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DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
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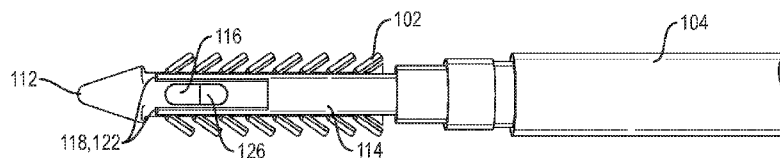


FIG. 4

(57) Abstract: An anchor driver includes an elongated, tubular shaft. A plurality of tines extends distally from the distal end of the driver shaft. An anchor includes a cannulated anchor body, extending along a longitudinal axis, a distal tip, and a closed suture eyelet. The eyelet is formed through the anchor body, transverse to the longitudinal axis, in communication with the anchor body cannulation, and dimensioned to receive a suture. The surface of the anchor body cannulation is threaded along at least a portion of its length and further includes a plurality of slots. Each of the slots extends longitudinally within the threaded portion of the anchor body cannulation, radially below the root of the anchor, and is dimensioned to receive a respective one of the inserter tines. The circumferential position of each of the slots is further selected such that the slots are circumferentially adjacent to, but do not intersect, the eyelet.



SUTURE ANCHOR SYSTEM WITH SLOTTED SUTURE ANCHOR

FIELD

The present disclosure relates to the repair of soft tissue and, specifically, devices for
5 use in such repair.

BACKGROUND

Arthroscopy surgery is a minimally-invasive surgery that involves the repair of tissue
inside or around a joint. In shoulder arthroscopy, for example, common injuries include a
10 torn or damaged cartilage ring or ligaments (causing shoulder instability), a torn rotator cuff,
or a torn or damaged biceps tendon. Each of these injuries necessitates the reattachment of
soft tissue (that is, the ligaments or tendons) to bone.

Suture anchors and suture anchor systems are useful fixation devices for fixing
tendons and ligaments to bone. A typical suture anchor is inserted into the bone by pounding
15 the suture anchor into the bone or by way of a bone hole using an anchor inserter. The suture
anchor can be configured as a screw mechanism or an interference fit device and may be
made of metal, plastic or bioabsorbable material (which dissolves in the body over time). The
suture anchor can include an eyelet that allows one or more sutures to pass therethrough and
link the suture anchor and the suture. The current methods of arthroscopic fixation of soft
20 tissues to bone involve the placement of suture anchors and reducing tissue to bone by passing
a suture through the tissue and tying surgical knots to secure it. Unfortunately, the act of
tying the knots is subject to human error. Additionally, it has been shown that large knot
stacks can abrade healthy tissue and cartilage. This makes knotless suture anchors which can
pass many sutures at once more desirable.

25 One problem with knotless anchors is that anchor strength during bending and
compression is compromised as an effect of suture eyelets becoming larger to accommodate
more sutures. With larger suture eyelets, it is a challenge to keep high-strength support
around the eyelet during insertion. High-strength support of the eyelet is needed to prevent
the anchor from cracking or breaking during insertion or alignment with bone.

SUMMARY

Described herein is a suture anchor system having an anchor driver for use with a knotless suture anchor that provides mechanical reinforcement within an anchor eyelet area during insertion into bone. In general, the anchor driver includes an elongated, tubular shaft defining a threaded driver cannulation extending between a proximal end and a distal end. A plurality of tines extends distally from the distal end of the driver shaft. The anchor includes a cannulated anchor body, extending along a longitudinal axis, a distal tip, and a closed suture eyelet. The eyelet is formed through the anchor body, transverse to the longitudinal axis, in communication with the anchor body cannulation, and dimensioned to receive a suture. The surface of the anchor body cannulation is threaded along at least a portion of its length and further includes a plurality of slots. Each of the slots extends longitudinally within the threaded portion of the anchor body cannulation, radially below the root of the anchor, and is dimensioned to receive a respective one of the inserter tines. The circumferential position of each of the slots is further selected such that the slots are circumferentially adjacent to, but do not intersect, the eyelet.

