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(12) **United States Patent**
Donner et al.

(10) **Patent No.: US 10,314,710 B2**
(45) **Date of Patent: Jun. 11, 2019**

(54) **METHODS OF FUSING A SACROILIAC JOINT**

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(73) Assignee: **JCBD, LLC**, Fort Collins, CO (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 186 days.

(21) Appl. No.: **15/216,472**

(22) Filed: **Jul. 21, 2016**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(Continued)

(51) **Int. Cl.**

A61F 2/30 (2006.01)
A61F 2/44 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***A61F 2/30988*** (2013.01); ***A61B 17/0218*** (2013.01); ***A61B 17/1757*** (2013.01);

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(58) **Field of Classification Search**

CPC A61F 2/30988; A61F 2/32; A61F 2/46; A61F 2/4455; A61F 2/4611;

(Continued)

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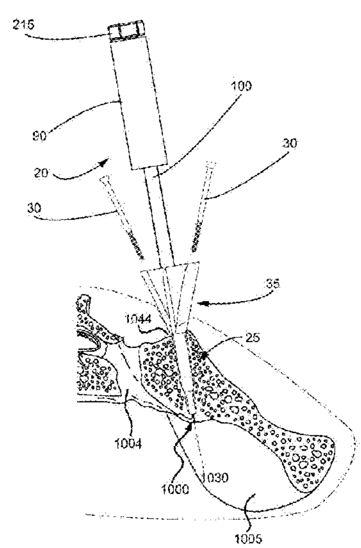
Assistant Examiner — Tessa M Matthews
(74) *Attorney, Agent, or Firm* — Polsinelli PC; Joshua J. Pranckum; Samuel Wade Johnson

(57) **ABSTRACT**

One implementation of the present disclosure may include a method of sacroiliac joint fusion involving a joint implant and a delivery tool. The joint implant includes at least one integral anchor configured to move relative to a body of the implant when being brought into anchoring engagement with bone defining a sacroiliac joint space in which the body of the implant is located. In certain embodiments, the anchor extends distally and laterally relative to a body of the implant or the anchor rotates relative to the body of the implant via a center axle when being brought into anchoring engagement with the bone. The delivery tool may be configured to support the implant and to cause the displacement of the at least one anchor relative to the implant body so as to cause the at least one anchor to be brought into anchoring engagement with the bone.

69 Claims, 99 Drawing Sheets



Related U.S. Application Data

continuation-in-part of application No. 13/475,695, filed on May 18, 2012, now Pat. No. 9,381,045, which is a continuation-in-part of application No. 13/236,411, filed on Sep. 19, 2011, now Pat. No. 9,017,407, which is a continuation-in-part of application No. 12/998,712, filed as application No. PCT/US2011/000070 on Jan. 13, 2011, now Pat. No. 8,979,928.

(60) Provisional application No. 61/674,130, filed on Jul. 20, 2012, provisional application No. 61/335,947, filed on Jan. 13, 2010.

(51) **Int. Cl.**

A61F 2/46	(2006.01)
A61B 17/17	(2006.01)
A61B 17/70	(2006.01)
A61B 17/68	(2006.01)
A61B 17/84	(2006.01)
A61B 17/02	(2006.01)
A61B 17/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 17/68*** (2013.01); ***A61B 17/7055*** (2013.01); ***A61B 17/844*** (2013.01); ***A61F 2/4455*** (2013.01); ***A61F 2/4611*** (2013.01); *A61B 17/025* (2013.01); *A61B 17/7043* (2013.01); *A61B 2017/0046* (2013.01); *A61B 2017/0225* (2013.01); *A61F 2002/30163* (2013.01); *A61F 2002/30433* (2013.01); *A61F 2002/30622* (2013.01); *A61F 2002/30995* (2013.01); *A61F 2002/4622* (2013.01); *A61F 2002/4687* (2013.01); *A61F 2310/00017* (2013.01); *A61F 2310/00023* (2013.01); *A61F 2310/00179* (2013.01); *A61F 2310/00359* (2013.01)

(58) **Field of Classification Search**

CPC .. A61F 2002/30163; A61F 2002/30995; A61F 2002/30433; A61F 2002/30622; A61F 2002/4622; A61F 2002/4687; A61F 2310/00017; A61F 2310/00023; A61F 2310/00179; A61F 2310/00359; A61B 17/0218; A61B 17/1757; A61B 17/68; A61B 17/7055; A61B 17/844; A61B 17/025; A61B 17/7043; A61B 2017/0046; A61B 2017/0225

See application file for complete search history.

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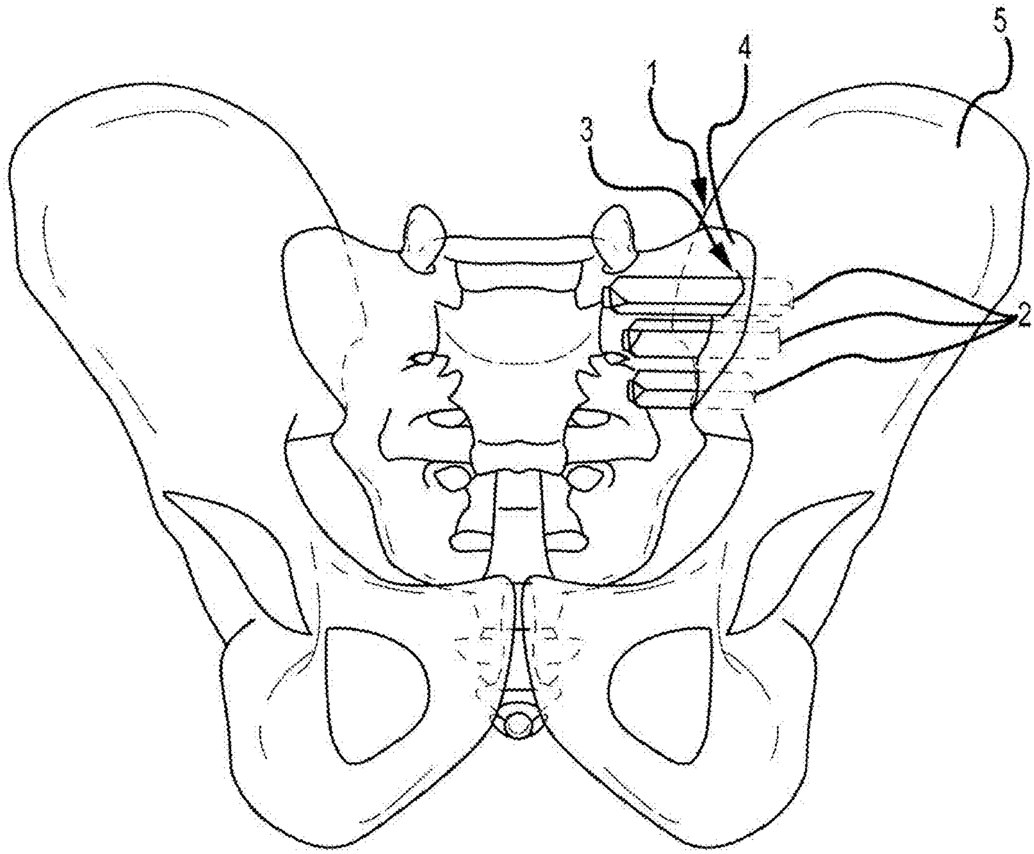

FIG.1
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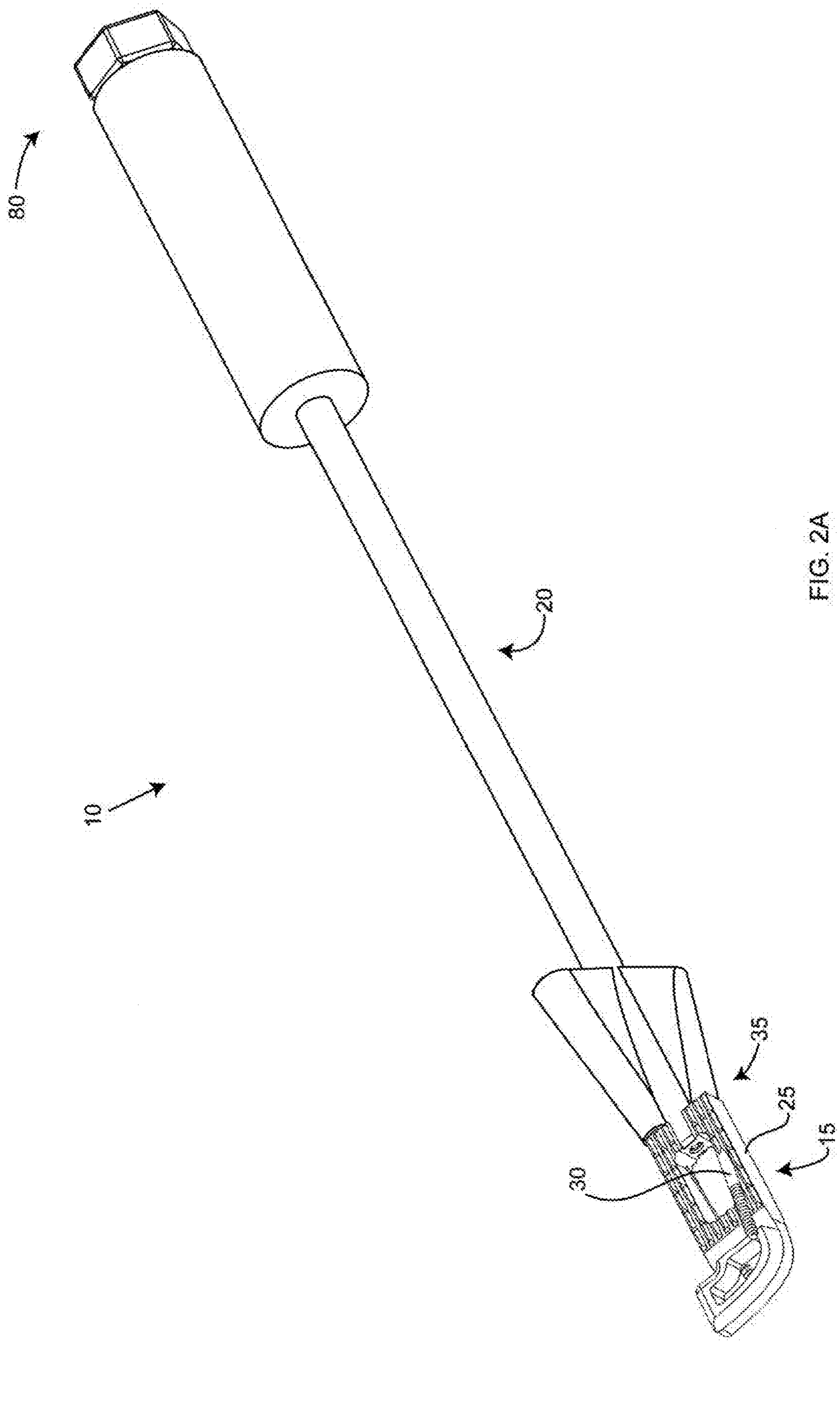

