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(54) **Title:** SURGICAL DEVICE AND METHOD OF USE THEREOF

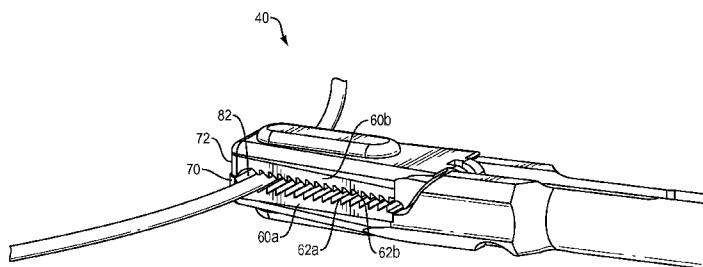


FIG. 3A

(57) **Abstract:** A surgical device for grasping both tissue and a suture during arthroscopic surgery. The surgical device includes jaws having retrograde teeth preventing tissue from slipping out of the jaws. When closed, the distal end of the jaws form a suture passage allowing a suture to slide therethrough so that its ends can be retrieved through a cannula and a knot can be tied in the suture.



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SURGICAL DEVICE AND METHOD OF USE THEREOF

FIELD

The following disclosure relates generally to surgical devices and, more particularly,
5 to surgical devices for grasping both soft tissue and a suture.

BACKGROUND

Arthroscopic surgery is a minimally-invasive surgical procedure during which an
interior portion of the human body, such as a knee or shoulder joint, is examined or operated
10 on using an arthroscope. The arthroscope is a type of endoscope or miniature camera that is
passed through a cannula which is inserted into the joint through a small incision in the skin to
enable a surgeon to view the joint and/or perform a surgical operation without fully opening
the joint.

During arthroscopic tissue repair surgery, a tissue grasper may be used to manipulate
15 the torn tissue - for example, to move the tissue back to its original position. During the
surgery, it is also often necessary to pass sutures through the torn tissue and the ends of the
sutures through the cannula. This is often done by means of a specially designed suture
grasper that will not damage the suture as it is drawn through the cannula and allows the
suture to slide therethrough. The combination of these two devices - a tissue grasper and
20 suture grasper - would therefore be desirable, for both cost reduction and efficiency reasons.
Such a device would also shorten surgical times, as the surgeon would not have to swap
devices or switch between portals made through the skin to the repair site. However, in
current surgical devices, the tissue grasper will damage a suture and the suture grasper cannot
grasp tissue. Additionally desirable features would be disposable elements that could be
25 mounted to the surgical device for cost reduction and ease of sterilization.

Accordingly, there is a need for a partially disposable surgical device that acts as a
tissue grasper that will not damage sutures and allows the suture to slide therethrough, and a
suture grasper that will also grasp soft tissue.

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SUMMARY

Described herein is a surgical device for grasping both tissue and a suture during arthroscopic surgery. The surgical device includes jaws having retrograde teeth preventing tissue from slipping out of the jaws. When closed, the distal end of the jaws form a suture passage allowing a suture to slide therethrough so that its ends can be retrieved through a cannula and a knot can be tied in the suture.

In one example, the surgical device has an elongate member including a proximal end terminating at a proximal terminus and a distal end terminating at a distal terminus, and a longitudinal axis extending between the proximal end and the distal end; a frame fixedly mounted at the proximal terminus of the elongate member; first and second jaws disposed at a distal terminus of the elongate member, the first jaw movable relative to the second jaw between an open position and closed position; a suture passage defined at a distal end of the first and second jaws in the closed position, the suture passage being transverse to the longitudinal axis of the surgical device and being sized to enable a suture to slide through the suture passage with the first and second jaws in the closed position; and a plurality of rows of teeth, each extending from opposing surfaces of the first and second jaws, the plurality of rows of teeth positioned between the suture passage and proximal end of the first and second jaws, the plurality of rows of teeth for grasping soft tissue with the first and second jaws in the closed position.

As further described in the examples herein, the first jaw may be hingedly attached to the distal end of the elongate member. The surgical device may further include a jaw actuation member pivotally mounted to the frame and the elongate member may include a jaw actuation rod having a proximal and a distal end, the distal end of the jaw actuation rod engaging the first jaw, and the proximal end of the jaw actuation rod mounted to the jaw actuation member. The plurality of rows of teeth may be formed from a material selected from any one of silicon rubber, vinyl or plastic and/or a material having a durometer selected within the range between about 40 to about 50. The plurality of rows of teeth may configured to be removably

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attached to the opposing surfaces of the first and second jaws and may comprise a jaw mountable portion. The jaw mountable portion may be formed integrally with the plurality of rows of teeth or may be removably attached to the plurality of rows of teeth. Any of the plurality of rows of teeth and the jaw mountable portion may be
5 disposable. The suture passage may be defined by a first and second stopping member disposed at a distal end of the first and second jaws, respectively. A distance between the suture passage and the proximal end of the first and second jaws may be about 9.0 mm to about 14.0 mm. The suture passage may be sized to accommodate a #2 monofilament suture and an inner diameter of the suture passage may be about 1.0 mm
10 to about 2.0 mm.

Examples of the methods described herein may include (a) providing a surgical device according to any preceding claim in an area adjacent soft tissue to be repaired, a suture having been passed through the soft tissue; (b) retaining a portion of the soft tissue between the first jaw and second jaws; (c) moving the retained soft tissue to a desired position and releasing the
15 soft tissue from the first and second jaws; (d) grasping the suture within the suture passage of the surgical device; and (e) pulling the suture away from the soft tissue with the surgical device. The method may further include, prior to step (a), providing an arthroscope in the area adjacent to the soft tissue to be repaired, attaching the plurality of rows of teeth to the opposing surfaces of the first and second jaws, and/or passing the suture through the soft
20 tissue to be repaired with another surgical device different from the surgical device. The method may also include, after step (e), removing the plurality of rows of teeth from the opposing surfaces of the first and second jaws and, after removing the plurality of rows of teeth from the opposing surfaces of the first and second jaws, disposing of the plurality of rows of teeth. The method may also include, after step (e), sliding the suture through the
25 suture passage while tying a knot in the suture.

Described herein is also a kit including the surgical device, at least one other surgical device different from the first surgical device, and/or at least one other plurality of rows of teeth. The at least one other surgical device may be a suture relay and/or a suture passer.

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BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages will be apparent from the following more particular description of the examples, as illustrated in the accompanying drawings, in which:

5 FIG. 1a is an illustration of an example of a surgical device, including a suture grasper;

 FIG. 1b is a detailed illustration of the jaw actuation rod of the surgical device of FIG. 1a.

 FIG. 2a is a detailed illustration of an example of the suture grasper in a closed
10 position;

 FIG. 2b is a detailed illustration of an example of the suture grasper in an open position;

 FIG. 2c is a detailed illustration of the teeth of FIGs. 2a-b;

 FIG. 3a is a detailed illustration of an example of the suture grasper while grasping a
15 suture;

 FIG. 3b is a detailed illustration of an example of the suture grasper while grasping tissue;

 FIGs. 4a-c illustrate examples of the disposable elements of the surgical device; and

 FIGs. 5a-b illustrate examples of the method of using the surgical device.