Embodiments of the suture anchor system include an anchor having an elongated body with a proximal end, a distal end and a longitudinal axis extending between the proximal and distal ends. The anchor body further includes a tip formed in the distal end of the anchor body, a cannulation extending from the proximal end of the anchor body to a proximal end of the tip, an eyelet formed through the anchor body and extending transverse to the longitudinal axis, the eyelet in communication with the cannulation and dimensioned to receive one or more sutures, and a plurality of longitudinally extending slots formed in a surface of the cannulation and positioned circumferentially adjacent to the eyelet. A length of each of the slots is selected to be greater than a length of the eyelet. The suture anchor system also includes an anchor driver having an elongated, cannulated driver body extending between a proximal end and a distal end, and a plurality of tines extending from the distal end of the driver body. A cross-section of each of the plurality of tines is further dimensioned to couple with a respective one of the plurality of slots. A length of each of the plurality of tines is greater than a length of the eyelet such that, when the tines are in contact with a proximal end of the anchor tip, the tines extend both distally and proximally beyond the longitudinal extent

of the eyelet for inhibiting deformation of the eyelet. At least a portion of the anchor driver may be made of metal.

In further embodiments, the suture anchor system includes a locking member within the cannulation and engageable with the anchor driver for locking a suture in the eyelet. The locking member may be a threaded plug. The anchor system may include a suture extending through the eyelet. A length of the eyelet may be between about 0.068" and about 0.125".

In further embodiments, a portion of the plurality of tines is in direct communication with the eyelet. The plurality of tines does not obstruct the locking member from locking the suture in the eyelet. The plurality of tines are not threaded. A length of each one of the plurality of the tines may be between about 0.07" and about 0.200".

In further embodiments, an inner surface of both the anchor body cannulation and the eyelet is threaded. The anchor body may be made from a bioreabsorbable material. The anchor body may also have surface features, which may be threads. The tip of the anchor body is tapered to facilitate delivery into bone.

Other embodiments of the suture anchor system include a plurality of longitudinally extending slots formed in a surface of the anchor body cannulation and positioned circumferentially adjacent to the eyelet. In this embodiment, a length of each of the plurality of tines is selected to be smaller than a length of the eyelet such that, when the tines are distally advanced into the slots, the tines extend distally along a portion of the eyelet for inhibiting deformation of the eyelet. A length of the eyelet may be between about 0.068" and about 0.125". A length of each of the plurality of tines may be between about 0.01" and about 0.10".

The advantages of the suture anchor system of this disclosure are that the metal tines absorb the bending stresses placed on the anchor, making the anchor less likely to break. This also accommodates surgeons using the anchor as a pivot point to move soft tissue aside in order to regain alignment to a prepared bone hole.

For a better understanding of the present disclosure, together with other and further needs thereof, reference is made to the accompanying drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Objects, features and advantages will be apparent from the following more particular description of the embodiments, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the
5 embodiments.

FIG. 1A is a cross-sectional view of the anchor of this disclosure;

FIG. 1B is an illustration of the distal end of an anchor driver of this disclosure;

FIG. 2 is a front perspective view of the distal end of the suture anchor system of this
10 disclosure;

FIGs. 3A-C are disassembled views of the suture anchor system of FIG. 2; and

FIG. 4 is an assembled view of the suture anchor system of FIG. 2.

DETAILED DESCRIPTION

15 Examples of the suture anchor system and methods of use will now be discussed with reference to the figures.

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 example(s) in a clear and concise manner, the drawings may not necessarily be to scale and
20 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.

Comprise, include, and/or plural forms of each are open ended and include the listed
25 parts and can include additional parts that are not listed. And/or is open ended and includes one or more of the listed parts and combinations of the listed parts.