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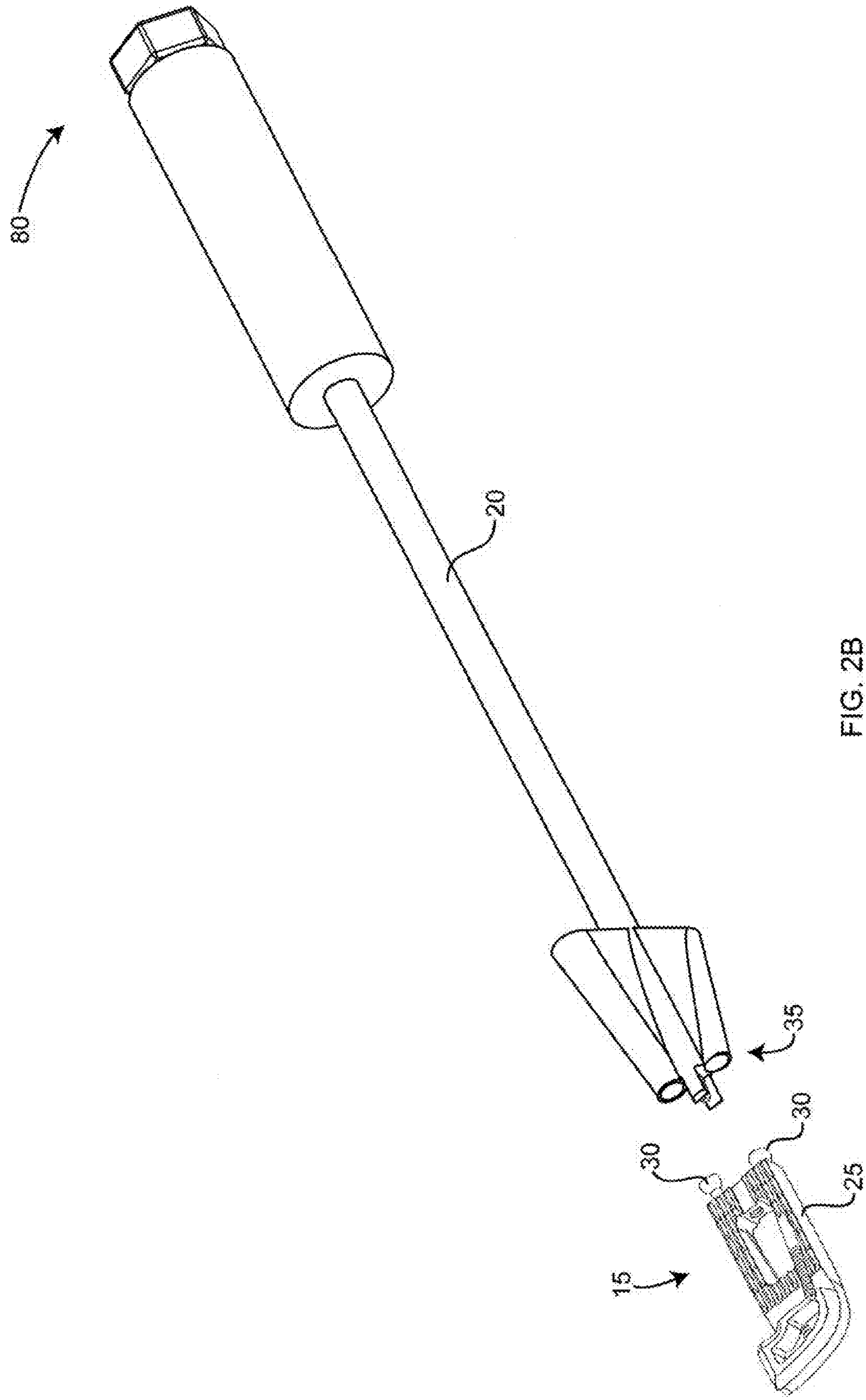

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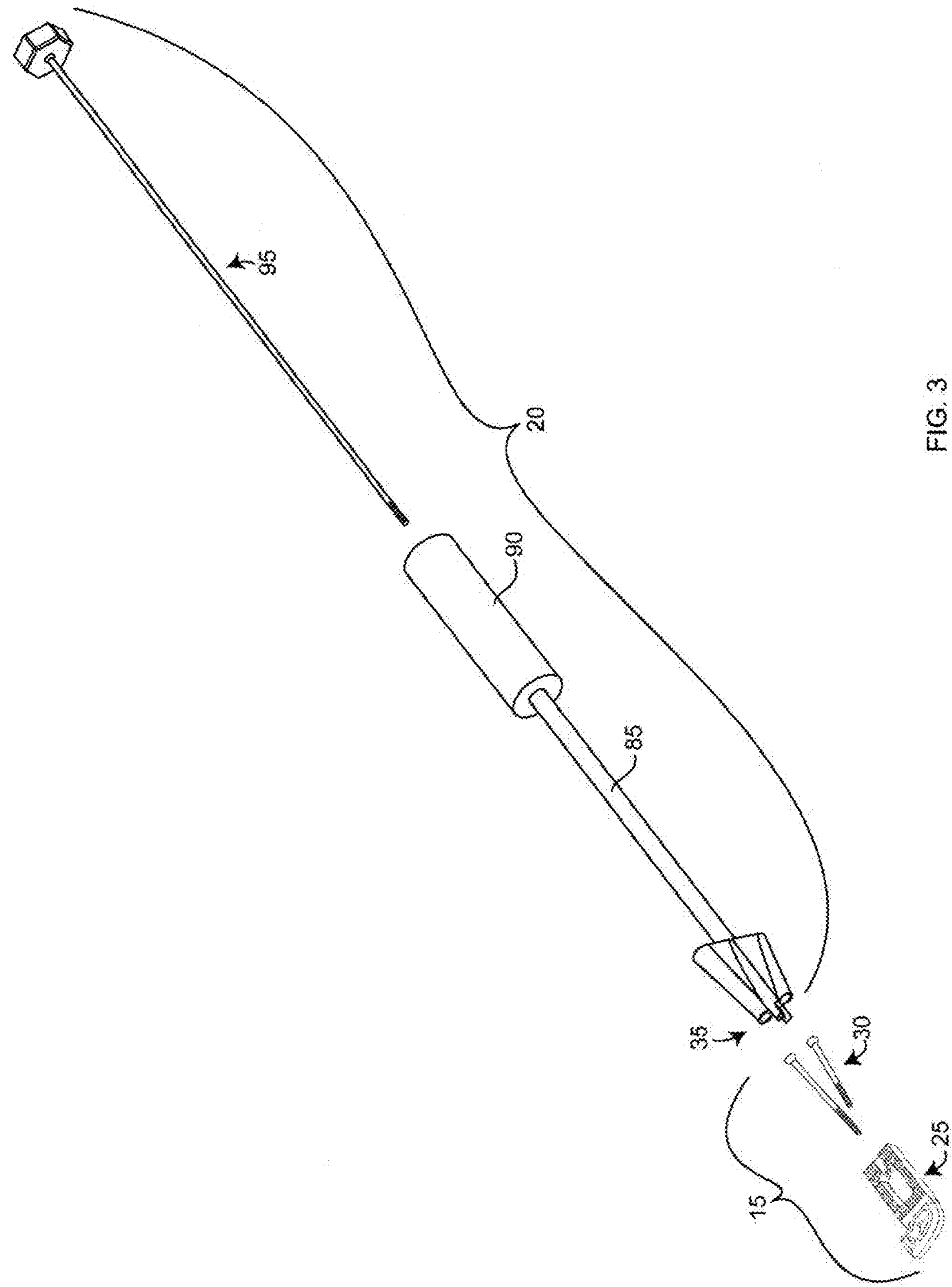

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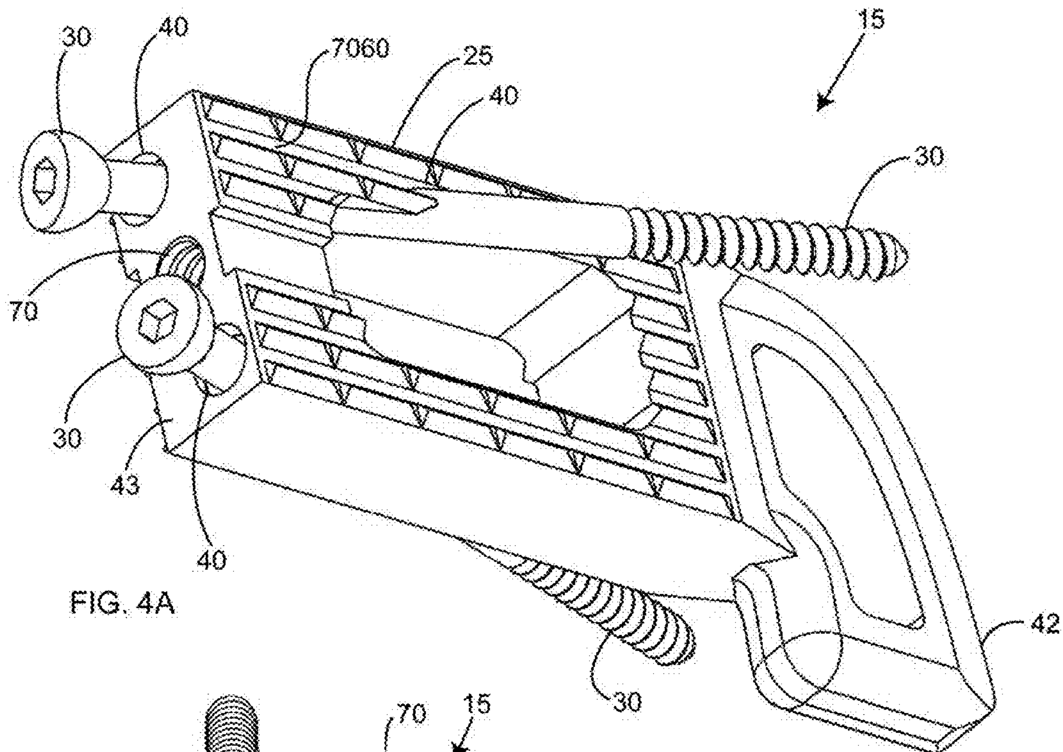