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DETAILED DESCRIPTION

In the description that follows, like components have been given the same reference numerals, regardless of whether they are shown in different examples. To illustrate an example(s) in a clear and concise manner, the drawings may not necessarily be to scale and
25 certain features may be shown in somewhat schematic form. Features that are described and/or illustrated with respect to one example may be used in the same way or in a similar way in one or more other examples and/or in combination with or instead of the features of the other examples.

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As used in the specification, the terms “about” and “substantially” are used to represent the inherent degree of uncertainty that may be attributed to any quantitative comparison, value, measurement, or other representation. The terms “about” and “substantially” are also used herein to represent the degree by which a quantitative representation may vary from a stated reference without resulting in a change in the basic function of the subject matter at issue.

Referring now to FIG. 1a, an example of the surgical device 10 is shown. The surgical device 10 includes a frame 12 having a proximal end 14 and a distal end 16. Attached to the proximal end 14 of frame 12 is a thumb ring 20 having opening 21. A jaw actuation member 22 is pivotally mounted to the frame 12 by pivot pin 18 that extends transversely through both the frame 12 and the jaw actuation member 22. The pivot pin 18 biases the jaws in a closed position. Extending down from the jaw actuation member 22 is the finger ring 26 having opening 27. An elongate member 30 is fixedly mounted to and extends from the distal end 16 of the frame 12. Attached to the distal end 32 of the elongate member 30 is the grasping member 40 (shown in more detail in FIGs. 2a-b). A jaw actuation rod 17 is slidably mounted in a passage of the elongate member 30 and mounted at its proximal end to the jaw actuation member 22. FIG. 1b shows a detailed view of the distal end of the jaw actuation rod 17 as it engages with the upper jaw 42.

FIG. 2a illustrates an example of the grasping member 40 of FIG. 1 in a closed position. The lower jaw 44 of the grasping member 40 extends from the distal end 32 of the elongate member 30. The lower jaw 44 has a proximal end 46, a distal end 48 and an upper surface 50. The upper jaw 42 is shown as hingedly attached to the distal end 32 of the elongate member 30. The upper jaw 42 has a proximal end 52, a distal end 54 and a lower surface 56.

FIG. 2b illustrates an example of the grasping member 40 in an open position. Extending between the proximal end 46 and the distal end 48 of the lower jaw 44, and removably attached to the upper surface 50, is a plurality of rows of upwardly extending teeth 60a having tips 62a. The plurality of rows of teeth 60a can be formed from silicone rubbers or other suitable materials, such as vinyl or plastic, having a durometer within the range

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between about 40 to about 50. The distance between the proximal end 46 and the distal end 48 may be about 9.0 mm to about 14.0 mm. A lower jaw stop 70 is spaced from the most distal row of teeth at the distal end 48 of the lower jaw 44. A similar configuration exists in the upper jaw 42. A plurality of rows downwardly extending teeth 60b having tips 62b and comprising the same materials as upwardly extending teeth 60a extends between the proximal end 52 and the distal end 54 and removably attached to the lower surface 56. An upper jaw stop 72 is spaced from the most distal row of teeth 60b at the distal end 54 of the upper jaw 42. It can be seen in FIG. 2b that the height of the both the lower and upper jaw stops 70, 72 are greater than the height of the tips 62a,b as measured from the lower and upper surfaces 50, 56. Additionally, both the lower and upper jaw stops 70, 72 are spaced at greater distance from the most distal row of teeth 60a,b than the distance between each rows of teeth 60a,b. Therefore, when the grasping member 40 is closed, a passage is formed for a suture to be grasped without damage to the suture (see, e.g. Fig. 3a), while also allowing the suture to slide through the passage when, for example, a knot is tied in the suture.

FIG. 2c is a detailed view of the upward extending rows of teeth 60a. Each of the upwardly extending rows of teeth 60a are in retrograde form with a tissue surface 66 sloping distally from the tip 62a towards the lower surface 50. The height Y of each tip may be about 0.3 mm to about 0.5 mm. Although the upwardly extending rows of teeth 60a are shown as spaced equidistant from each other, other variations in spacing are possible. A mirror configuration may exist for the downwardly extending rows of teeth 60b, or the downwardly extending rows of teeth 60b may be offset from the upwardly extending rows of teeth by any distance.

Referring now to FIG. 3a, an example of the grasping member 40 is shown with a suture 80 loaded in a suture pass 82 created between the most distal rows of teeth 60a,b and the jaw stops 70, 72 when the grasping member 40 is in a closed position. The inner surface of suture pass 82 has a substantially circular shape with a diameter than can be about 1.0 mm to about 2.0 mm, and which is selected to accommodate a #2 monofilament suture, without causing damage thereto. Additionally, the size of suture pass 82 is selected to allow the suture 80 to remain slidable through the suture pass 82 during surgical repair and when tying

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a knot in the suture after the repair is completed. It can also be seen that the tips 62a,b are vertically aligned when the grasping member 40 is closed. In FIG. 3b, the grasping member 40 is shown grasping tissue 100 during a surgical repair. Because the rows of teeth 60a,b are slightly deformable, the tissue can be grasped and pulled in a distal direction without damage to the tissue 100.

Now turning to FIGs. 4a-b, the disposable elements of the grasping member 40 are illustrated. In FIG. 4a, a disposable set of teeth 60a are shown attached to a jaw inserter 90 prior to being attached to the lower jaw 44. An opening 92 in the lower jaw 44 is configured to receive a jaw mountable portion (shown in FIGs. 4c-d) which can be formed integrally with and comprised of the same material as the teeth 60a. As shown in FIG. 4a, the opening 92 may be serrated about its edges or have some other suitable configuration. FIG. 4b shows the teeth 60a as mounted to the lower jaw 44.

Similarly, FIG. 4c illustrates a disposable set of teeth 60b attached to the jaw inserter 90 prior to being attached to the upper jaw 42. An opening 94 in the upper jaw 42 is configured to receive jaw mountable portion 96 of the teeth 60b. FIG. 4d shows the teeth 60b as mounted to the upper jaw 42.

In certain embodiments, not shown, the jaw mountable portion 96 could be formed separately from the teeth 60a,b and attachable thereto, and comprised of a different material than the teeth 60a,b. In this case, the teeth 60a,b would still be disposable, while the jaw mountable portion 96 could be used repeatedly with other disposable teeth 60a,b and capable of sterilization.

Having understood the basic structure and nature of the surgical device 10, a more complete disclosure of the method of using the surgical device will now be described.