Referring now to FIGs. 1A and 1B, an example of the suture anchor system 100 of this disclosure is shown. The suture anchor system 100 generally includes an anchor 102 (FIG. 1A) and an anchor driver 104 (FIG. 1B). As shown in FIG. 1A, the anchor 102 has an
30 elongated anchor body 106 having a proximal end 108 and a distal end 110. The anchor body 106 is tapered from the proximal end 108 to the distal end 110 such that a tip 112 of the distal

end 110 is pointed to facilitate driving into bone. The anchor body 106 may have surface features 124, such as threads, along at least a partial length of the anchor body 106, such that at least a portion of the tip 112 is not threaded. The surface features 124a toward the distal end 110 of the anchor body 106 may have the same or a different profile than the surface features 124b toward the proximal end 108. For example, the profile of the surface features 124a may be selected to aid in the cutting of bone, while the profile of the surface features 124b may be selected to increase the interference between the anchor body 106 and bone.

The anchor body 106 also includes a cannulation 114 extending from the proximal end 108 of the anchor body 106 to a proximal end of the tip 112, and a transverse eyelet 116 formed through the anchor body 106. The eyelet 116 is in communication with the cannulation 114 and dimensioned to receive a suture 10 therethrough. The cannulation 114 extends through the anchor body 106 such that a portion of the cannulation extends around the eyelet 116 to form longitudinally extending slots 118. Each of the slots 118 extends within the threaded portion of the cannulation 114, radially below the root of the anchor body 106, and is dimensioned to receive a respective portion of the anchor driver 104, as further described below. Inner surfaces of both the cannulation 114 and the eyelet 116 are at least partially threaded along their lengths to mate with a locking member 126, such as a threaded plug, for securing the suture 10 in the eyelet 116 by compression between the distal end of the cannulation 114 and the distal end of the locking member 126.

The anchor body 106 may be completely, or a portions thereof, made from a formulation of poly(lactic-co-glycolic) acid (PLGA), β -Tricalcium phosphate (β -TCP) and calcium sulfate, poly-L-lactic acid-hydroxyapatite (PLLA-HA), poly-D-lactide (PDLA), polyether ether ketone (PEEK) or variants thereof. Biocomposite embodiments of the suture anchor made from a combination of PLGA, β -TCP, and calcium sulfate are absorbable by the body, which is beneficial to natural healing. An example formulation of PLGA, β -TCP, and calcium sulfate is described in U.S. Patent No. 8,545,866, the entirety of which is herein incorporated by reference. Other commonly used material for suture anchors are also contemplated by this disclosure.

FIG. 1B shows a distal end of the anchor driver 104. The anchor driver 104 comprises an elongated driver body 120 defining a threaded driver cannulation (not shown) extending between a proximal end and the distal end of the driver body 120. The driver cannulation

may be used to house a moveable threaded shaft (not shown) to engage with the locking member 126 (FIG. 1) and drive the locking member 126 distally through the eyelet 116. A plurality of tines 122, which may be two tines, extends from the distal end of the driver body 120. The anchor driver 104, and/or the tines 122, can be comprised of metal or other suitable material. A cross-section of each of the tines 122 is dimensioned to couple with a respective one of the slots 118 of the anchor body 106. Housing of the tines 122 in the slots 118 advantageously provides the anchor driver 104 with a higher insertion torque during advancement of the anchor 102 into bone.

FIG. 2 is a front perspective view of the distal end 112 of the anchor 102 of FIG. 1A, with the tines 122 of the anchor driver 104 inserted into the slots 118 of the anchor 102. (The tip 112 has been removed for clarity.) The circumferential position of each of the slots 118 is selected such that the slots 118 are circumferentially adjacent to, but do not intersect, the eyelet 116. As can be seen in FIG. 2, there is no material between the tines 122 and the eyelet 116. That is, the portions of the tines 122 adjacent to the eyelet 116 are in direct communication with the eyelet 116. Having no material between the tines 122 and the eyelet 116 advantageously allows for a larger eyelet 116 which can accommodate more or larger sutures, and/or allow the anchor 102 to accept a suture from another device, without sacrificing the structural integrity of the eyelet 116. It also should be noted that, while the internal surface of the eyelet 116 comprises inner threads 128, the slots 122 are not themselves threaded. The threaded eyelet 116 may advantageously allow for a shorter length of a locking member (FIG. 1) to be used. Because the tines 122 have a lower profile than the slots 118, the tines 122 do not obstruct the locking member 126 from descending down the inner threads 128 of the eyelet 116 to lock in a suture.