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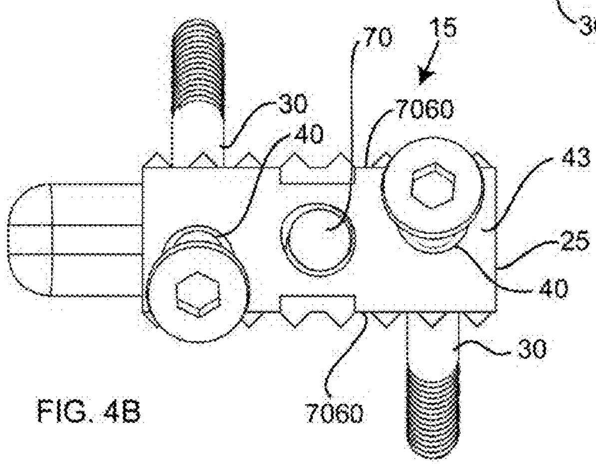

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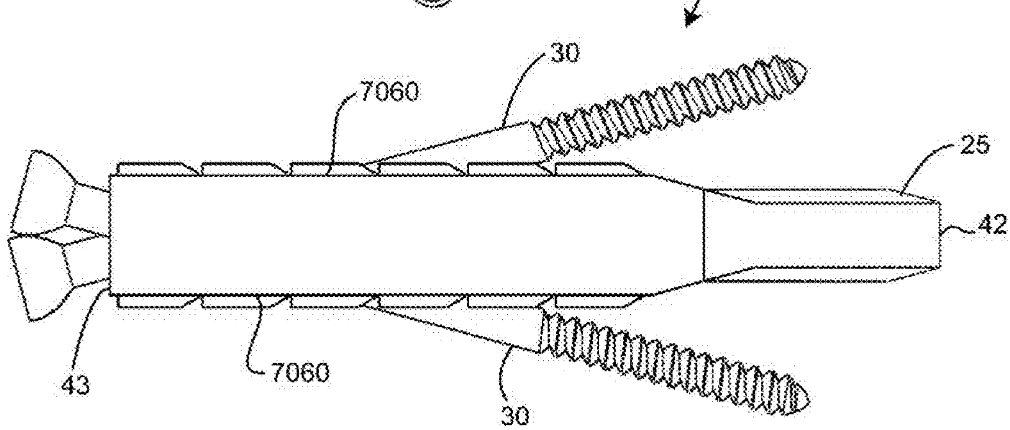

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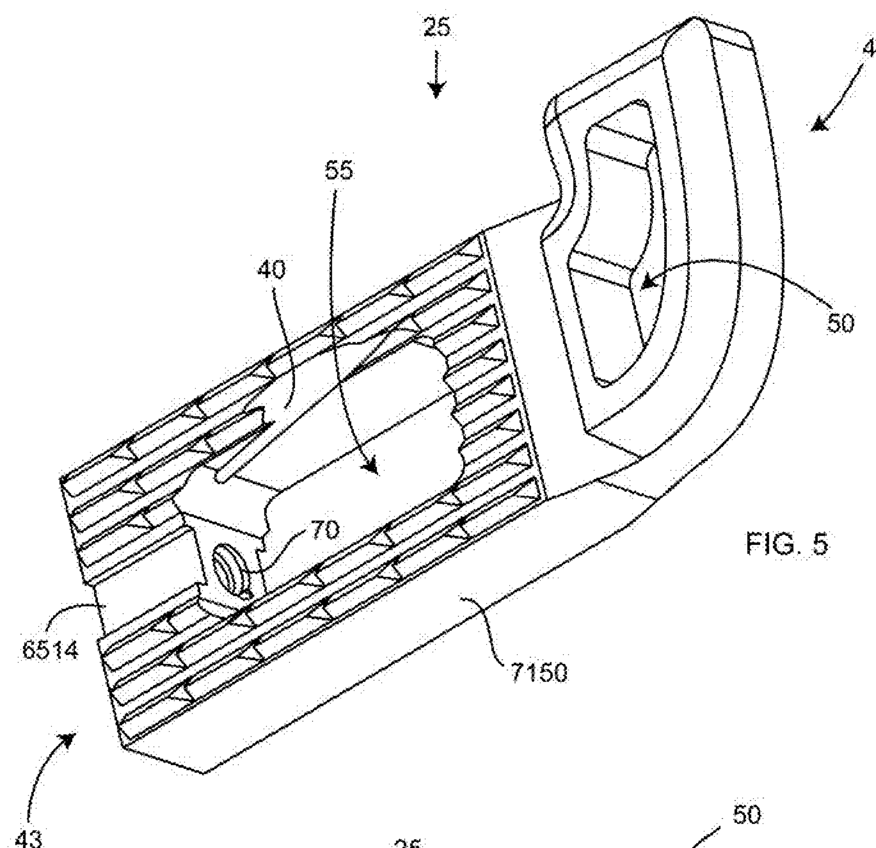

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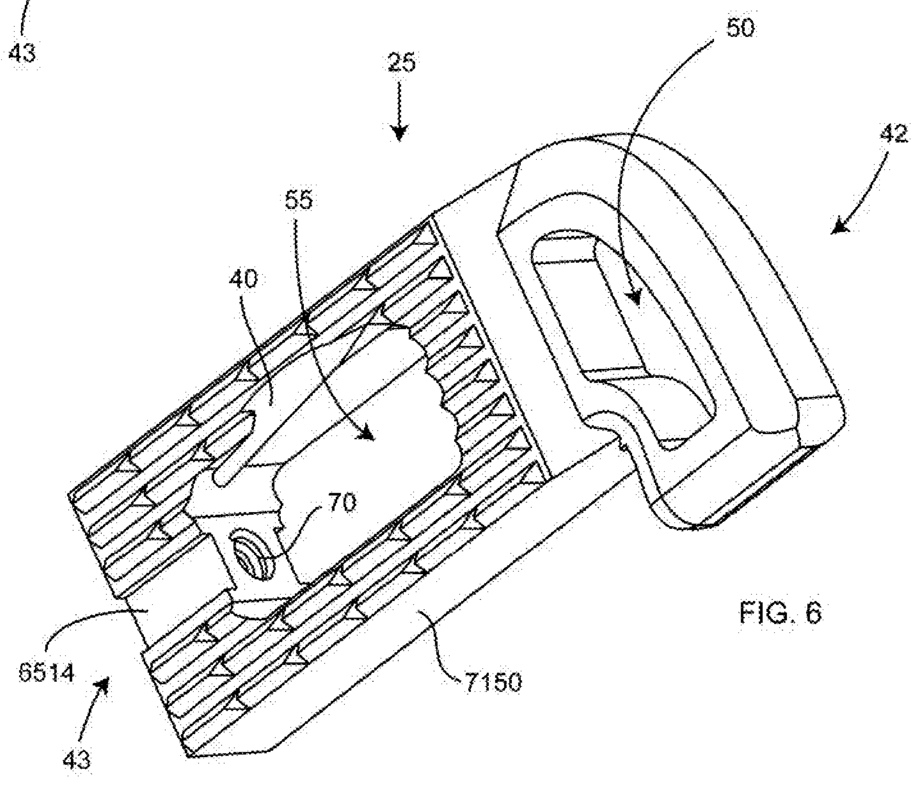