Referring now to FIG. 5a, there may be seen an example of the same surgical device 10 as shown in the preceding figures. In one embodiment, the surgical device 10 is inserted through a cannula 200 and then the cannula 200 is inserted through an incision in a patient's skin (not shown) to the repair site. The distal end of the surgical device 10 comprising the grasping member 40 is inserted through the cannula under direct visualization of an endoscope (not shown) from a separate cannula that has been previously inserted. The grasping member 40 is

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inserted until the upper and lower jaws 42, 44 reach, for example, torn rotator cuff tissue 100 through which a suture 80 has been passed. The tissue 100 is then introduced into the space between the upper jaw and the lower jaw (as shown in FIG. 3b). The soft tissue 100 is immobilized between the upper and lower jaws 42, 44 and can be moved into a desired
5 position and released. Subsequently, the suture 80 can then grasped by the suture pass 82 and a free end removed through the cannula, as shown in FIG. 5b. Afterwards, an arthroscopic knot can be tied in the suture.

A kit may be provided that includes an example of the surgical device 10 described herein, one or more disposable teeth 60a,b including a jaw mountable portion 96, a jaw
10 inserter 90, and one or more other surgical devices (for example, a suture relay or a suture passer).

Although the surgical device has been described with respect to various examples, it should be realized these teachings are also capable of a wide variety of further and other examples within the spirit and scope of the appended claims.

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CLAIMS

1. A surgical device for grasping soft tissue and suture, the surgical device comprising:
 - 5 an elongate member including a proximal end terminating at a proximal terminus and a distal end terminating at a distal terminus, and a longitudinal axis extending between the proximal end and the distal end;
a frame fixedly mounted at the proximal terminus of the elongate member;
 - 10 first and second jaws disposed at a distal terminus of the elongate member, the first jaw movable relative to the second jaw between an open position and closed position;
a suture passage defined at a distal end of the first and second jaws in the closed position, the suture passage being transverse to the longitudinal axis of the surgical device and being sized to enable a suture to slide through the
15 suture passage with the first and second jaws in the closed position; and
a plurality of rows of teeth, each extending from opposing surfaces of the first and second jaws, the plurality of rows of teeth positioned between the suture passage and proximal end of the first and second jaws, the plurality of
20 rows of teeth for grasping soft tissue with the first and second jaws in the closed position.
2. The surgical device of claim 1, wherein the first jaw is hingedly attached to the distal end of the elongate member.
- 25 3. The surgical device of claim 1 or claim 2, further comprising a jaw actuation member pivotally mounted to the frame.

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4. The surgical device of claim 3, wherein the elongate member comprises a jaw actuation rod having a proximal and a distal end, the distal end of the jaw actuation rod engaging the first jaw, and the proximal end of the jaw actuation rod mounted to the jaw actuation member.

5

5. The surgical device of any one of claims 1-4, wherein the plurality of rows of teeth are formed from a material selected from any one of silicon rubber, vinyl or plastic.

6. The surgical device of any one of claims 1-5, wherein the plurality of rows of teeth are formed from silicone rubber.

7. The surgical device of any one of claims 1-6, wherein the plurality of rows teeth are formed from a material having a durometer selected within the range between about 40 to about 50.

15

8. The surgical device of any one of claims 1-7, wherein the plurality of rows of teeth are configured to be removably attached to the opposing surfaces of the first and second jaws.

9. The surgical device of any one of claims 1-8, wherein the plurality of rows of teeth comprise a jaw mountable portion.

20

10. The surgical device of claim 9, wherein the jaw mountable portion is formed integrally with the plurality of rows of teeth.

11. The surgical device of claim 9, wherein the jaw mountable portion is removably attached to the plurality of rows of teeth.

25

12. The surgical device of any one of claims 9-11, wherein any of the plurality of rows of teeth and the jaw mountable portion are disposable.

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13. The surgical device of any one of claims 1-12, wherein the suture passage is defined by a first and second stopping member disposed at a distal end of the first and second jaws, respectively.

5 14. The surgical device of any one of claims 1-13, wherein a distance between the suture passage and the proximal end of the first and second jaws is about 9.0 mm to about 14.0 mm.

15. The surgical device of any one of claims 1-14, wherein the suture passage is sized to accommodate a #2 monofilament suture.

10

16. The surgical device of any one of claims 1-14, wherein an inner diameter of the suture passage is about 1.0 mm to about 2.0 mm.

17. A method of suturing soft tissue using a surgical device, the method comprising:

15 (a) providing a surgical device according to any preceding claim in an area adjacent soft tissue to be repaired, a suture having been passed through the soft tissue;

(b) retaining a portion of the soft tissue between the first jaw and second jaws;

(c) moving the retained soft tissue to a desired position and releasing the soft tissue from the first and second jaws;

20 (d) grasping the suture within the suture passage of the surgical device; and

(e) pulling the suture away from the soft tissue with the surgical device.

18. The method of claim 17, further comprising:

25 prior to step (a), providing an arthroscope in the area adjacent to the soft tissue to be repaired.

19. The method of any one claims 17 or 18, further comprising:

prior to step (a), attaching the plurality of rows of teeth to the opposing surfaces of the first and second jaws.

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20. The method of any one of claims 17-19, further comprising:
prior to step (a), passing the suture through the soft tissue to be repaired with another
surgical device different from the surgical device.

5

21. The method of any of claims 17-20, further comprising:
after step (e), removing the plurality of rows of teeth from the opposing surfaces of the
first and second jaws.

10 22. The method of claim 21, further comprising:
after removing the plurality of rows of teeth from the opposing surfaces of the first and
second jaws, disposing of the plurality of rows of teeth.

15 23. The method of any one of claims 17-22, further comprising:
after step (e), sliding the suture through the suture passage while tying a knot in the
suture.

24. A surgical kit for arthroscopic tissue repair surgery comprising:
surgical device comprising:
20 an elongate member including a proximal end terminating at a proximal
terminus and a distal end terminating at a distal terminus, and a longitudinal
axis extending between the proximal end and the distal end;
a frame fixedly mounted at the proximal terminus of the elongate
member;
25 first and second jaws disposed at a distal terminus of the elongate
member, the first jaw movable relative to the second jaw between an open
position and closed position;
a suture passage defined at a distal end of the first and second jaws in
the closed position, the suture passage being transverse to the longitudinal axis

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of the surgical device and being sized to enable a suture to slide through the suture passage with the first and second jaws in the closed position; and
a plurality of rows of teeth, each extending from opposing faces of the first and second jaws, the plurality of rows of teeth positioned between the suture passage and proximal end of the first and second jaws, the plurality of rows of teeth for grasping soft tissue with the first and second jaws in the closed position; and

at least one other surgical device different from the surgical device.