FIGS. 3A-C show the anchor driver 104 disassembled from the anchor 102. In FIG. 3A, it can be seen that a length of each of the plurality of tines 122 is greater than a length of the eyelet 116. Therefore, when the tines 122 are distally advanced into contact with a proximal end of the anchor tip 112, the tines 122 extend both distally and proximally beyond the longitudinal extent of the eyelet 116 to inhibit deformation of the eyelet 116.

Alternatively, as shown in FIGS. 3B and 3C, the tines 122 can be half the length of the eyelet 116 (FIG. 3B), a quarter of the length of the eyelet 116 (FIG. 3C), or some other suitable length, while still conferring support strength to the eyelet 116. In this case, the length of the

slots 118 would be selected to be as long, or a small fraction longer, as the length of the tines 122. In various examples, a length of the eyelet may be between about 0.068" and about 0.125", and a length of the tines may be between about 0.01" and about 0.200".

5 In use, as shown in FIG. 4, the distal end of the anchor driver 104 is positioned within the cannulation 114 (partially exposed for clarity), with the tines 122 inserted into the slots 118. The anchor driver 104 is distally advanced until the distal end of the tines 122 contacts the distal end of the cannulation 114. As stated above, the tines 122 are of sufficient length such that the tines 122 are positioned circumferentially adjacent the eyelet 116 (i.e., not obstructing the eyelet 116), allowing a suture to be routed therethrough. After routing the
10 suture through the eyelet 116, the locking member 126 may be distally advanced through the anchor driver 104 and the cannulation 114 of the anchor 102 to secure the suture to the anchor 102.

Although the present disclosure has been described with respect to various examples, it would be apparent to one of ordinary skill in the art that various other examples are
15 possible, without departing from the spirit and scope as defined in the appended claims.

CLAIMS

What is claimed is:

1. A suture anchor system, comprising:

5 an anchor comprising:

an elongated body having a proximal end, a distal end and a longitudinal axis extending between the proximal and distal ends, the anchor body further comprising:

a tip formed in the distal end of the anchor body;

10 a cannulation extending from the proximal end of the anchor body to a proximal end of the tip;

an eyelet formed through the anchor body and extending transverse to the longitudinal axis, wherein the eyelet is in communication with the cannulation and dimensioned to receive one or more sutures; and

15 a plurality of longitudinally extending slots formed in a surface of the cannulation and positioned circumferentially adjacent to the eyelet, wherein a length of each of the slots is selected to be greater than a length of the eyelet; and

an anchor driver comprising:

20 an elongated, cannulated driver body extending between a proximal end and a distal end; and

a plurality of tines extending from the distal end of the driver body;

wherein a cross-section of each of the plurality of tines is further dimensioned to couple with a respective one of the plurality of slots; and

25 wherein a length of each of the plurality of tines is greater than a length of the eyelet such that, when the tines are in contact with a proximal end of the anchor tip, the tines extend both distally and proximally beyond the longitudinal extent of the eyelet for inhibiting deformation of the eyelet.

30 2. The suture anchor system of claim 1, wherein a portion of the plurality of tines is in direct communication with the eyelet.

3. The suture anchor system of claims 1 or 2, further comprising a locking member disposed within the cannulation and engageable with the anchor driver for locking a suture in the eyelet.

5 4. The suture anchor system of claim 3, wherein the locking member is a threaded plug.

5. The suture anchor system of claim 3, wherein the plurality of tines does not obstruct the locking member from locking the suture in the eyelet.