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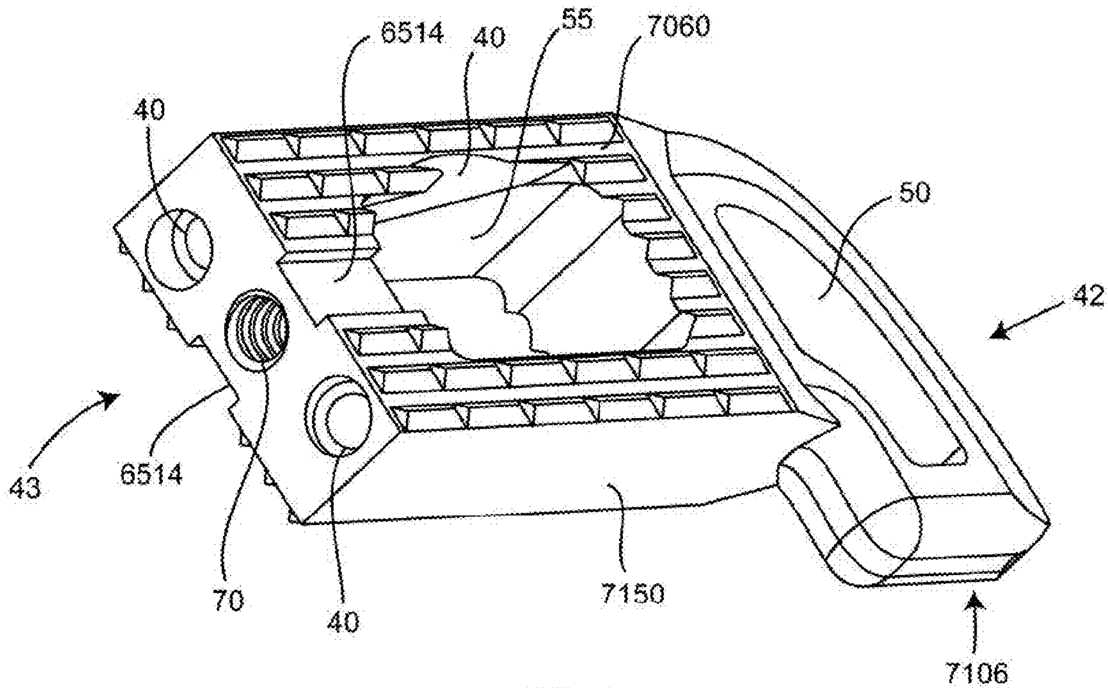
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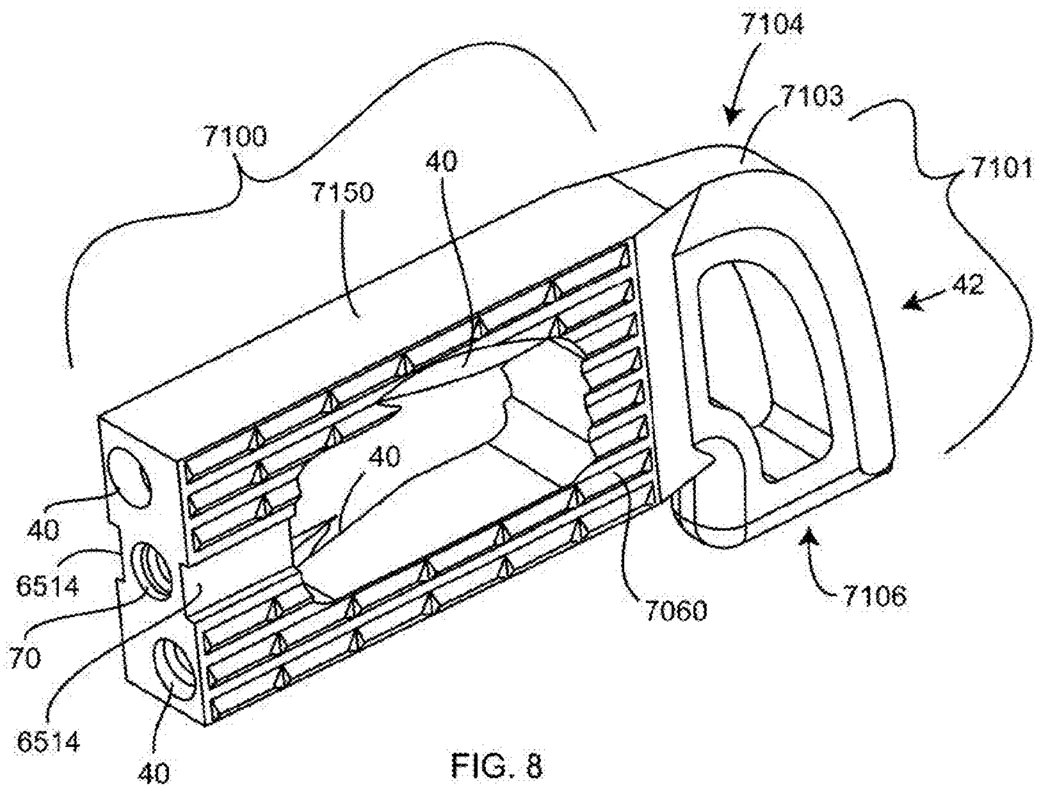
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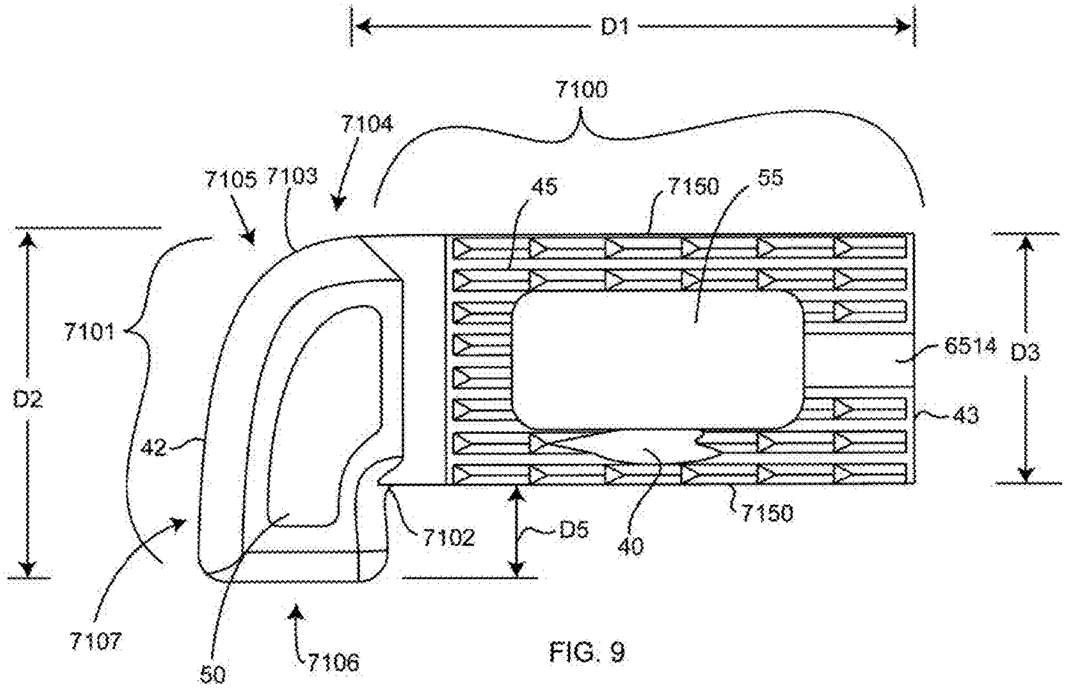
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FIG. 9

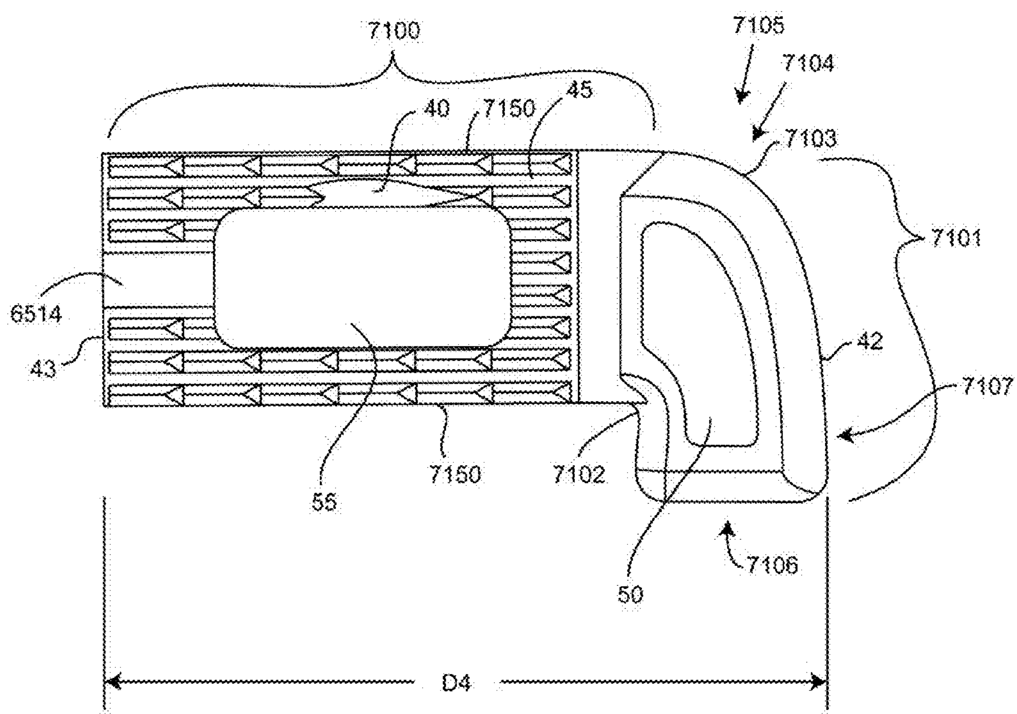
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FIG. 10

