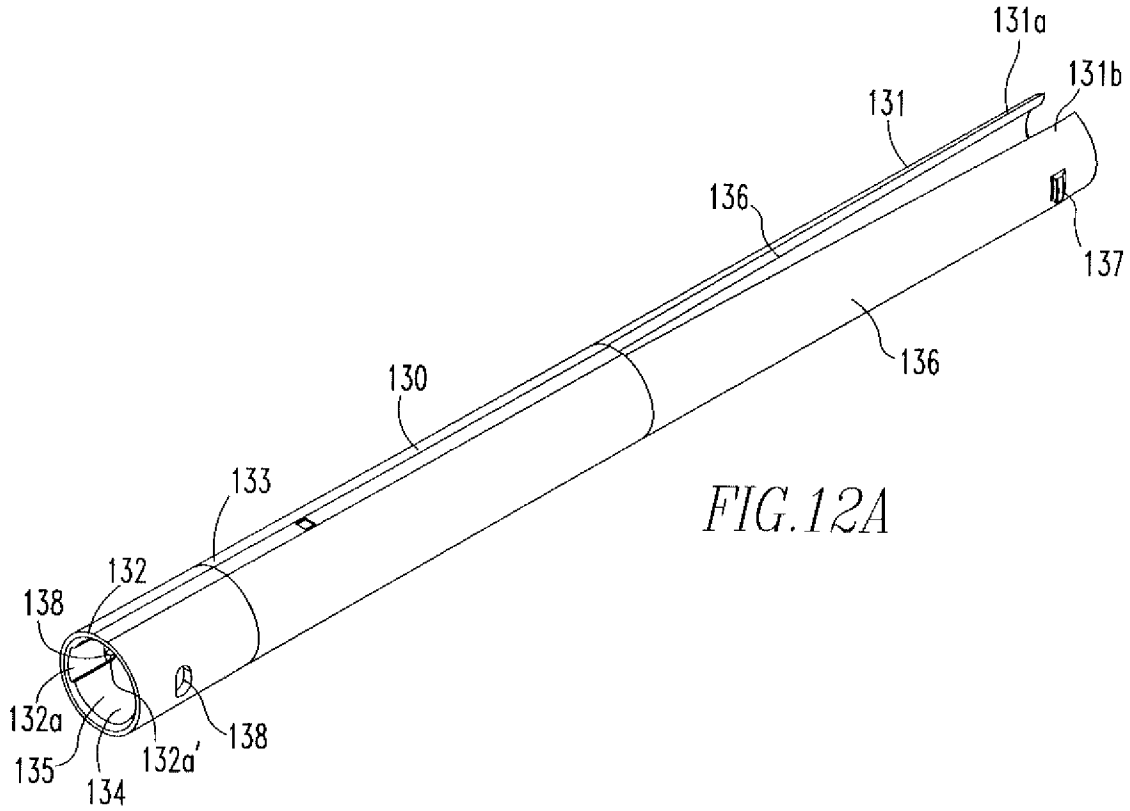

FIG.12A

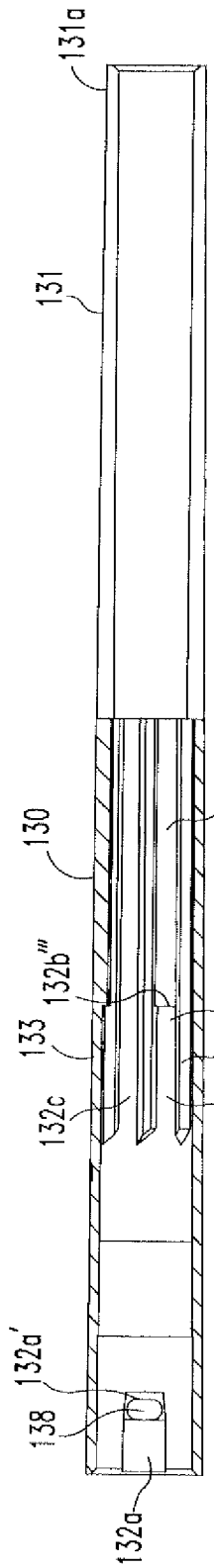

FIG.12B

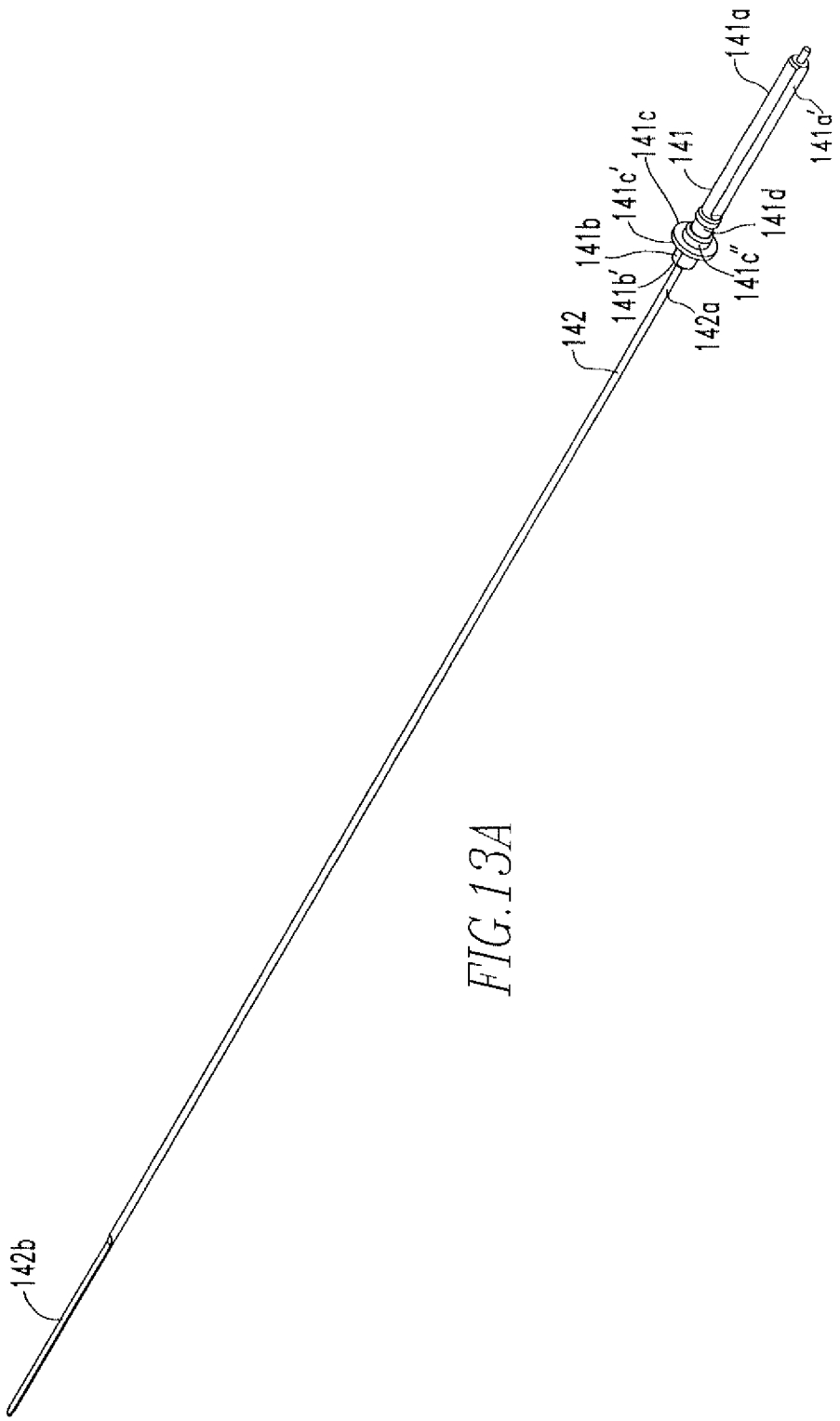

FIG.13A

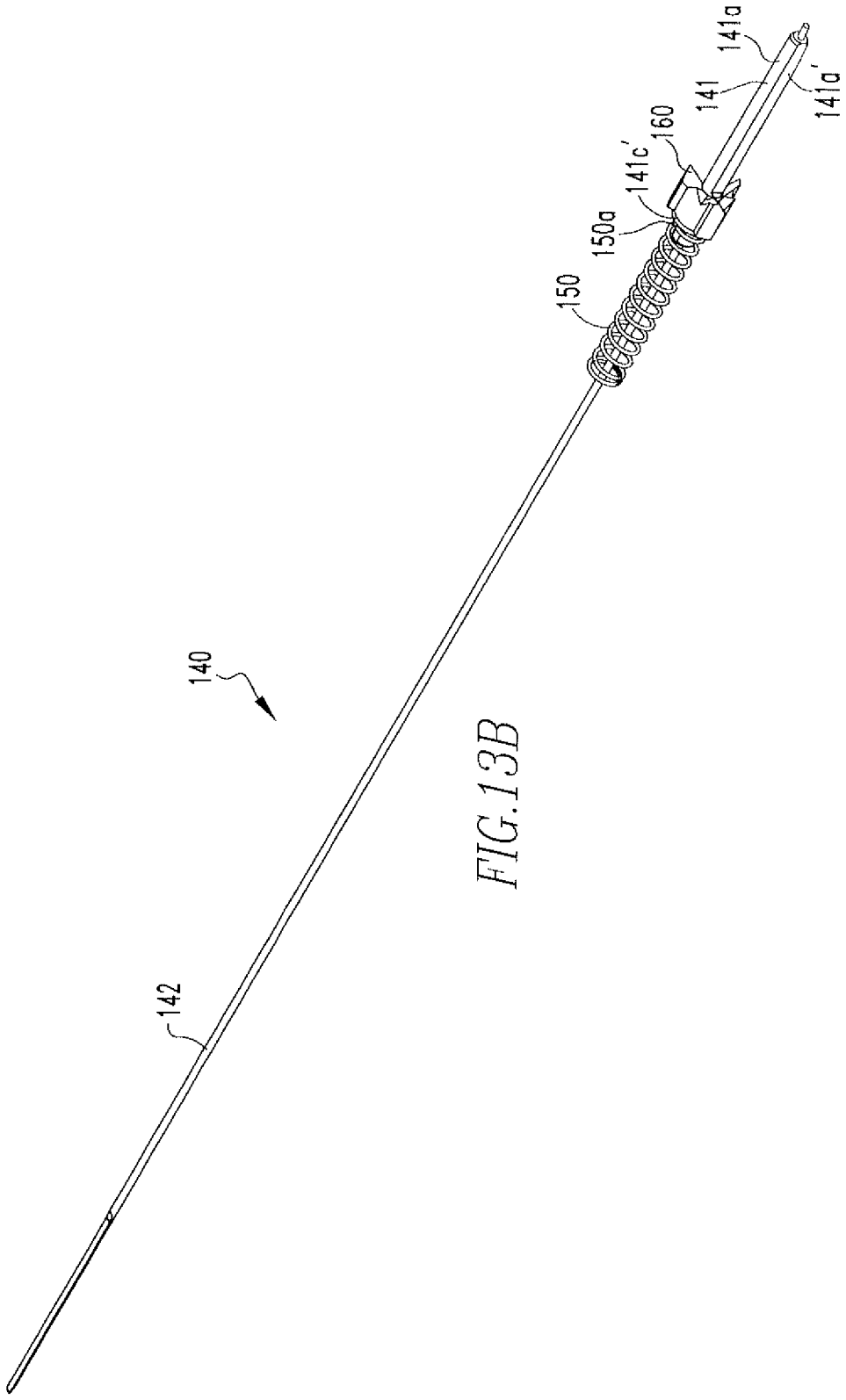

FIG.13B