10 6. The suture anchor system of any one of claims 1-5, wherein an inner surface of the anchor body cannulation is threaded.

7. The suture anchor system of any one of claims 1-6, wherein an inner surface of the eyelet is threaded.

15

8. The suture anchor system of any one of claims 1-7, wherein the plurality of tines are not threaded.

9. The suture anchor system of any one of claims 1-8, wherein the anchor body is
20 comprised of a bioreabsorbable material.

10. The suture anchor system of any one of claims 1-9, wherein the anchor body comprises surface features.

25 11. The suture anchor system of claim 10, wherein the surface features are threads.

12. The anchor system of any one of claims 1-11, wherein at least a portion of the anchor driver is comprised of metal.

30 13. The anchor system of any one of claims 1-12, wherein the tip of the anchor body is tapered to facilitate delivery into bone.

14. The anchor system of any one of claims 1-13, further comprising a suture extending through the eyelet.

15. The suture anchor system of any one of claims 1-14, wherein a length of the eyelet is between about 0.068" and about 0.125".

16. The suture anchor system of any one of claims 1-15, wherein a length of each one of the plurality of tines is between about 0.07" and about 0.200".

17. A suture anchor system, comprising:
an anchor comprising:

an elongated body having a proximal end, a distal end and a longitudinal axis extending between the proximal and distal ends, the anchor body further comprising:

a tip formed in the distal end of the anchor body;

a cannulation extending from the proximal end of the anchor body to a proximal end of the tip;

an eyelet formed through the anchor body and extending transverse to the longitudinal axis, wherein the eyelet is in communication with the cannulation and dimensioned to receive one or more sutures; and

a plurality of longitudinally extending slots formed in a surface of the cannulation and positioned circumferentially adjacent to the eyelet; and

an anchor driver comprising:

an elongated, cannulated driver body extending between a proximal end and a distal end; and

a plurality of tines extending from the distal end of the driver body;

wherein a cross-section of each of the plurality of tines is further dimensioned to couple with a respective one of the plurality of slots; and

wherein a length of each of the plurality of tines is selected to be smaller than a length of the eyelet such that, when the tines are distally advanced into the slots, the

tines extend distally along a portion of the eyelet for inhibiting deformation of the eyelet.

18. The suture anchor system of claim 17, wherein a length of the eyelet is between about
5 0.068" and about 0.125".

19. The suture anchor system of claims 17 or 18, wherein a length of each of the plurality of tines is between about 0.01" and about 0.10".