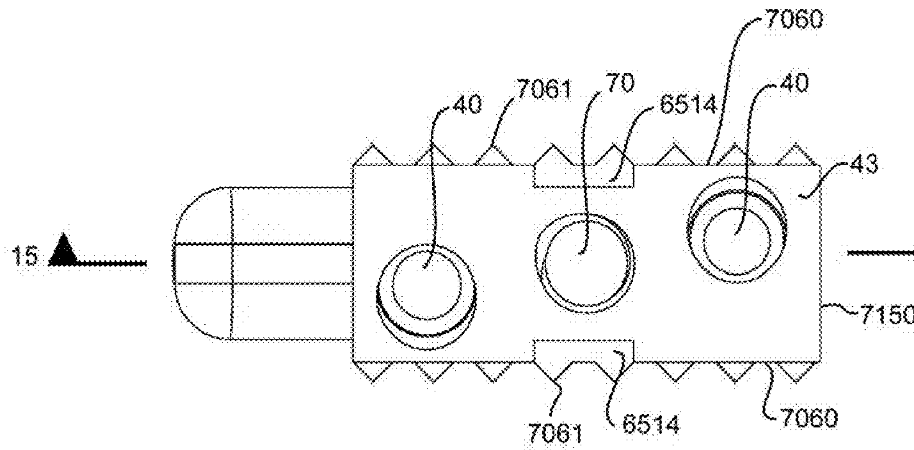

FIG. 11

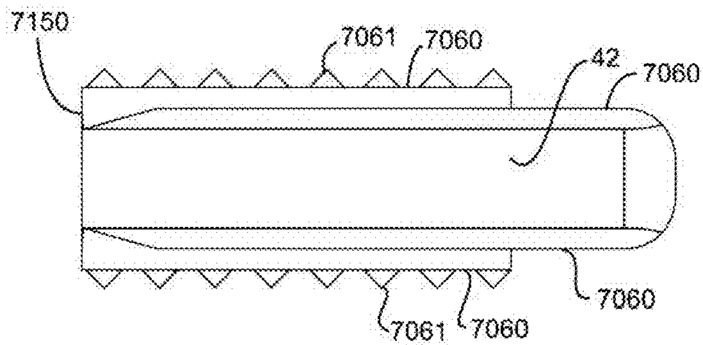

FIG. 12

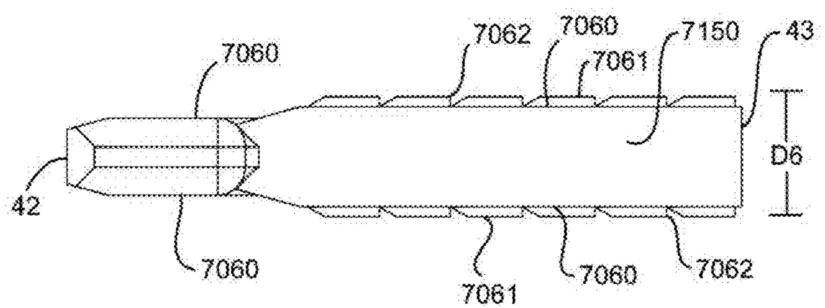

FIG. 13

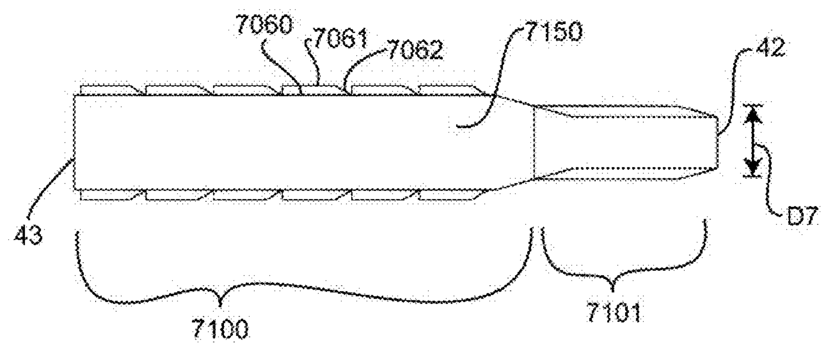