25. The surgical kit of claims 24, further comprising at least one other plurality of rows of teeth.

26. The surgical kit of any one of claims 24 or 25, wherein the at least one other surgical device is a suture relay.

27. The surgical kit of any one of claims 24-26, wherein the at least one other surgical device is a suture passer.

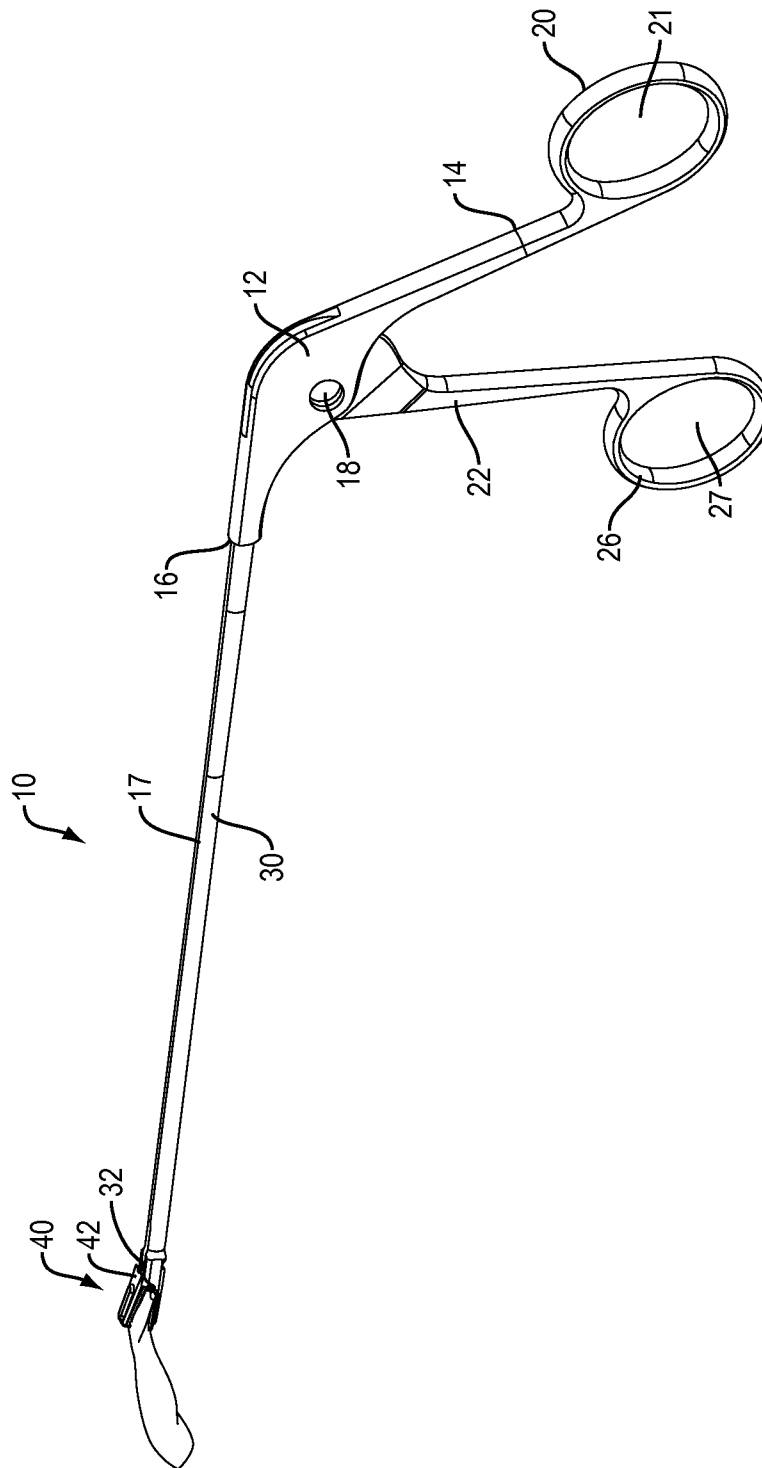


FIG. 1A

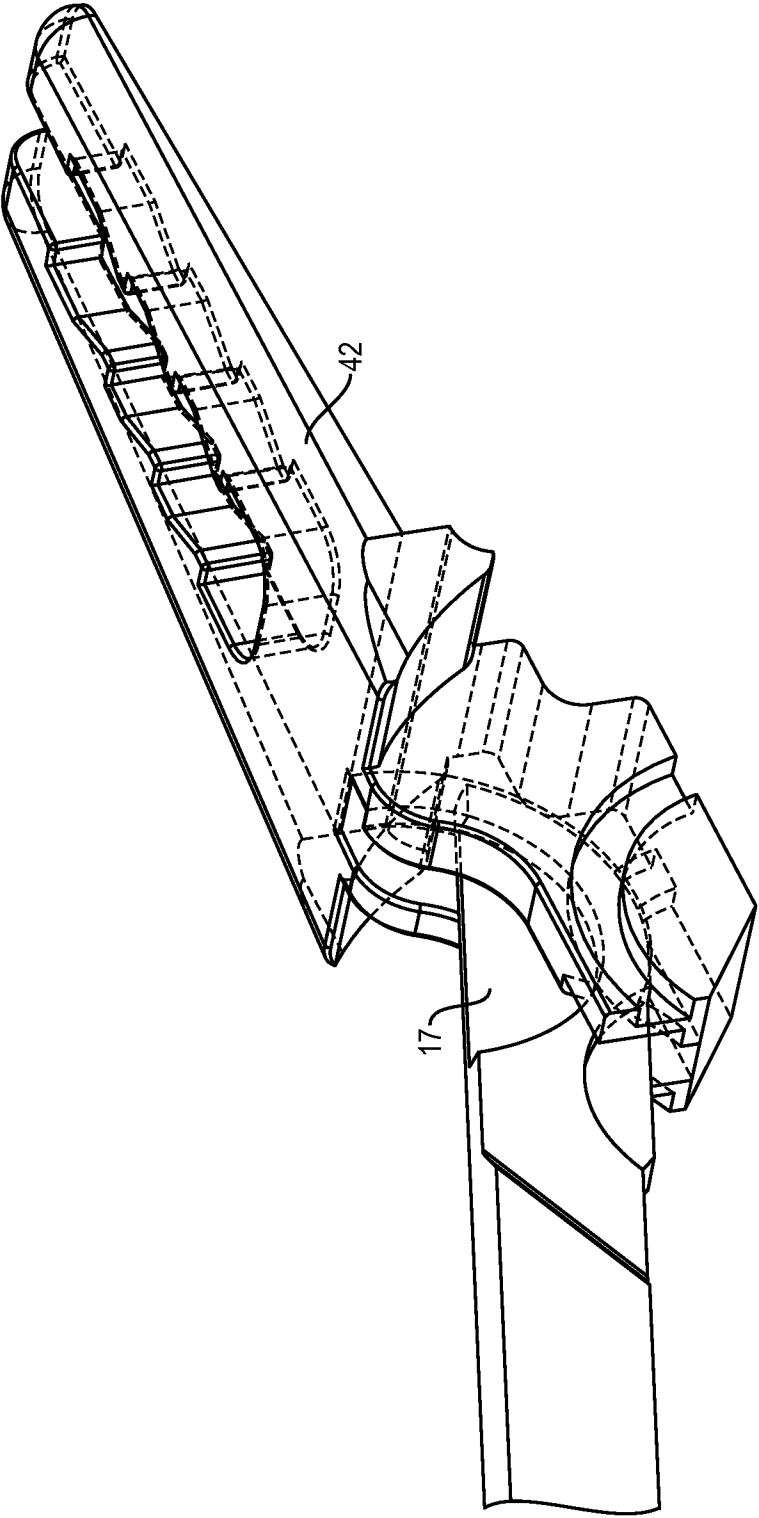


FIG. 1B

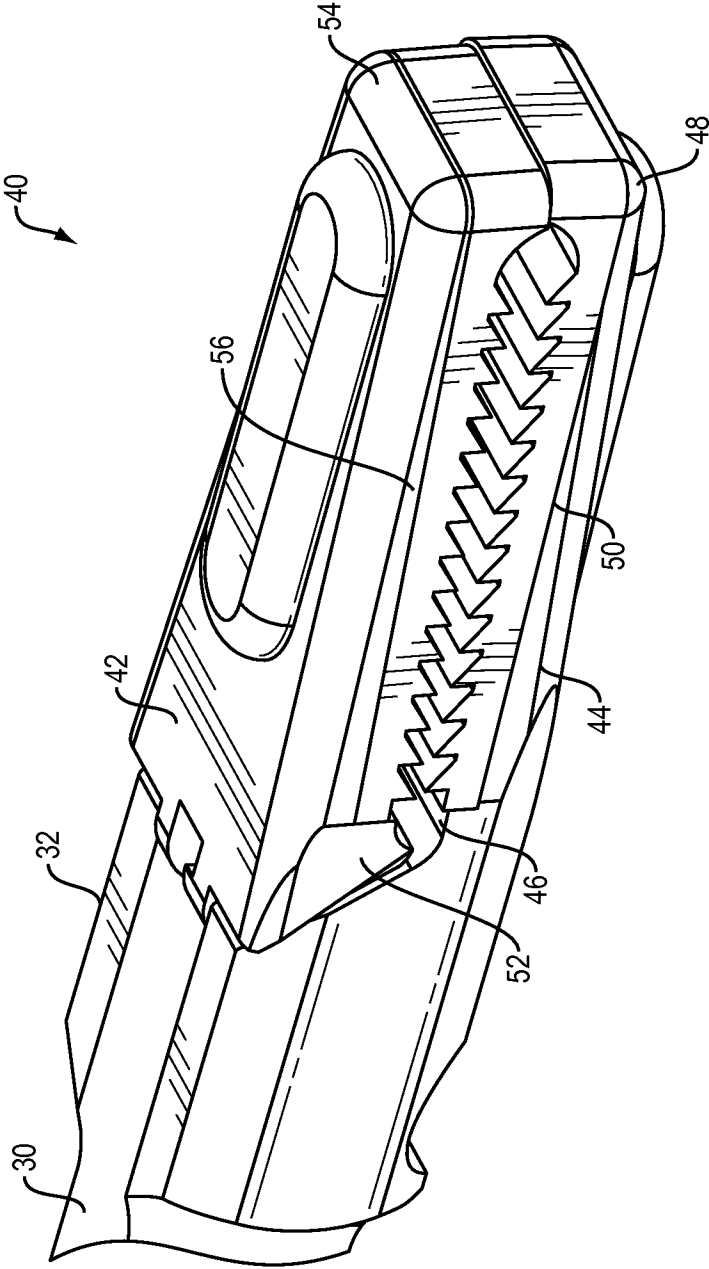


FIG. 2A

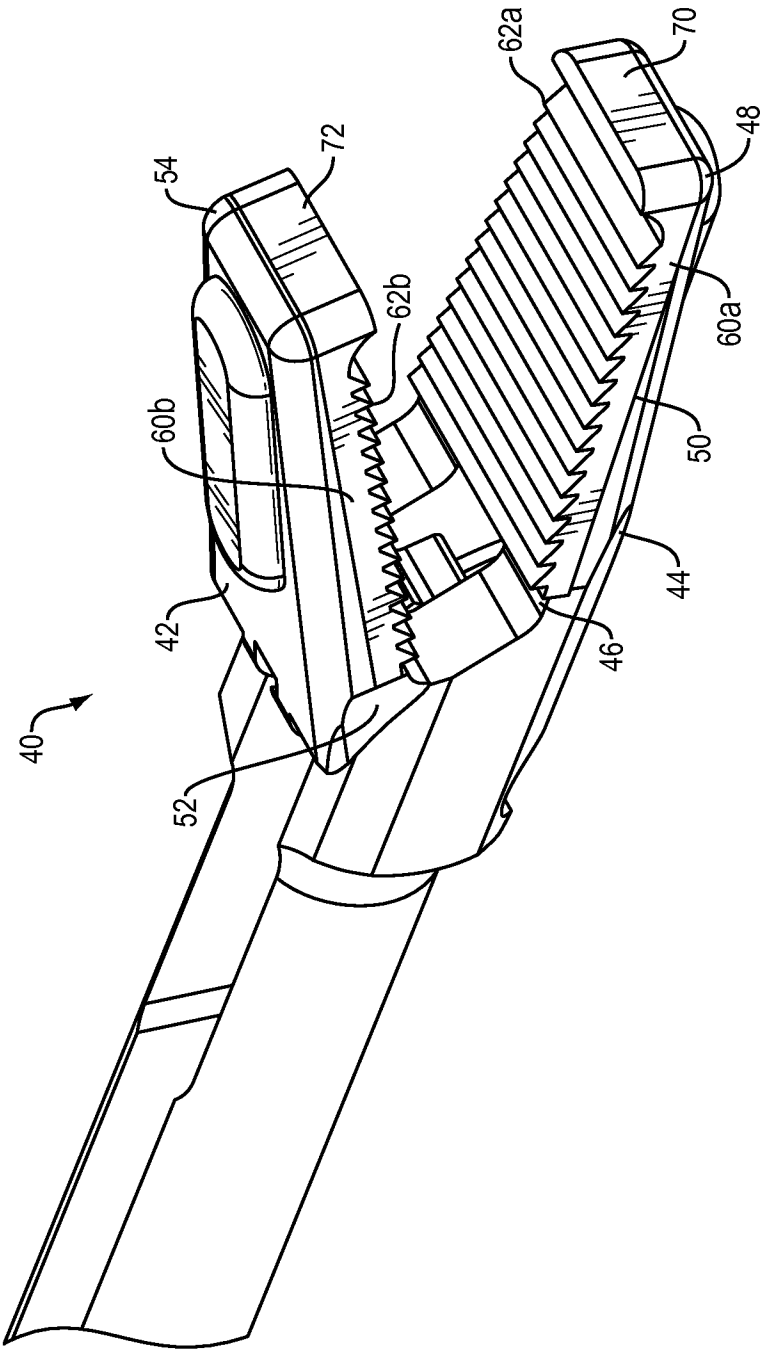


FIG. 2B

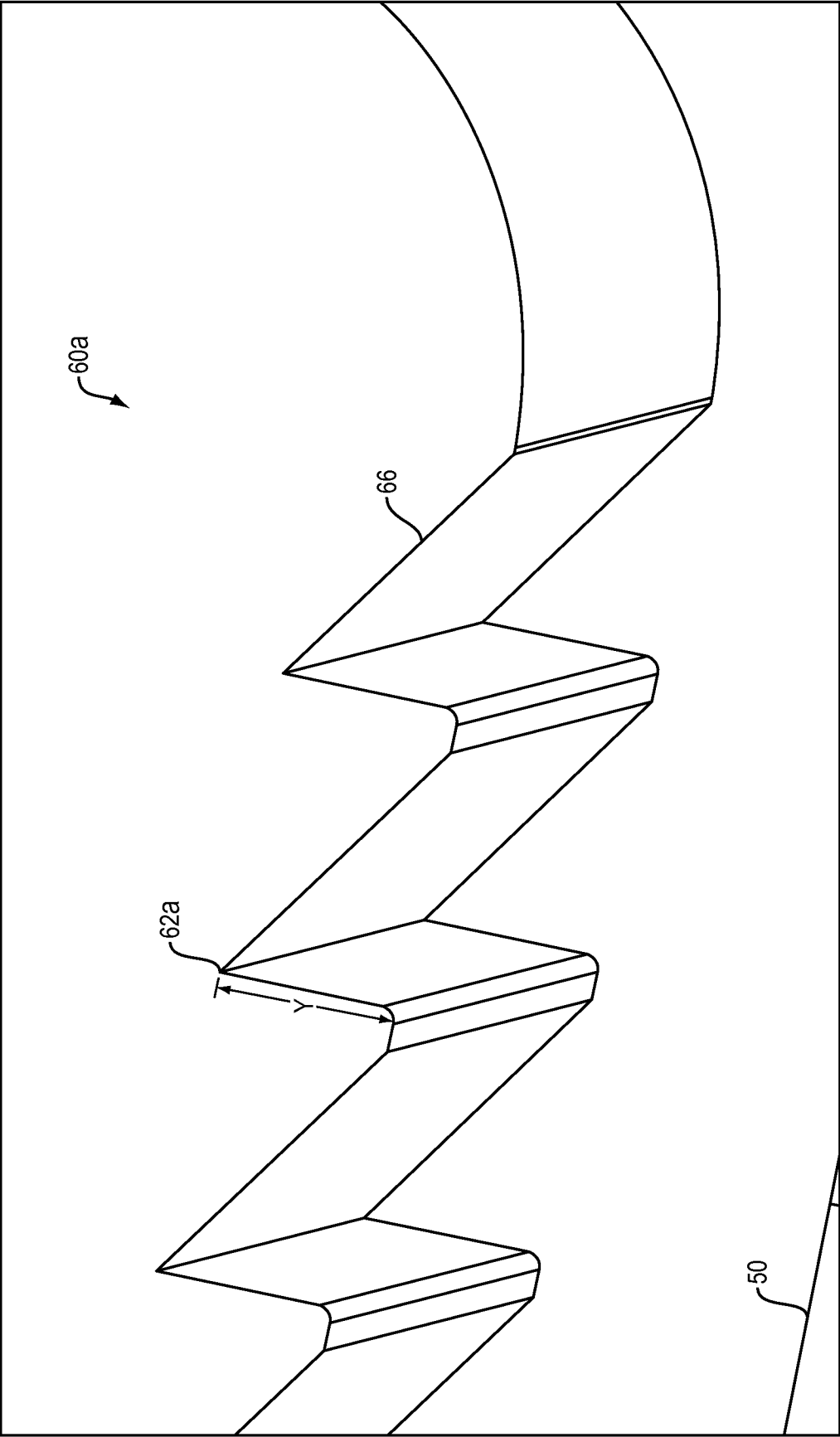