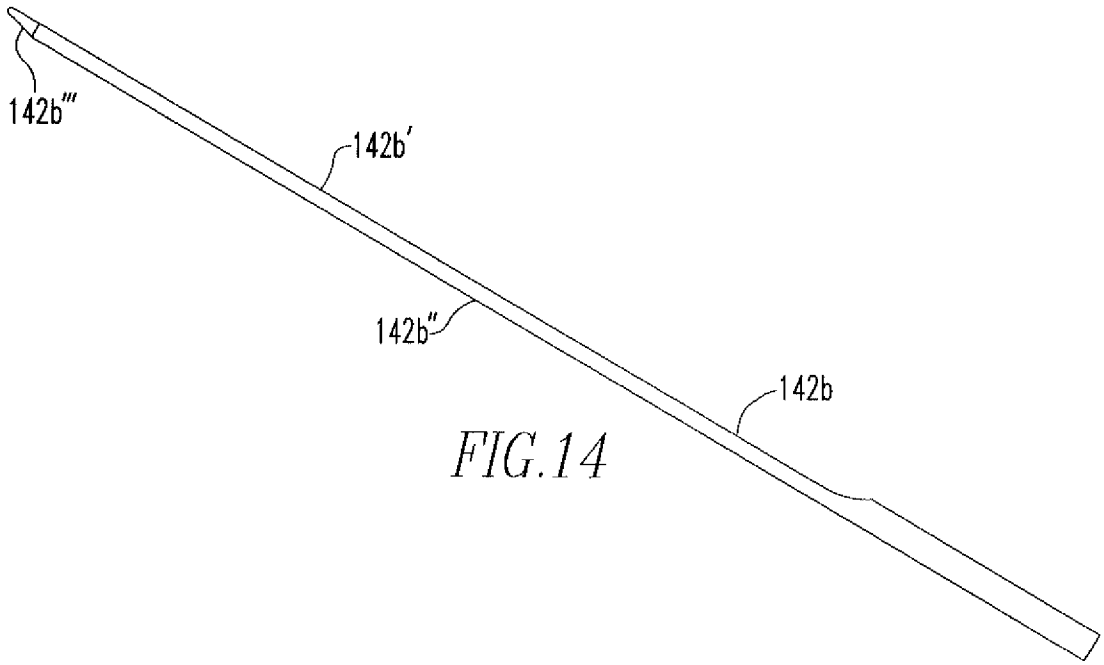
142b'''
142b'
142b''
142b

FIG.14

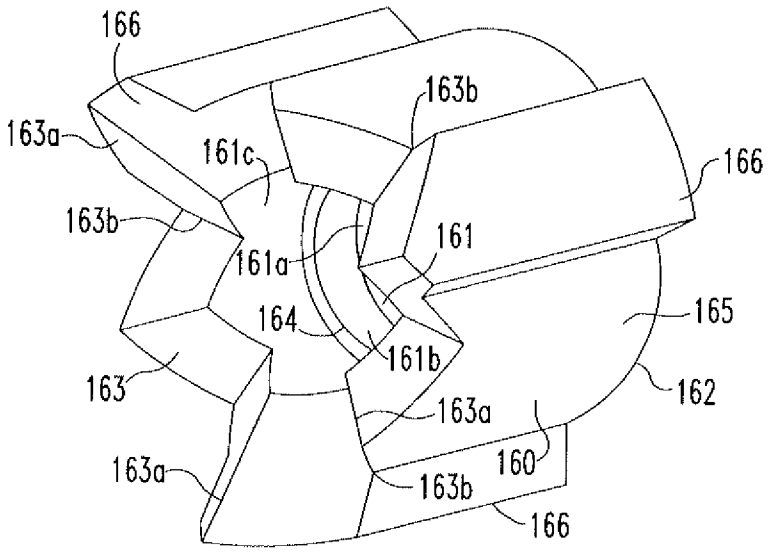
166
163b
163a
161c
166
163b
161
161a
165
164
161b
163
162
163a
160
163a
163b
166