FIG. 14

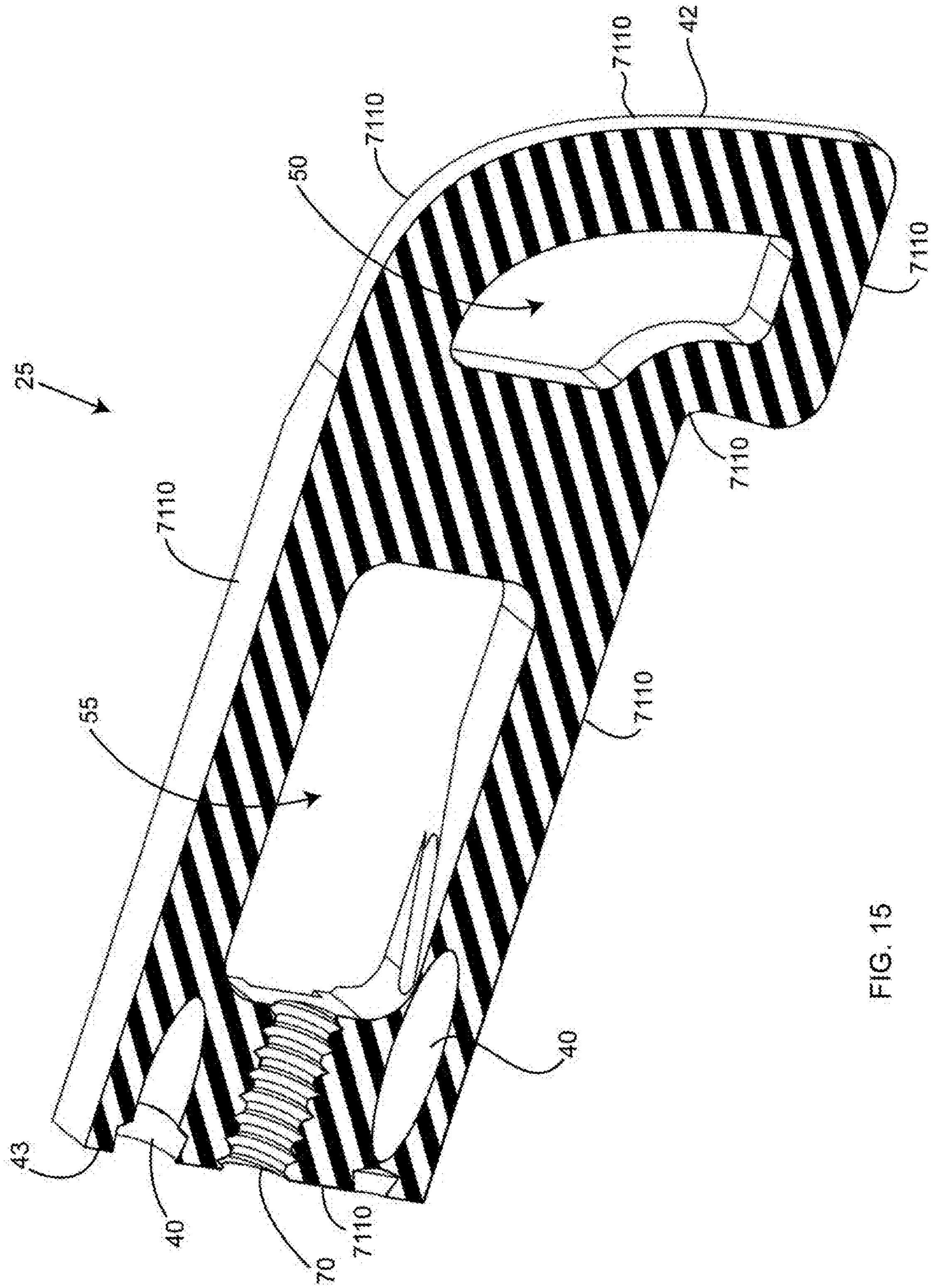

FIG. 15

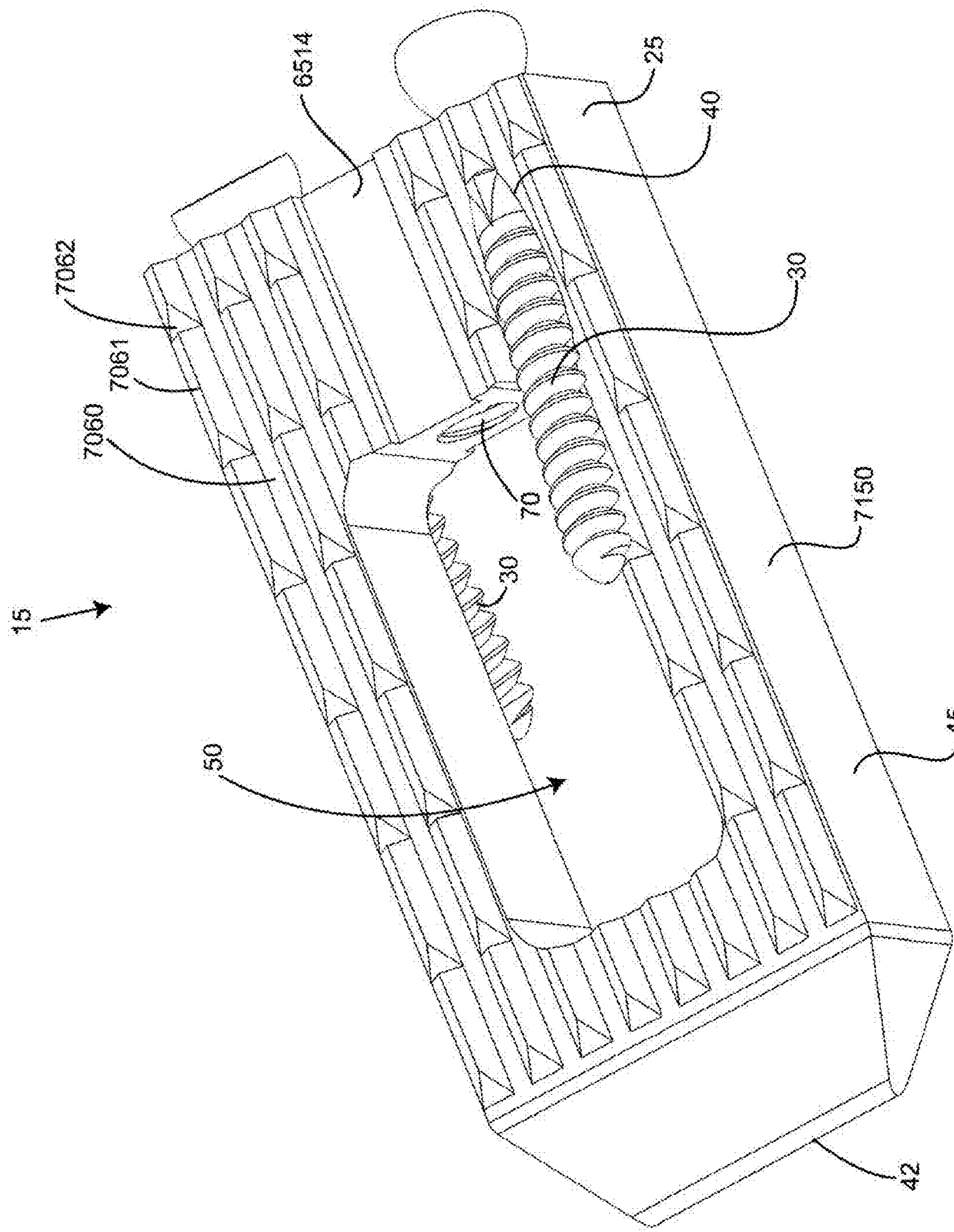

FIG. 16A

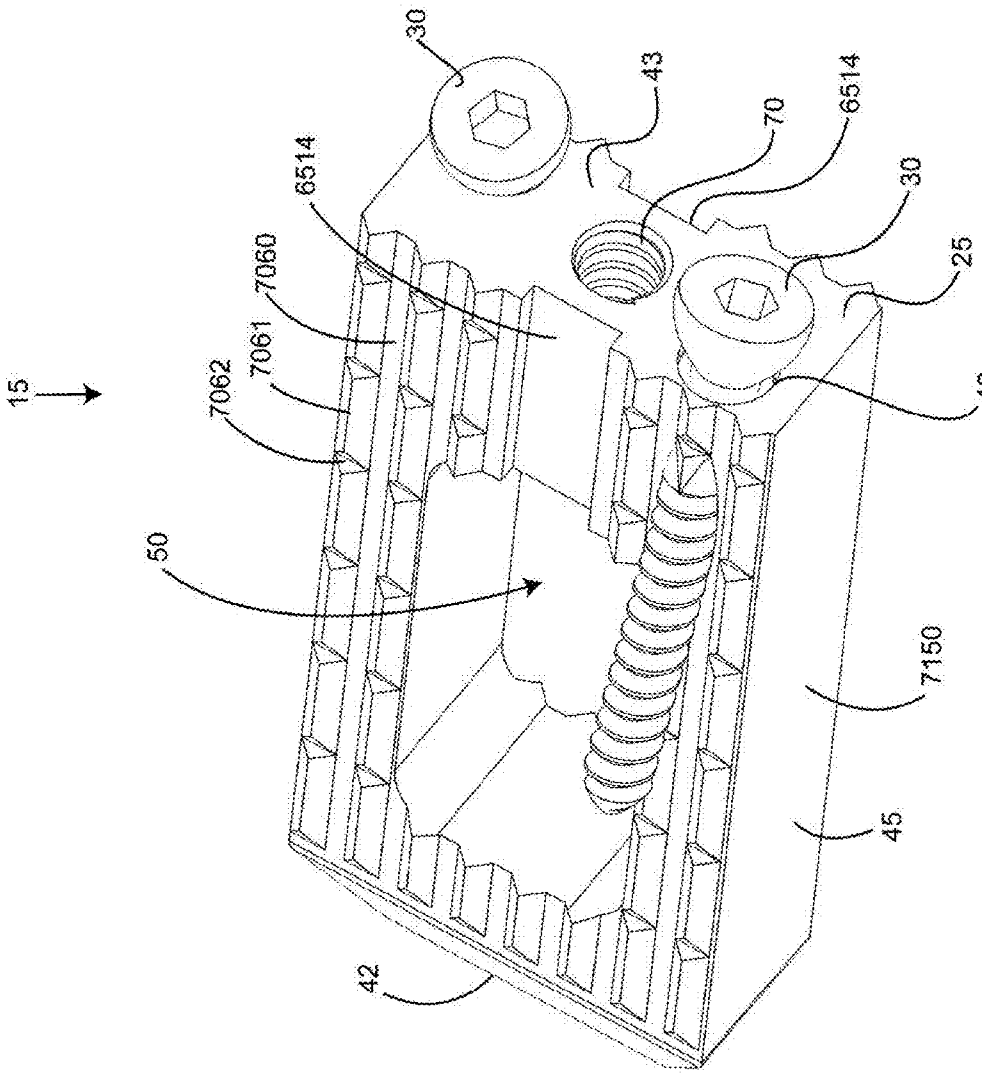

FIG. 16B

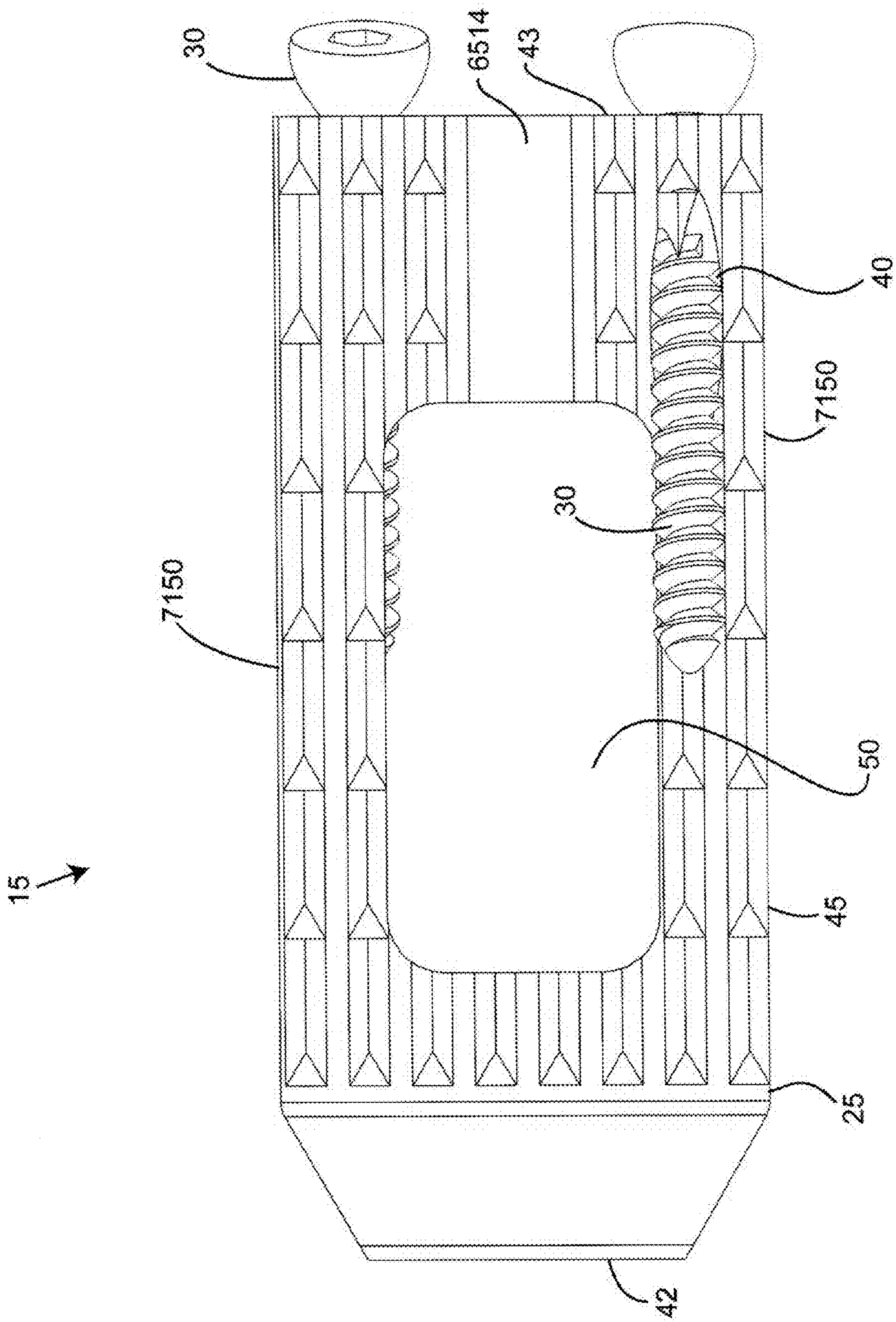