FIG. 2C

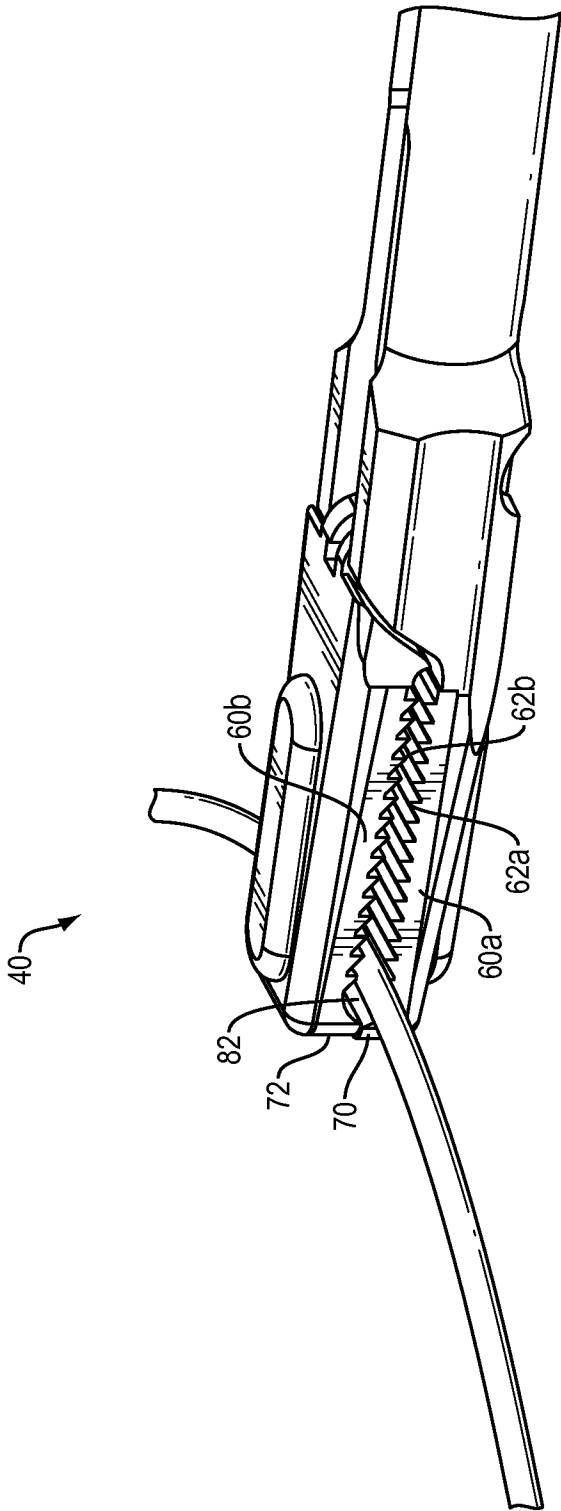


FIG. 3A

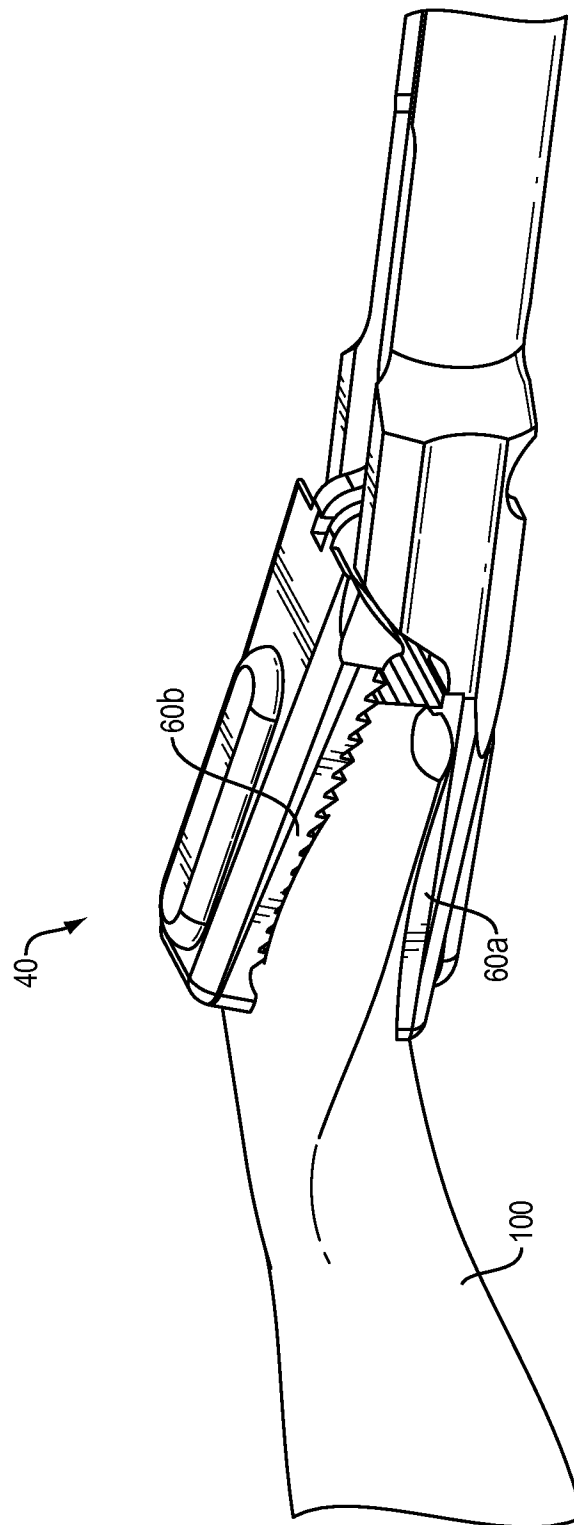


FIG. 3B

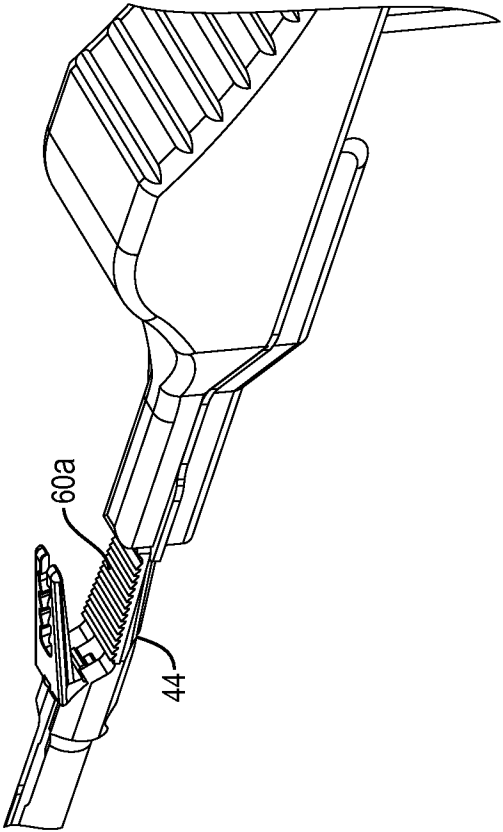


FIG. 4B

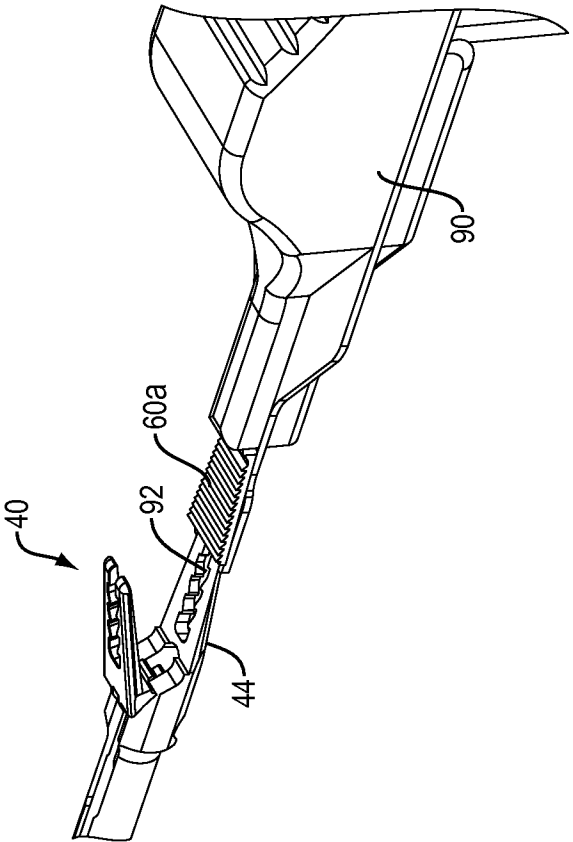


FIG. 4A

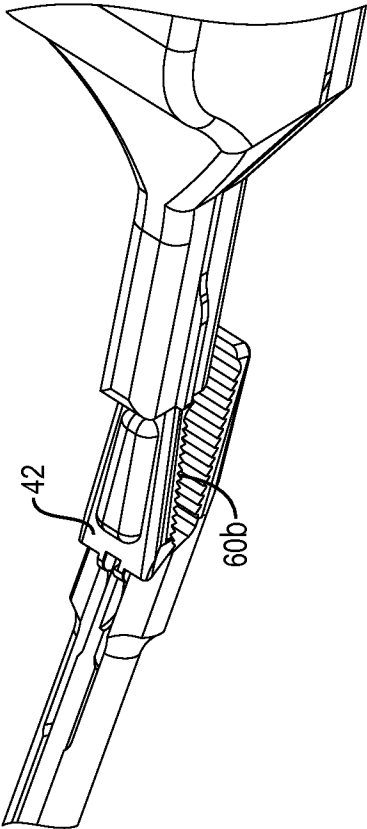


FIG. 4D

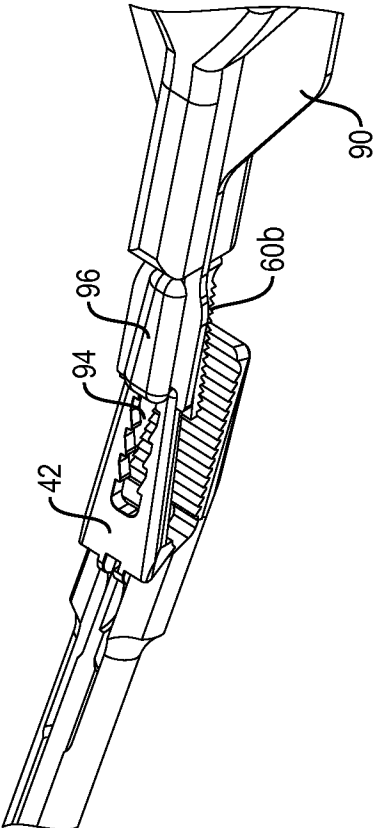


FIG. 4C

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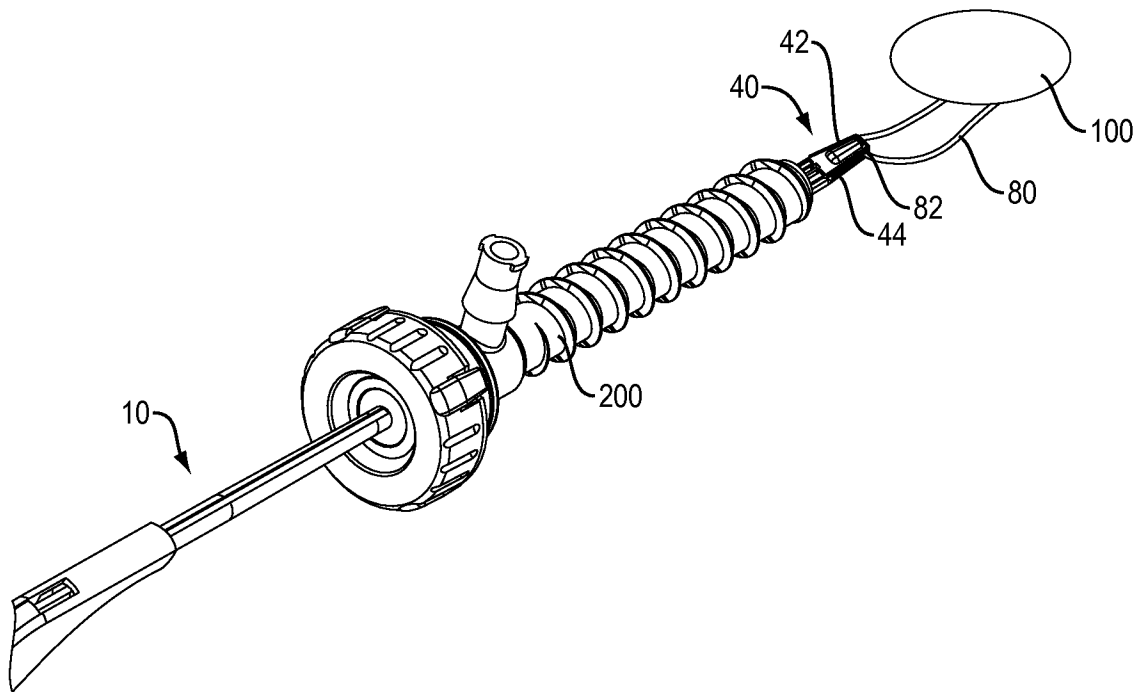


FIG. 5A

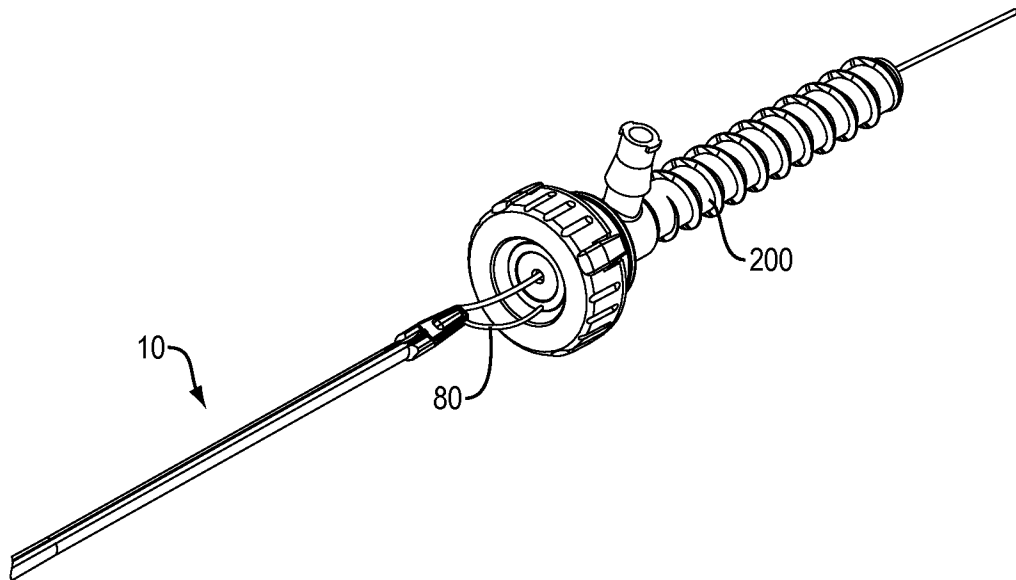


FIG. 5B

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/010460