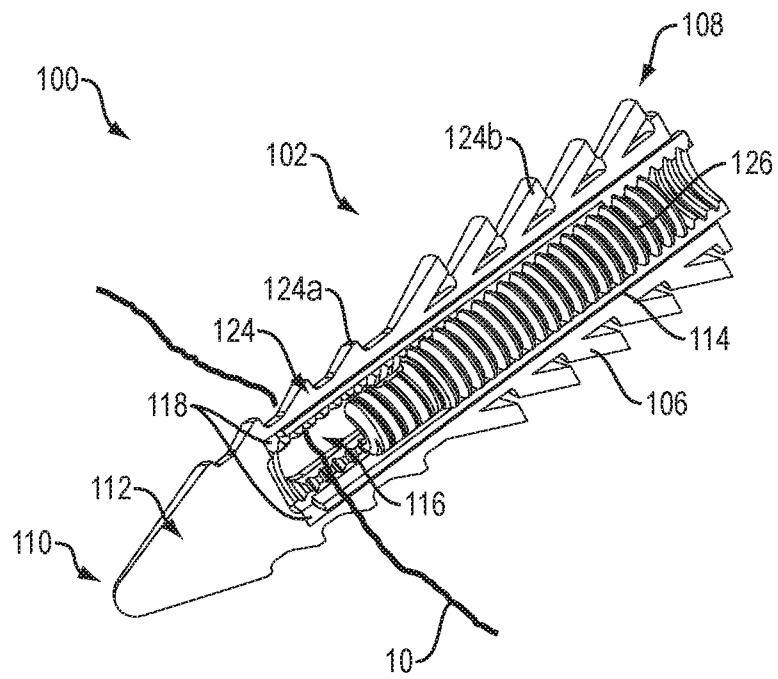


FIG. 1A

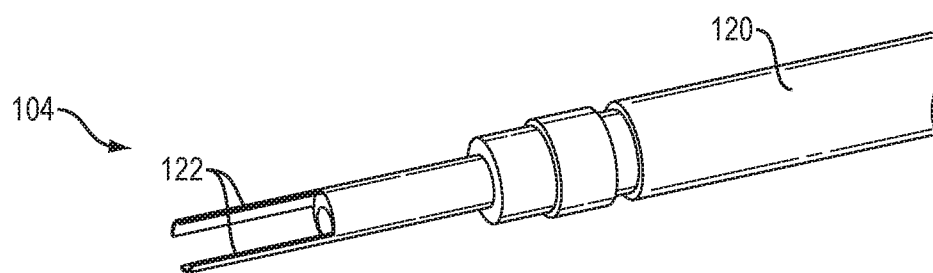


FIG. 1B

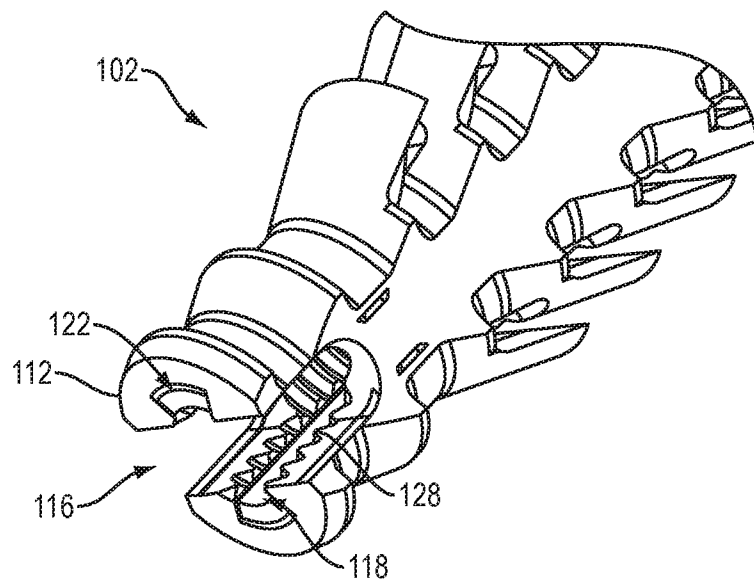
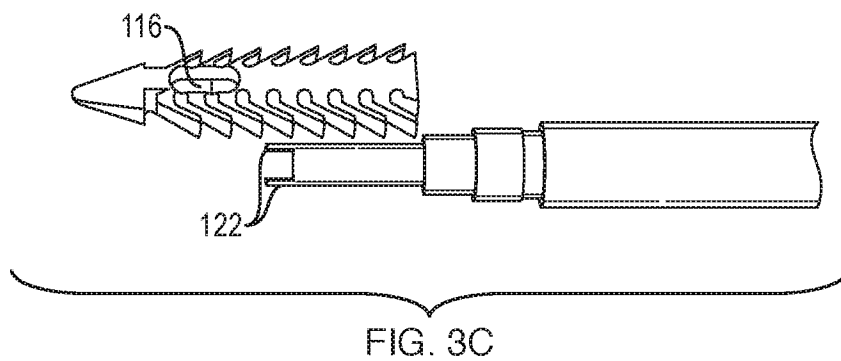
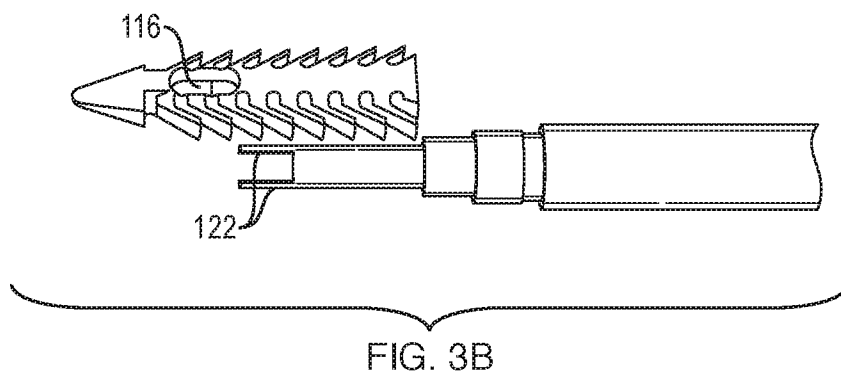
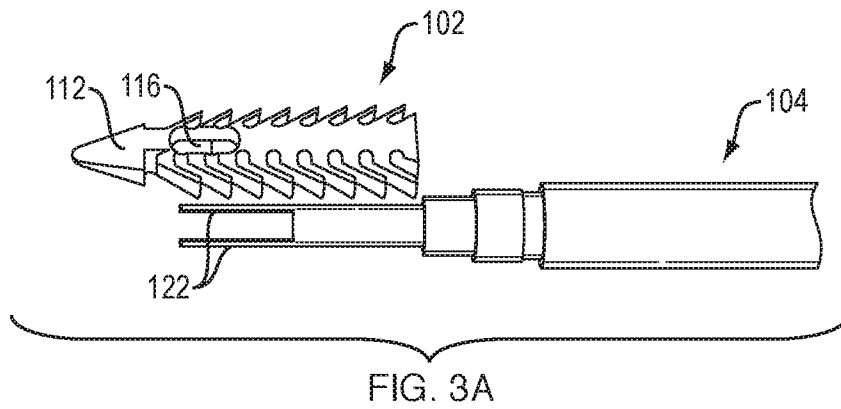