FIG. 16C

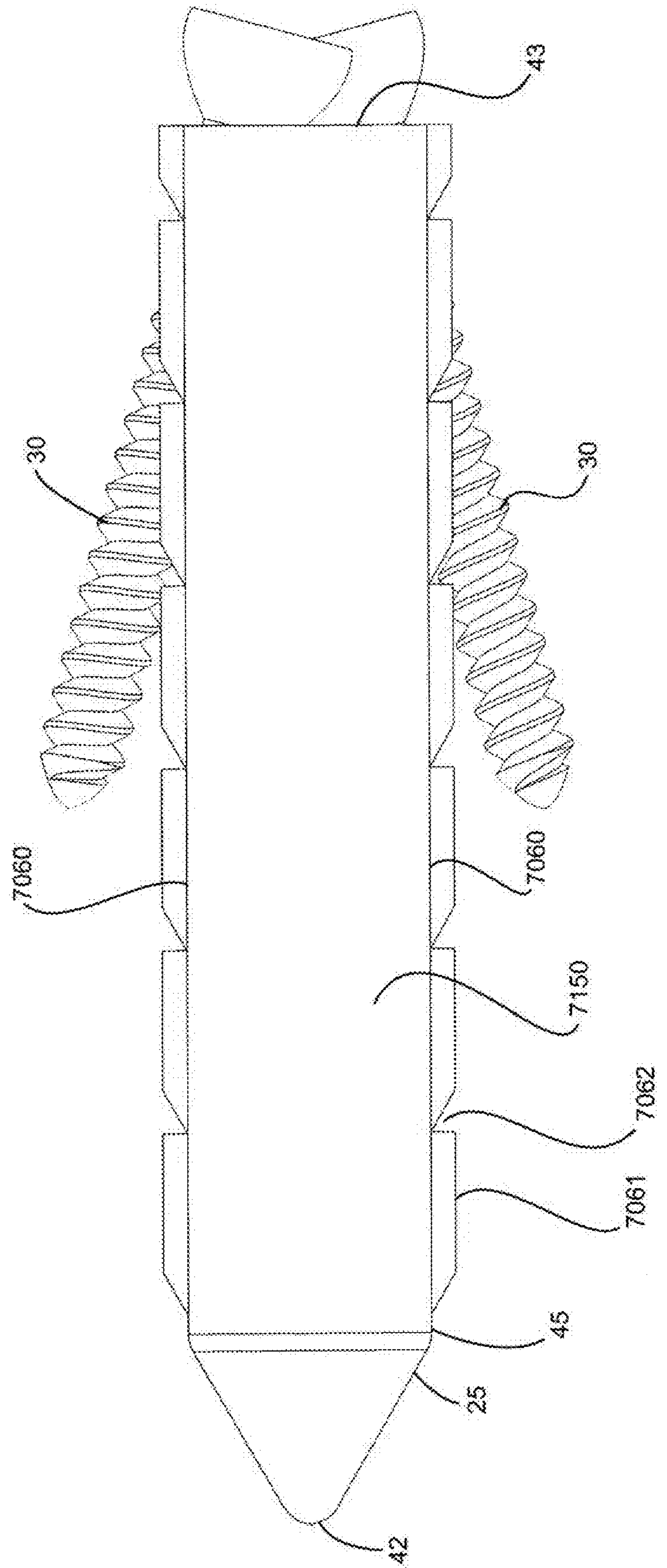

FIG. 16D

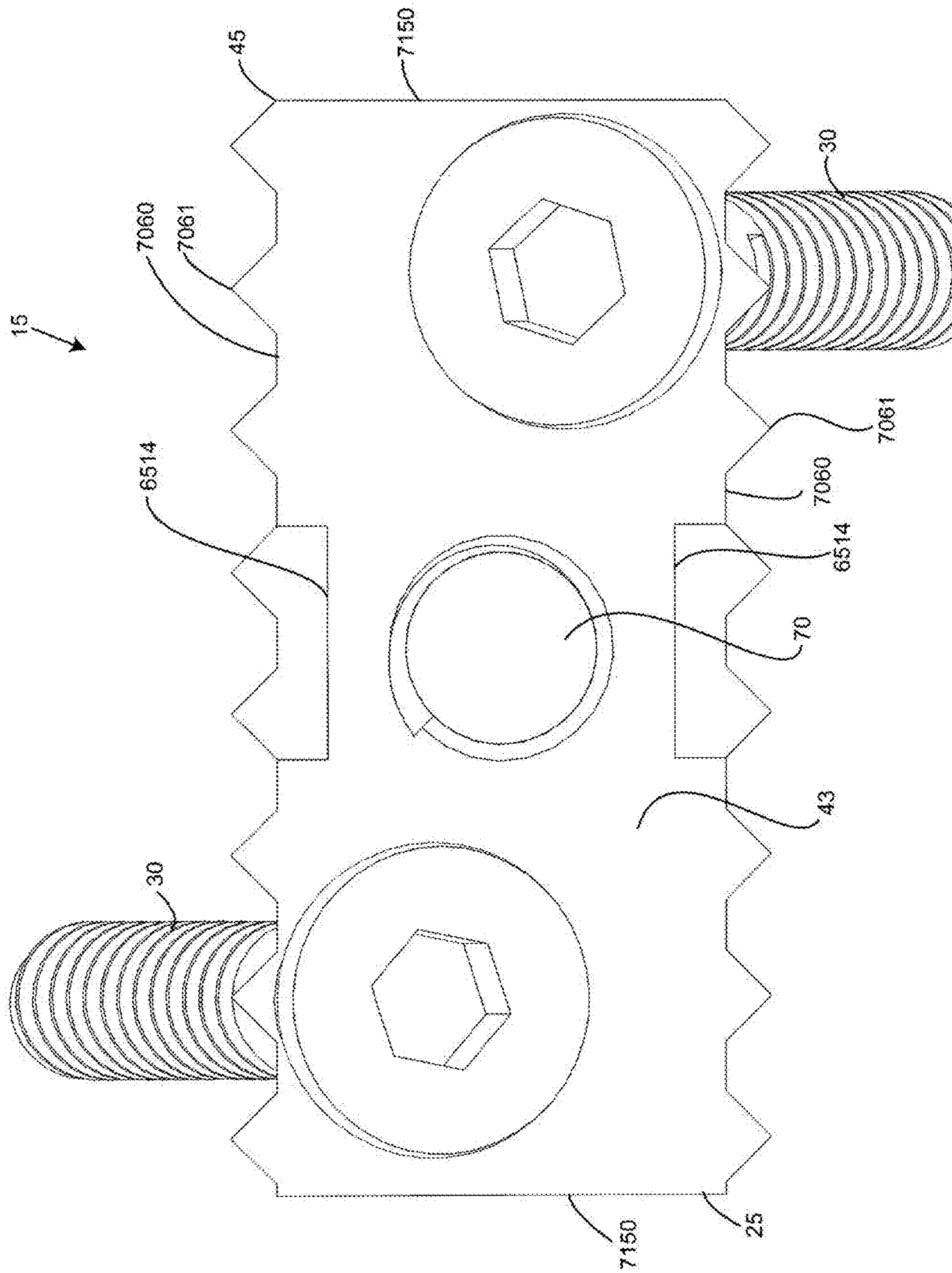

FIG. 16E

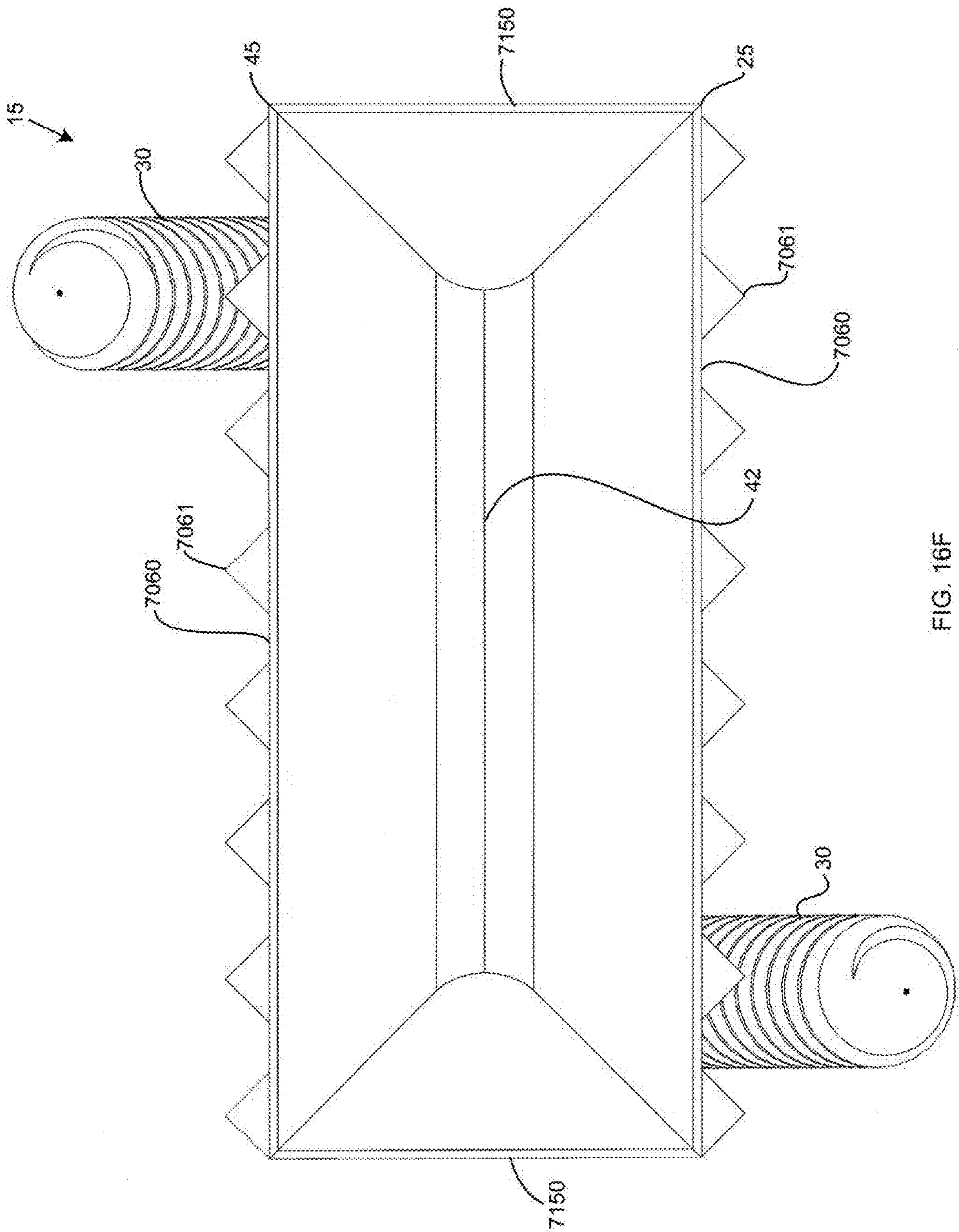

FIG. 16F