FIG.15

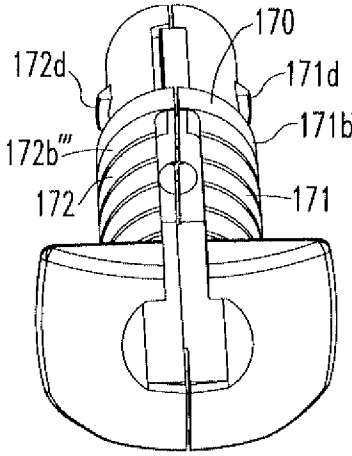

FIG.16A

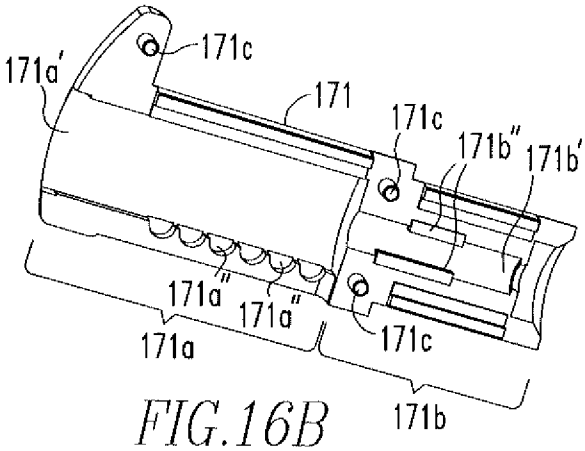

FIG.16B

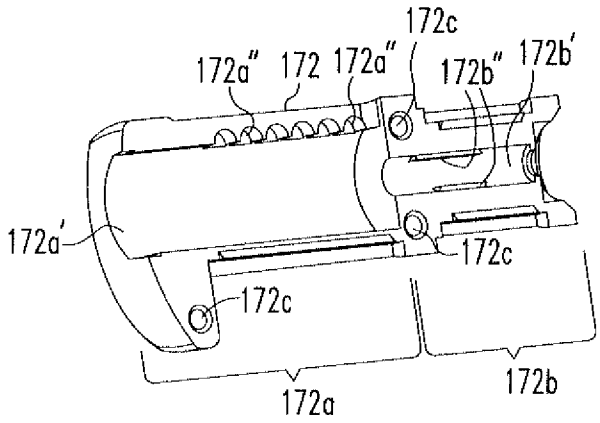

FIG.16C

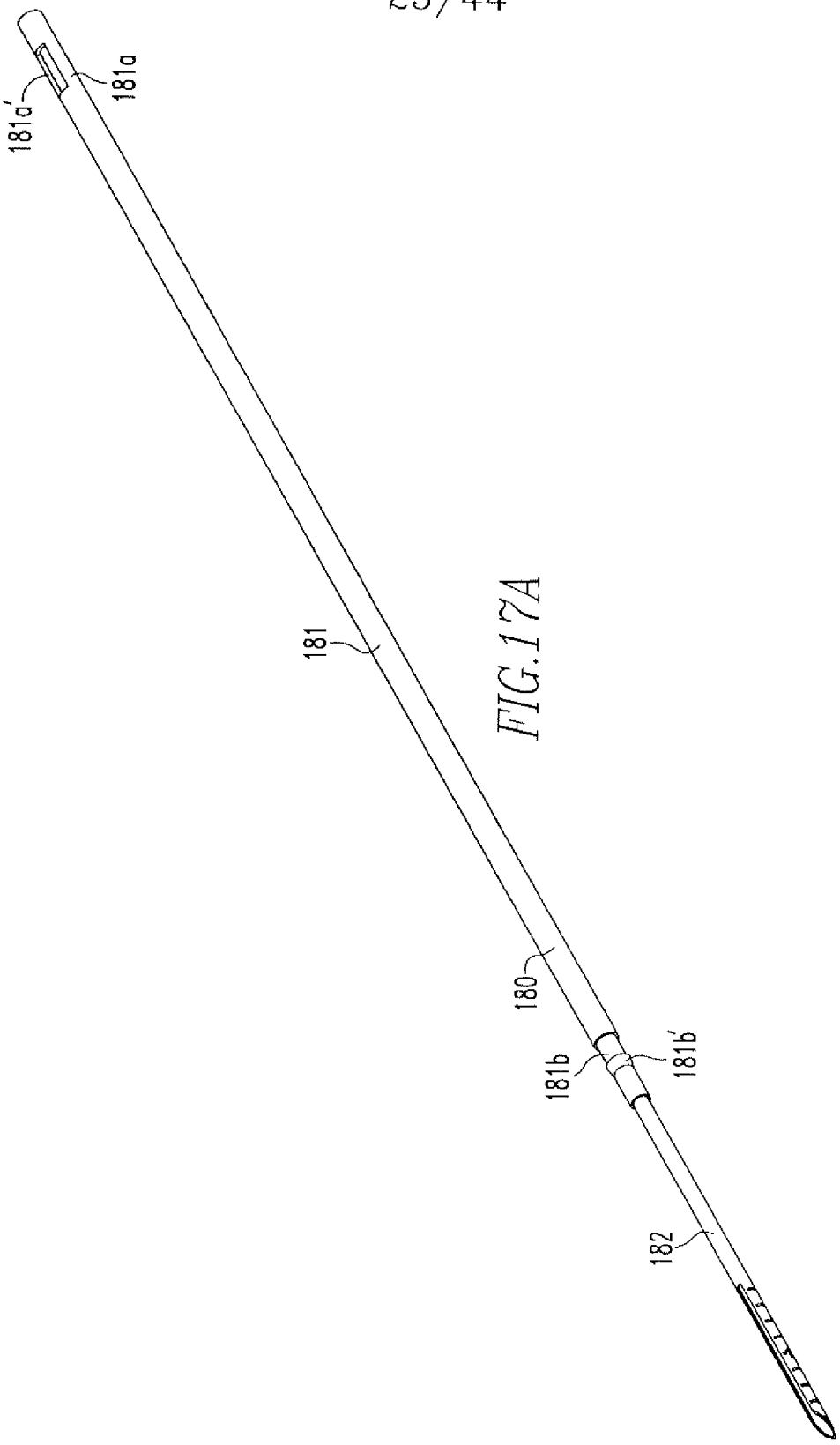

FIG. 17A

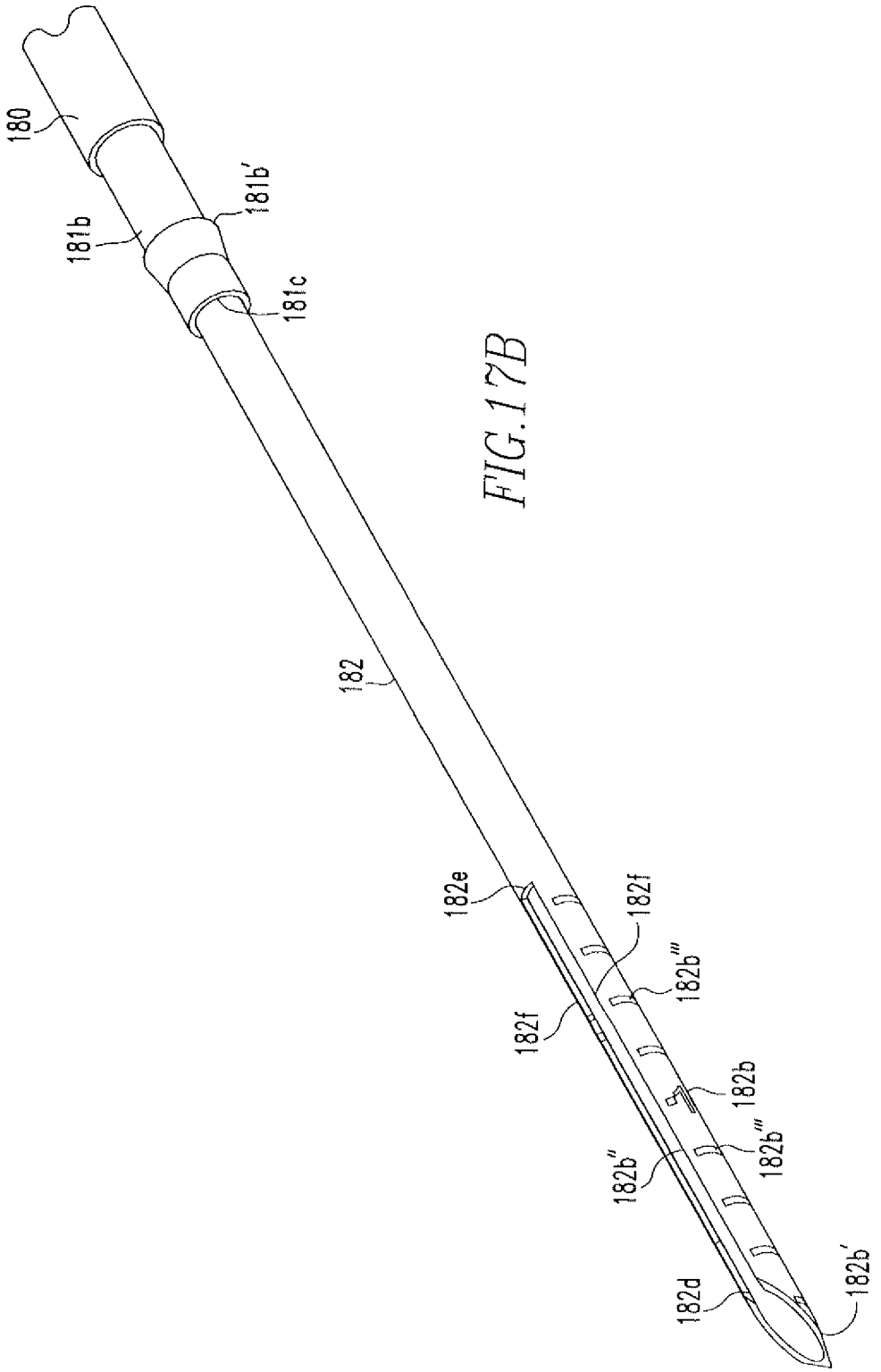
180
181b'
181b
181c
182
182e
182f
182b'''
182f
182b
182b''
182b'''
182d
182b'