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/04 A61B17/29
ADD.

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 871 379 A (CLARKE HENRY C N) 18 March 1975 (1975-03-18)	1-7, 13-16, 24-27
Y	column 3, line 58 - column 4, line 57; figures 3-5	8-12
X	----- US 2007/016249 A1 (REZNIK ALAN M [US]) 18 January 2007 (2007-01-18) paragraph [0012] - paragraph [0013]; figures 1-3	1-4, 13-16, 24-27
X	----- US 5 865 835 A (LOLAGNE FRITZ [HT]) 2 February 1999 (1999-02-02) abstract; figures 1-4 ----- -/-	1,24



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

26 August 2015

Date of mailing of the international search report

02/09/2015

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/010460

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013/046336 A1 (BLUMENKRANZ STEPHEN J [US]) 21 February 2013 (2013-02-21) paragraph [0062] - paragraph [0063]; figure 2 -----	8-12
A	US 6 146 391 A (CIGAINA VALERIO [IT]) 14 November 2000 (2000-11-14) abstract; figures 1-9 -----	1,24
A	US 2007/156172 A1 (ALVARADO ALFREDO [US]) 5 July 2007 (2007-07-05) abstract; figures 1-5 -----	1,24
A	US 2009/131976 A1 (KOWALSKI RICHARD C [US]) 21 May 2009 (2009-05-21) paragraph [0036]; figures 1-4 -----	5-7
A	US 2005/240219 A1 (KAHLE HENRY [US] ET AL) 27 October 2005 (2005-10-27) paragraph [0028] - paragraph [0035]; figures 1-9 -----	5-12

INTERNATIONAL SEARCH REPORT

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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. ☒ Claims Nos.: 17-23
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

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3871379	A	18-03-1975	NONE
US 2007016249	A1	18-01-2007	NONE
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