FIG. 2

3/4



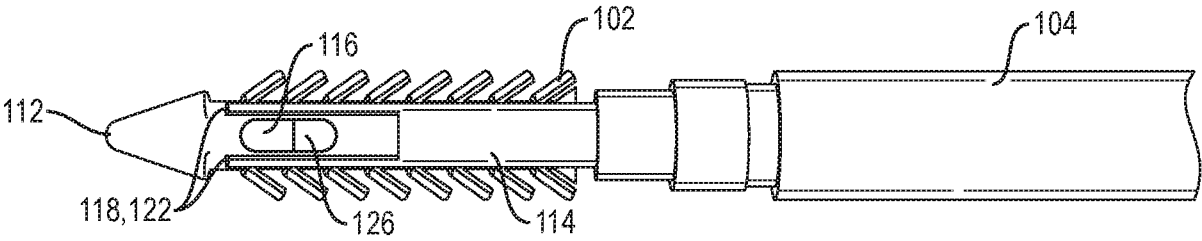


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/030906

A. CLASSIFICATION OF SUBJECT MATTER
 INV. A61B17/04
 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

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X	WO 2011/056701 A1 (SMITH & NEPHEW INC [US]; HOUSMAN MARK EDWIN [US]; VINCUIIIA PAUL STEVE) 12 May 2011 (2011-05-12)	1,2,8, 10-19
Y	figures 1-6, 10A, 10B, 11, 12 paragraph [0039] - paragraph [0042] paragraph [0045] - paragraph [0046] paragraph [0056]	3-7,9
Y	----- US 2011/112576 A1 (NGUYEN LINH TUONG [US] ET AL) 12 May 2011 (2011-05-12)	3-7,9
A	figures 1-6 paragraph [0070] - paragraph [0074] paragraph [0092] ----- -/-	1,10,13, 14,17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

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13/07/2016

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/030906

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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