FIG.17B

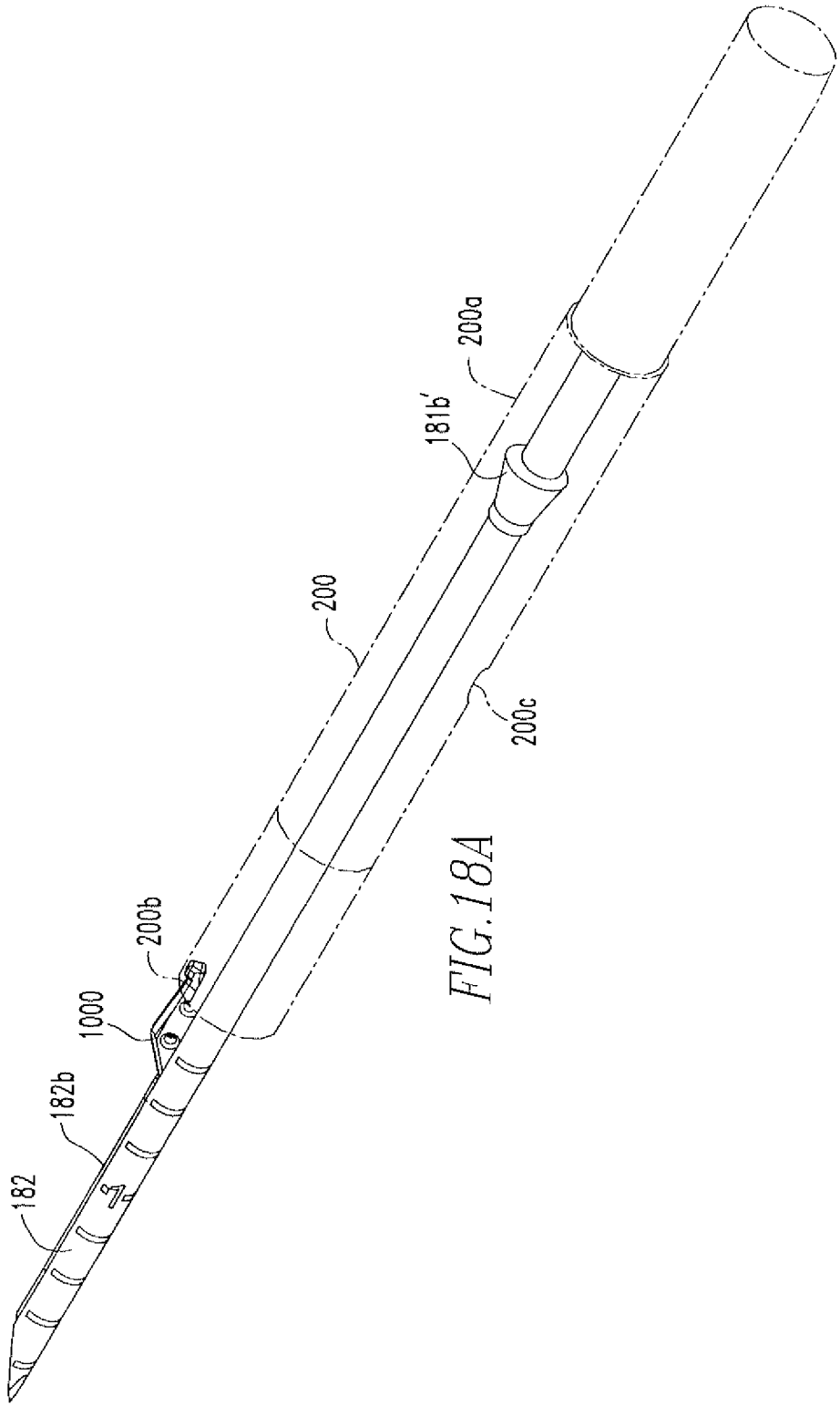

FIG.18A

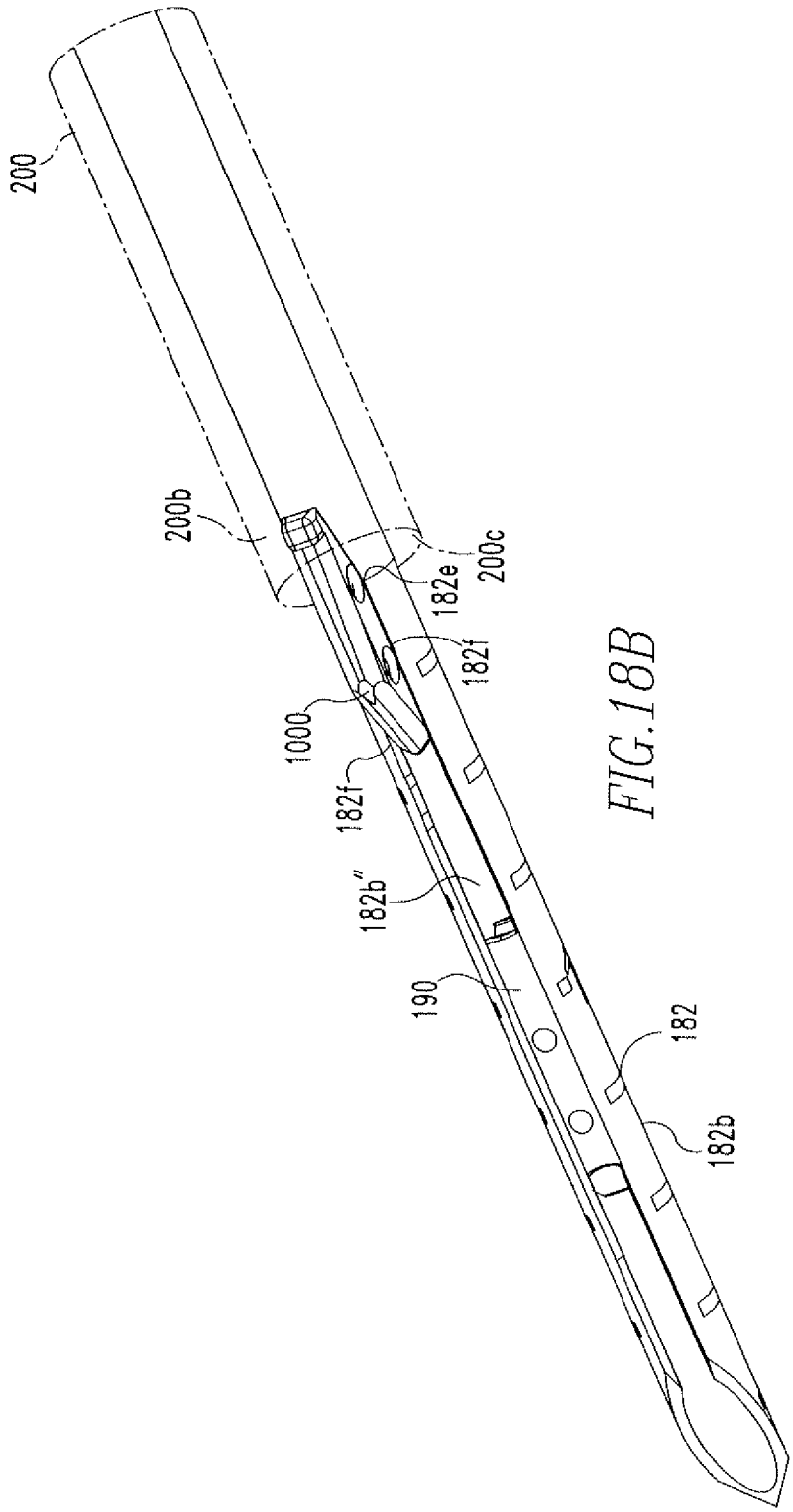

FIG.18B

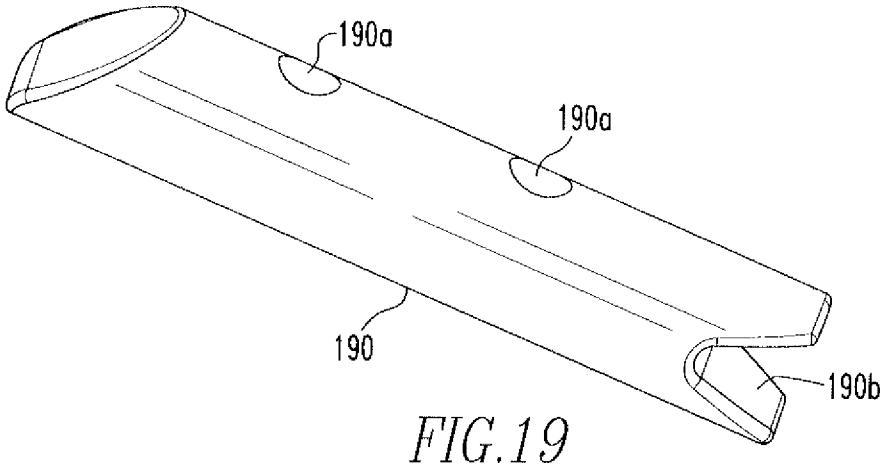

FIG.19

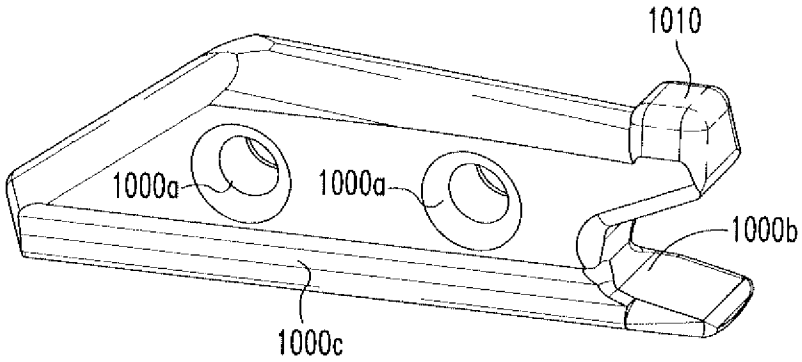

FIG.20

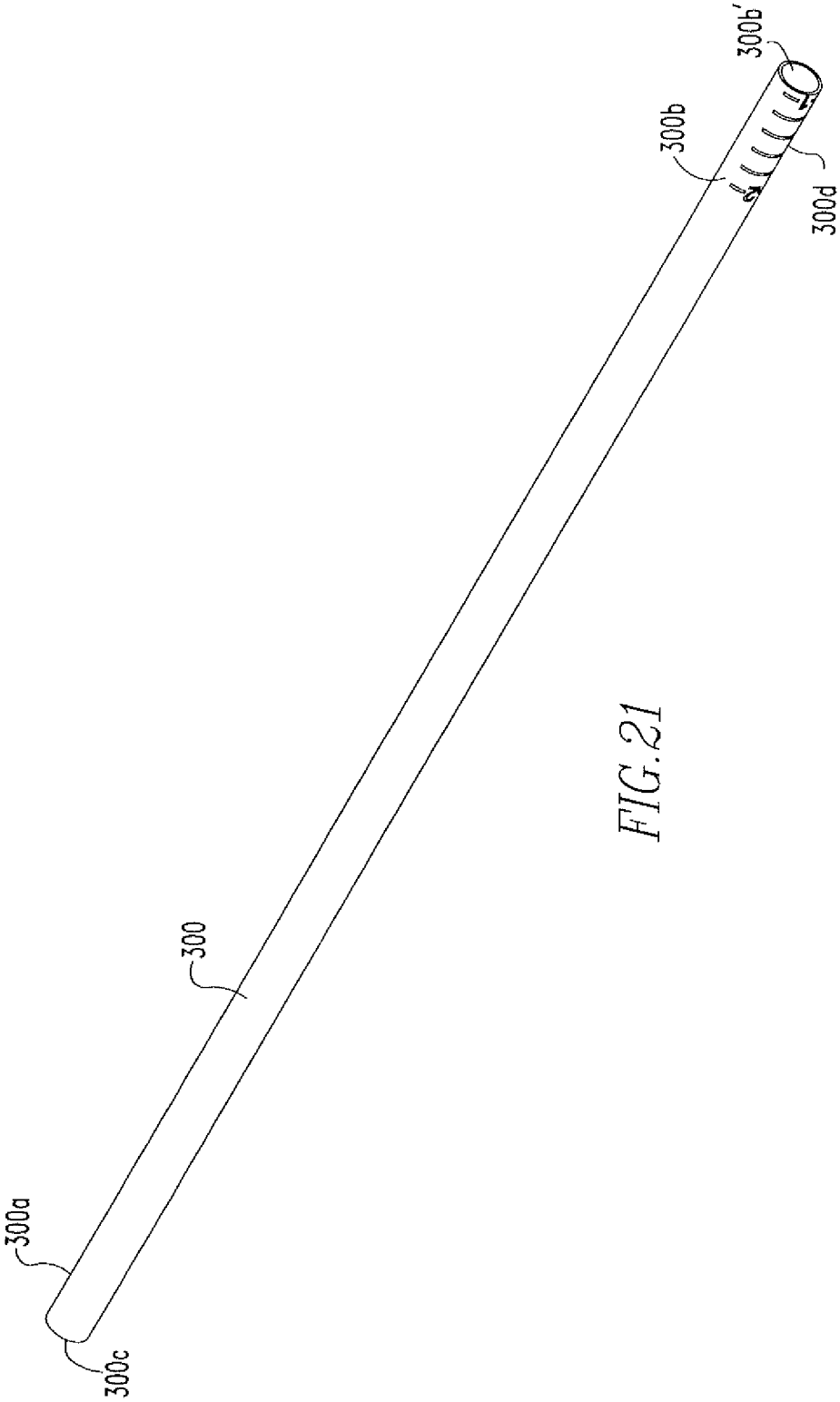

FIG.21

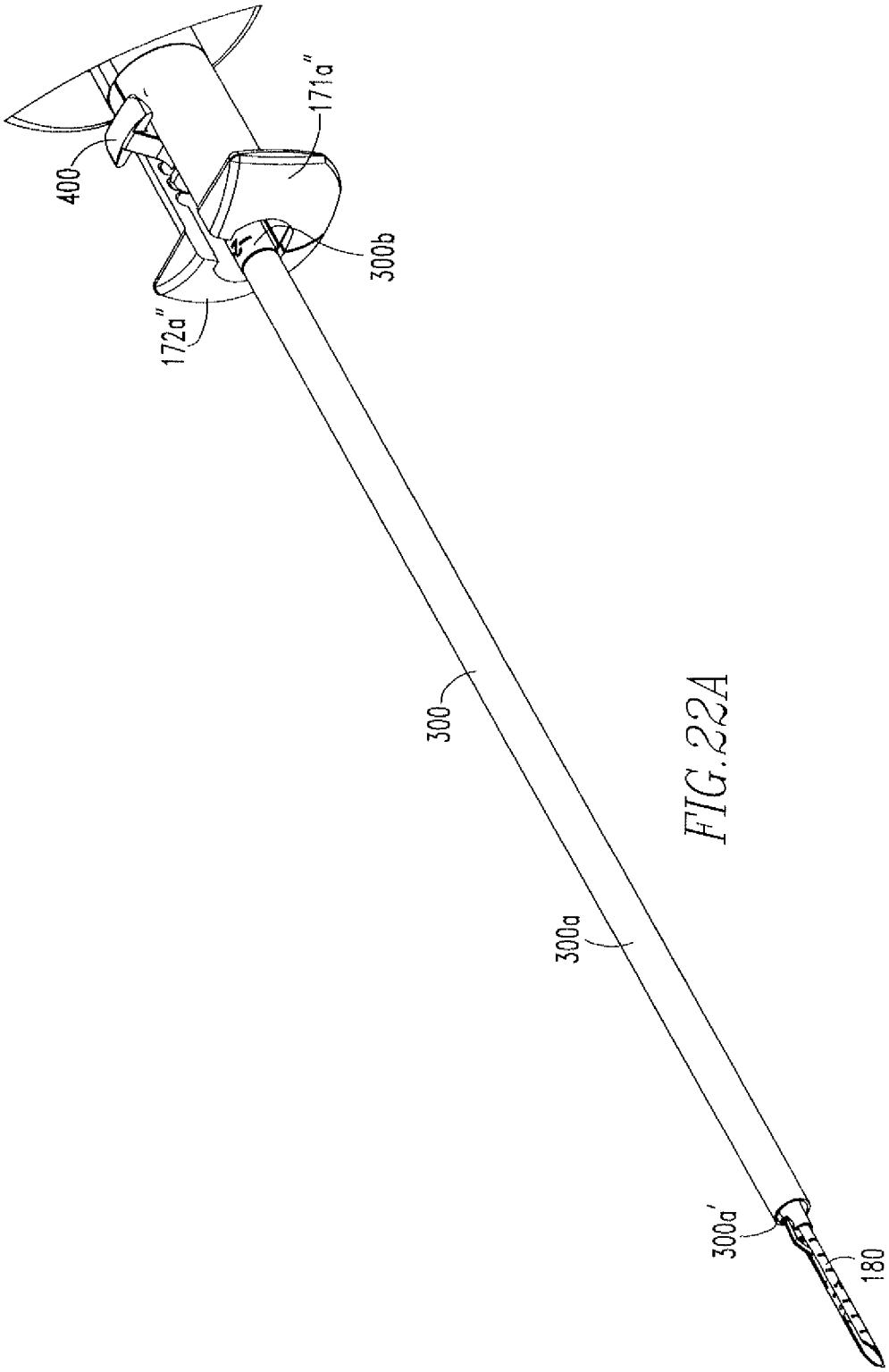

FIG.22A

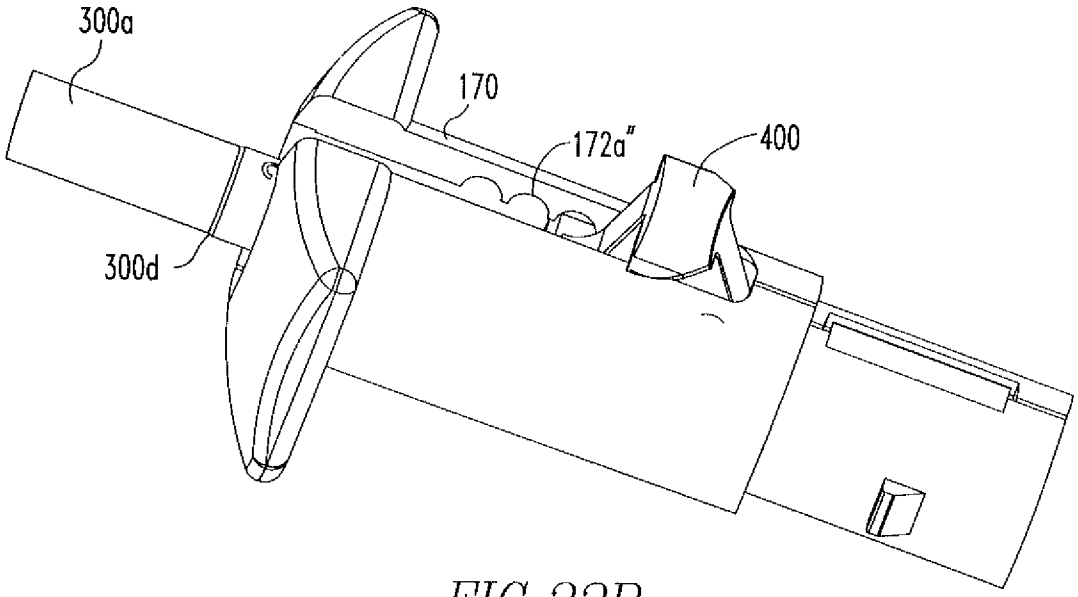

FIG.22B

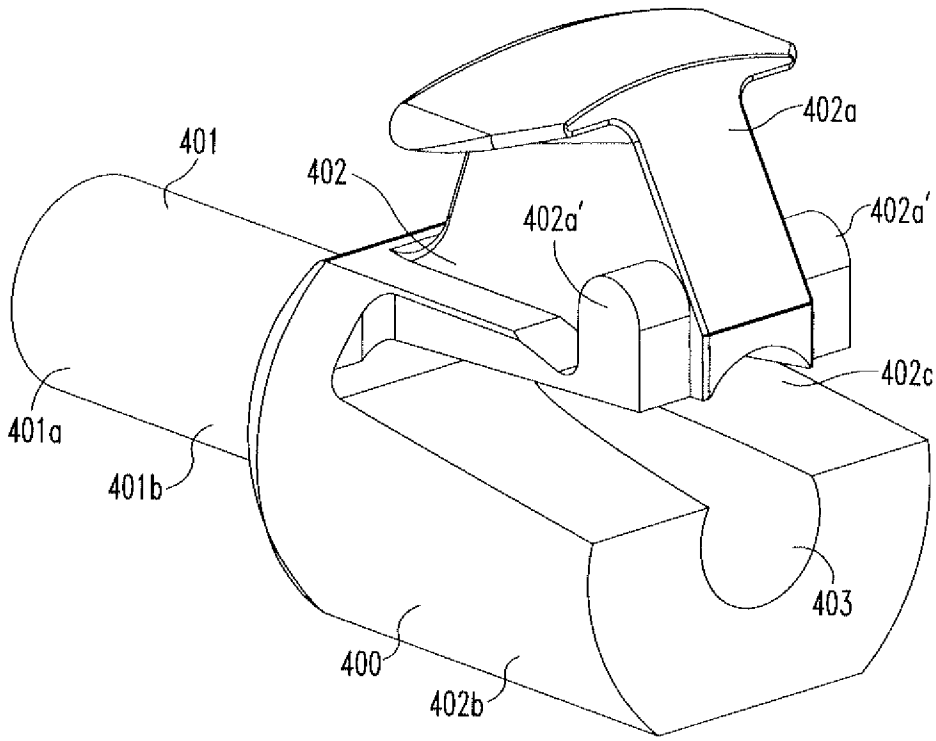

FIG.23

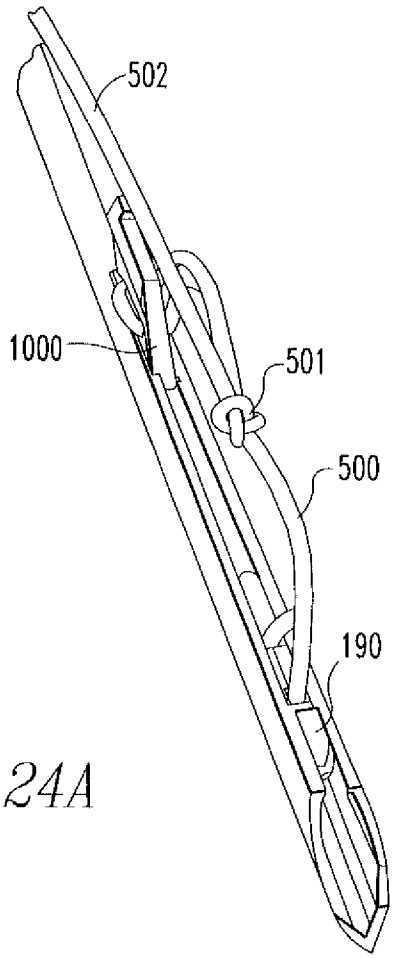

FIG.24A

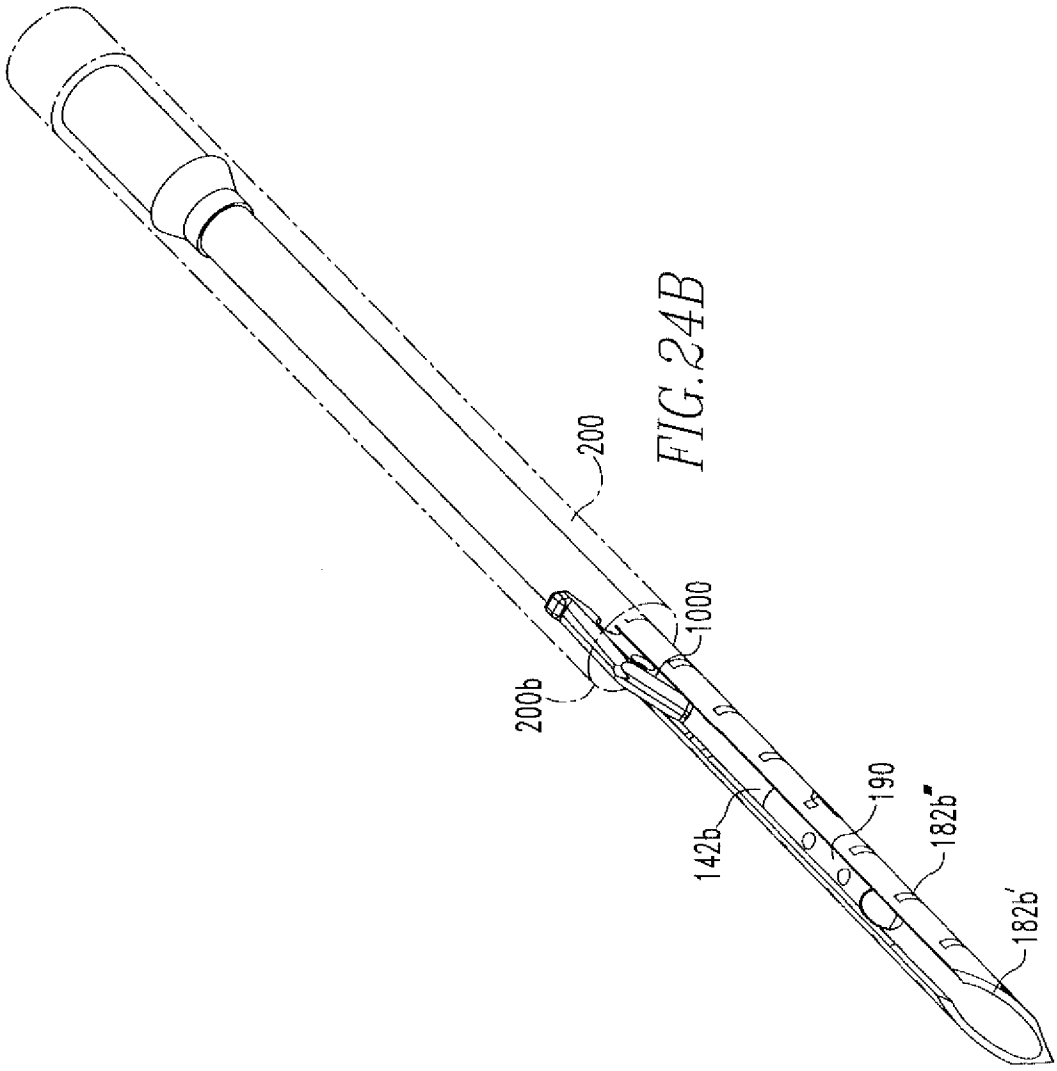

FIG. 24B

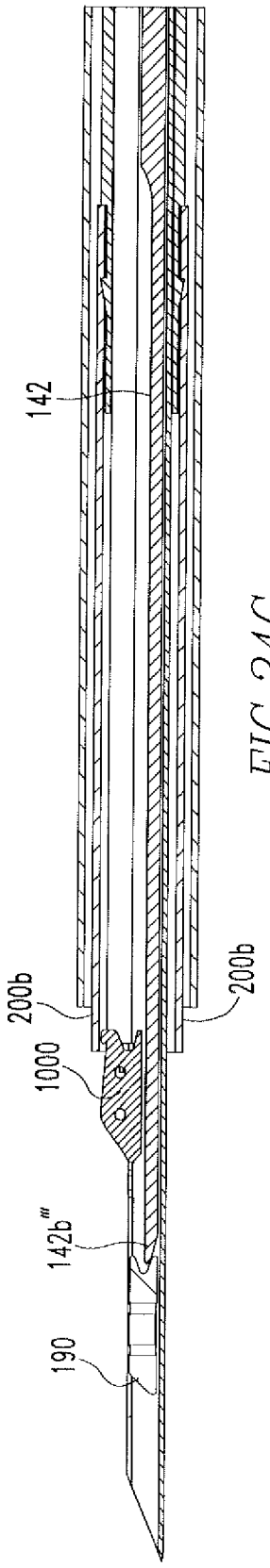

FIG. 24C

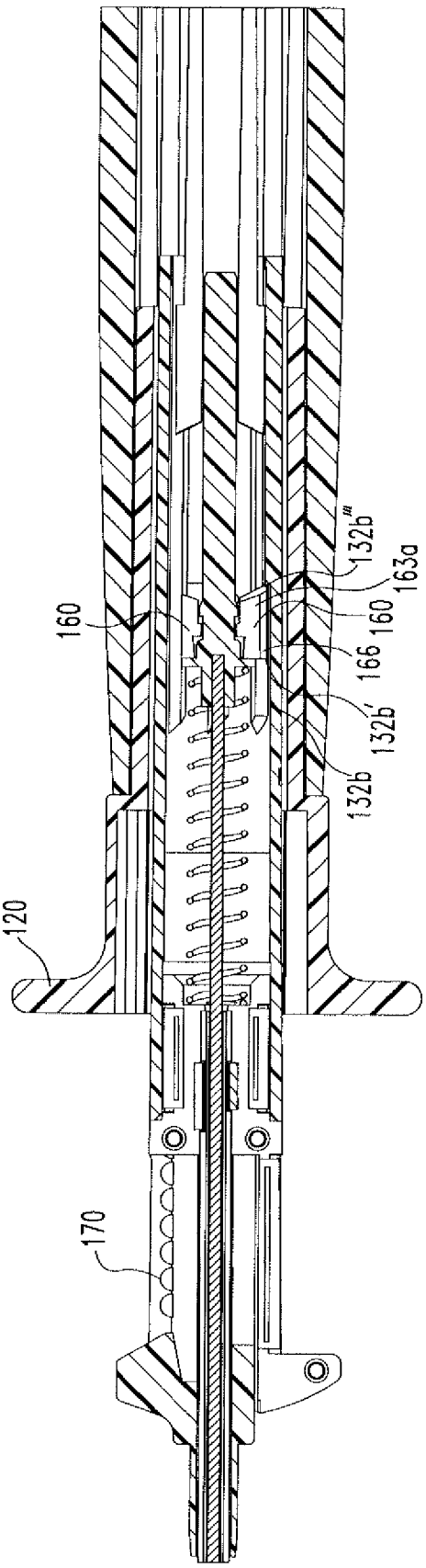

FIG. 24D

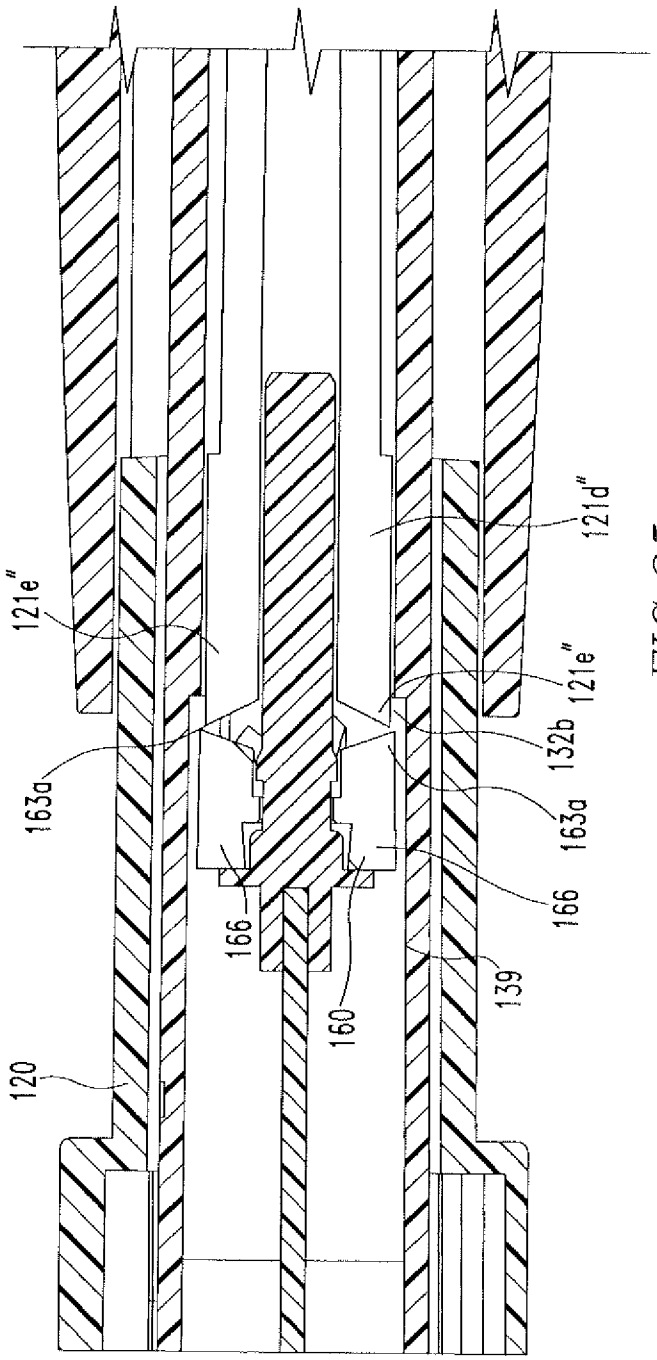

FIG.25

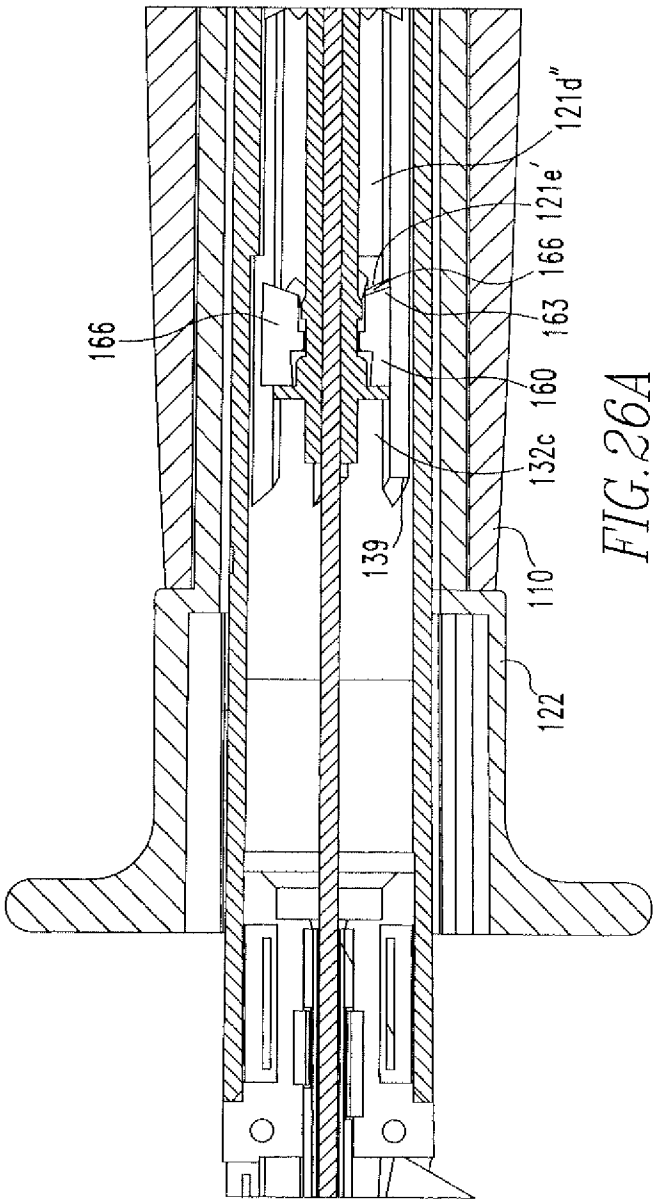

FIG.26A

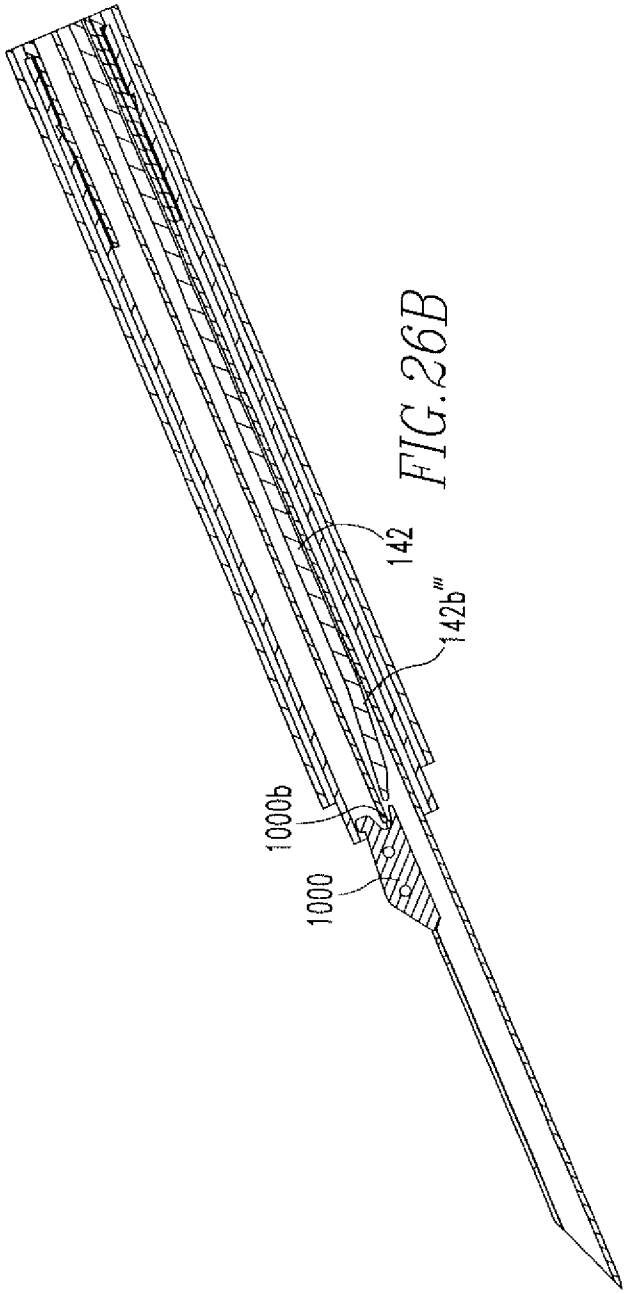

FIG.26B

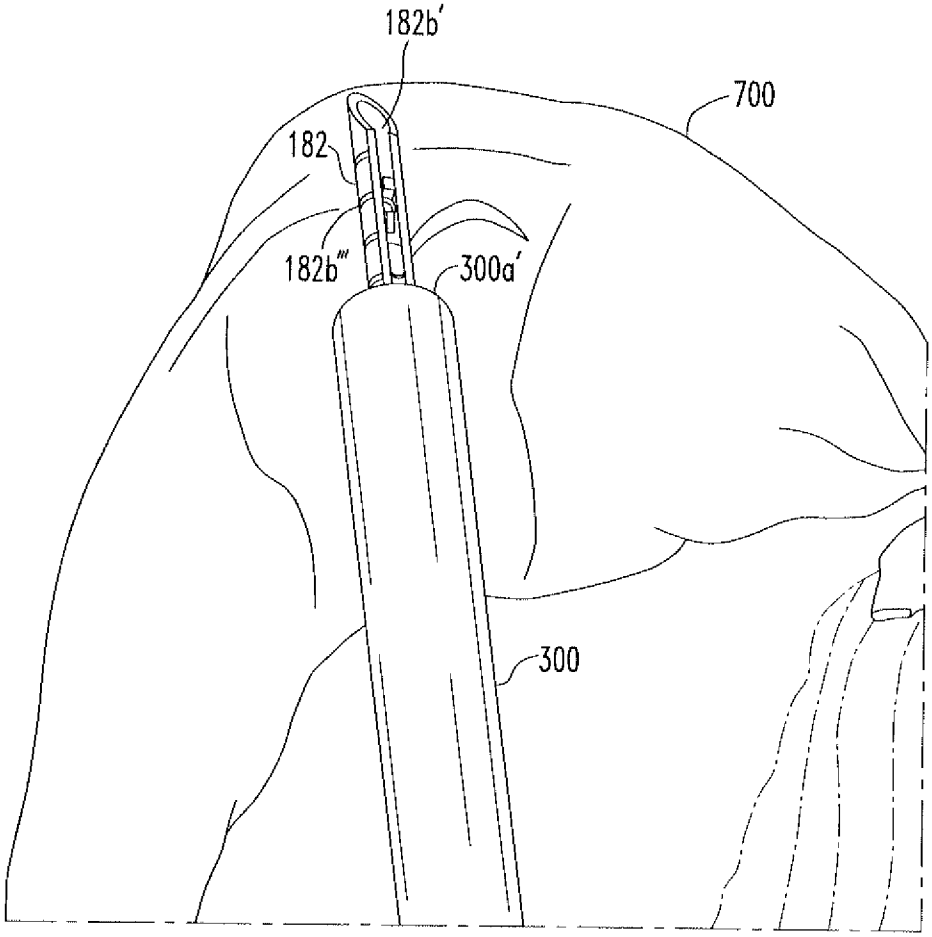

FIG.27

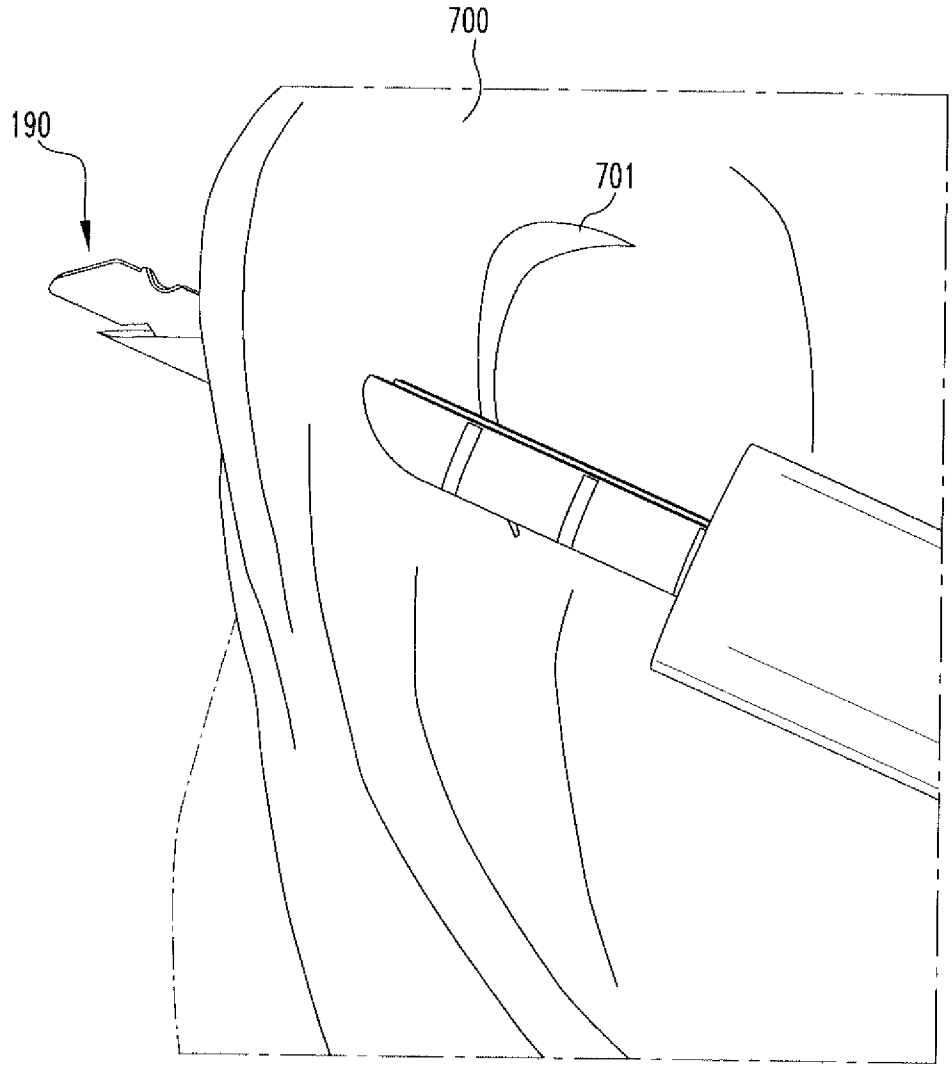

FIG.28

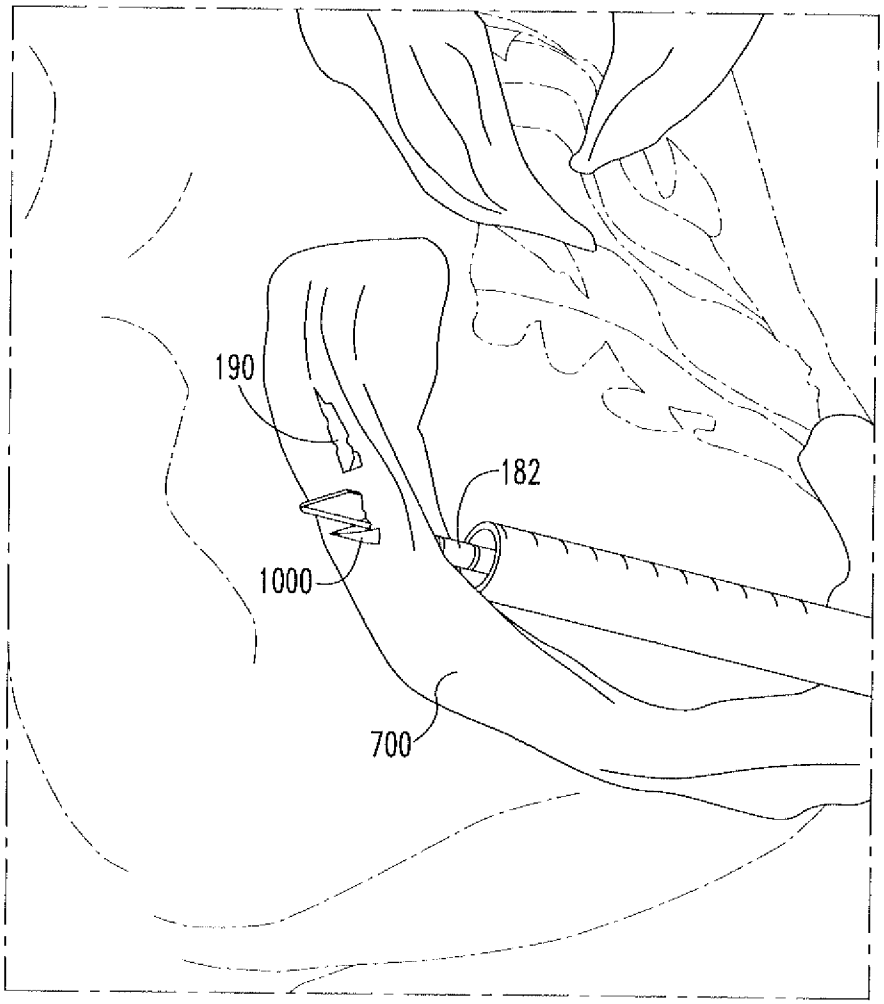

FIG.29

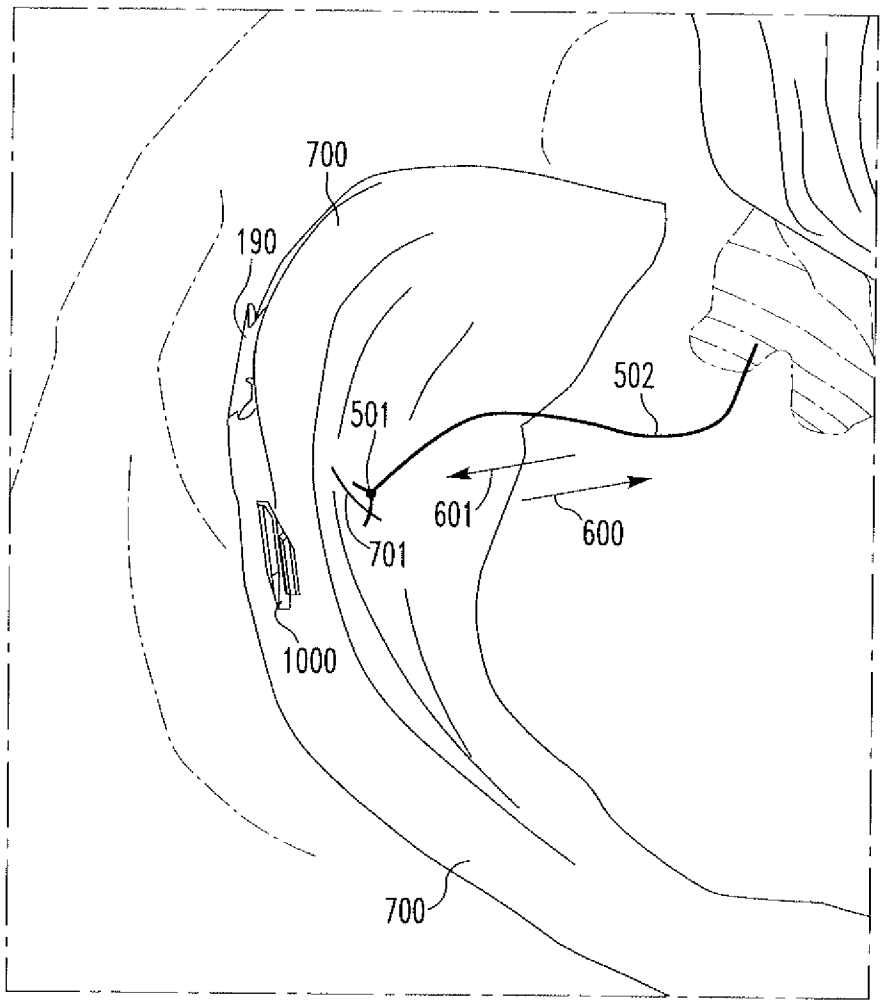

FIG.30

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/065516

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/04

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)
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.
X	US 2005/033363 A1 (BOJARSKI ET AL.) 10 February 2005 (2005-02-10) paragraphs [0225] - [0251]; figures 5,15A-19D	1
A	US 6 156 044 A (KAMMERER ET AL.) 5 December 2000 (2000-12-05) abstract; figures 5,6,21-31 column 9	1
A	WO 2007/124773 A (COVIDIEN AG ET AL.) 8 November 2007 (2007-11-08) abstract; figures paragraphs [0014], [0015], [0018] - [0025], [0030] - [0035]	
A	US 2002/188301 A1 (DALLARA ET AL.) 12 December 2002 (2002-12-12) the whole document	

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

☒ See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 January 2010	18/01/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Giménez Burgos, R

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/065516

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 2
because they relate to subject matter not required to be searched by this Authority, namely:

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2009/065516

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005033363 A1	10-02-2005	NONE	
US 6156044 A	05-12-2000	AU 735951 B2	19-07-2001
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WO 2007124773 A	08-11-2007	EP 2019629 A1	04-02-2009
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US 2002188301 A1	12-12-2002	NONE	