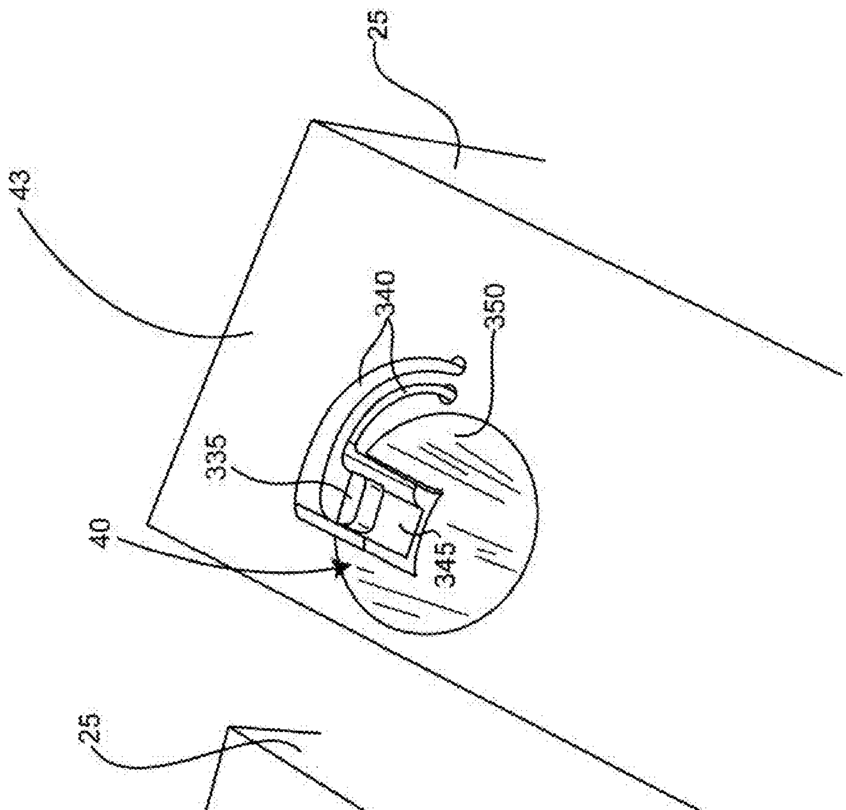

FIG. 16 H

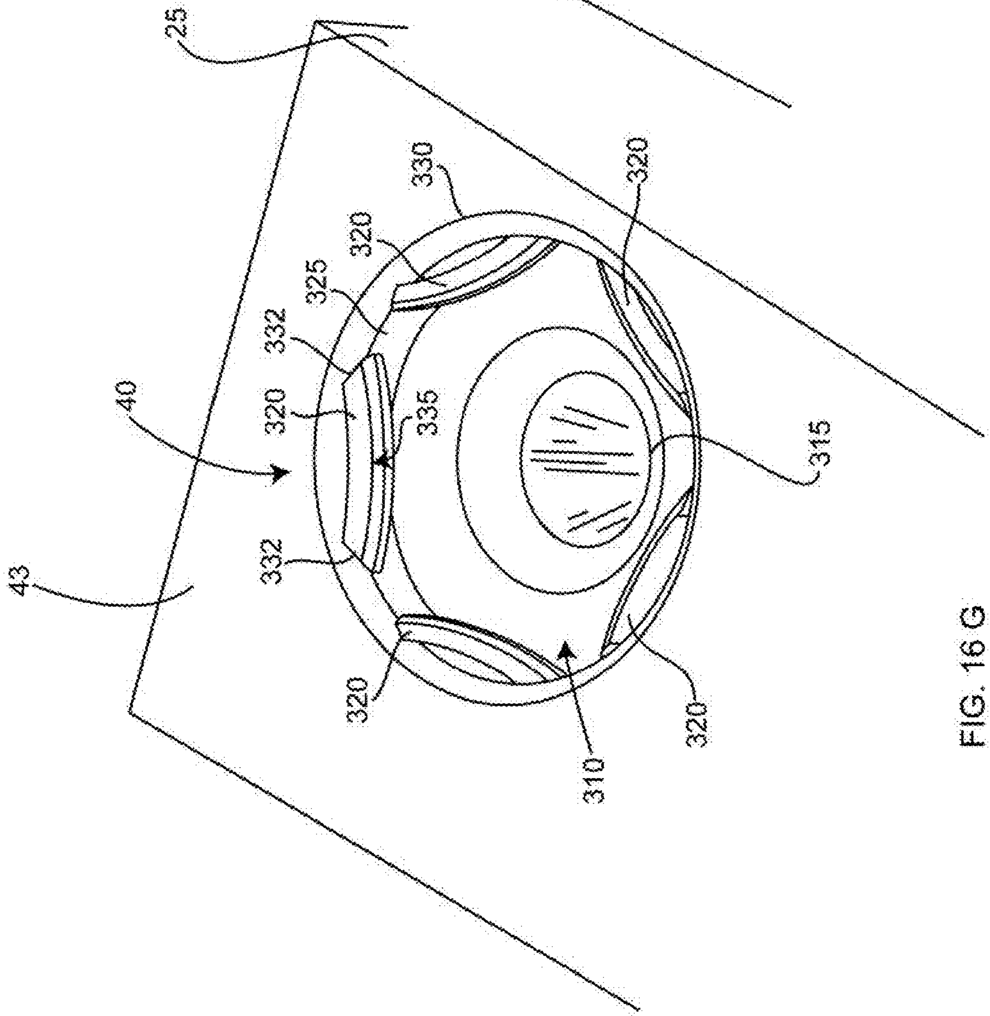

FIG. 16 G

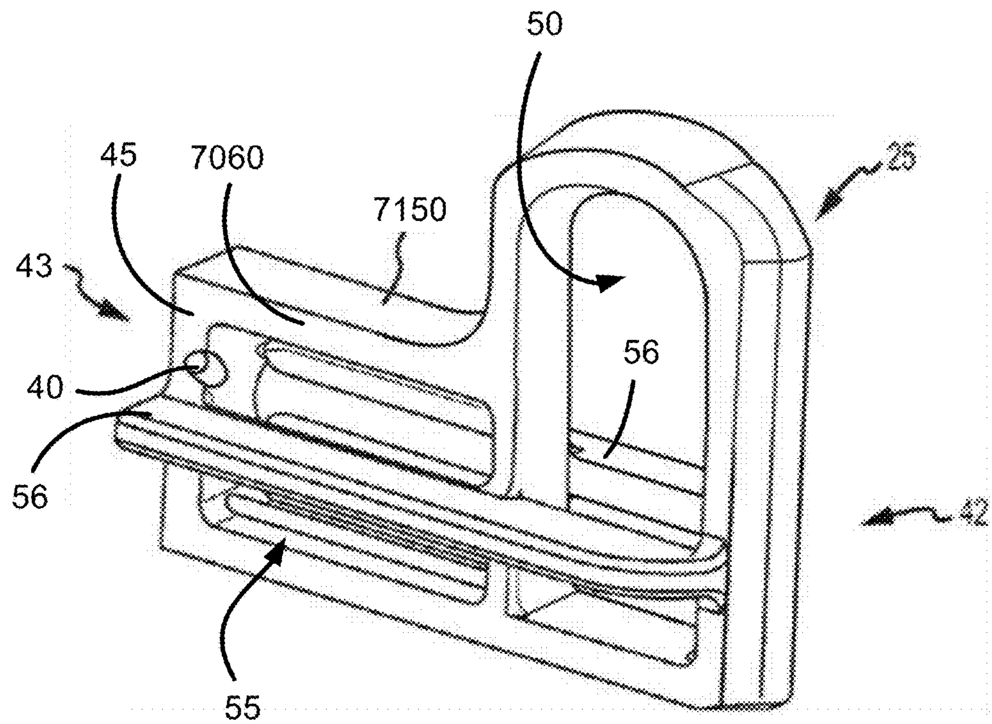

FIG. 16I

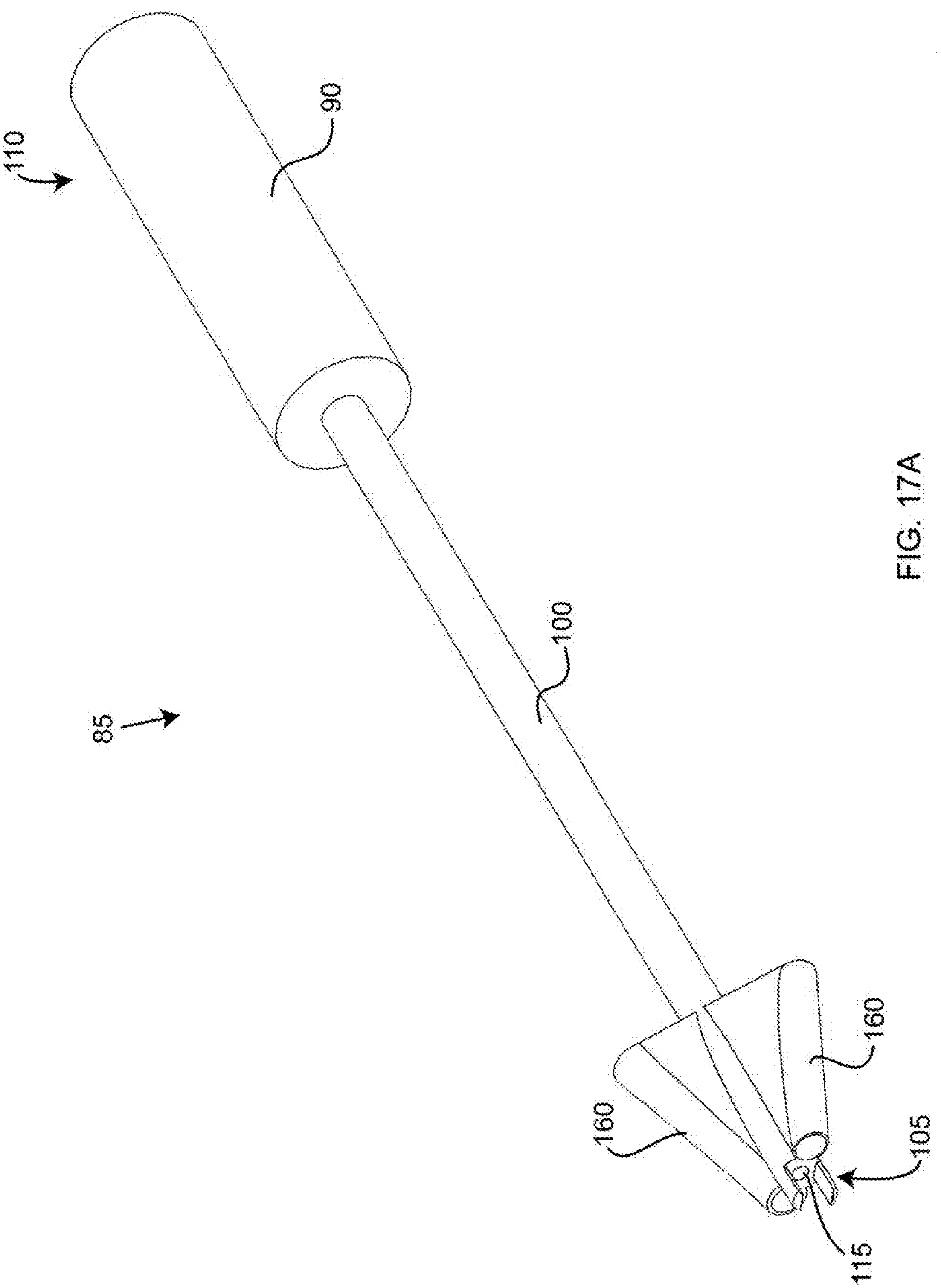

FIG. 17A

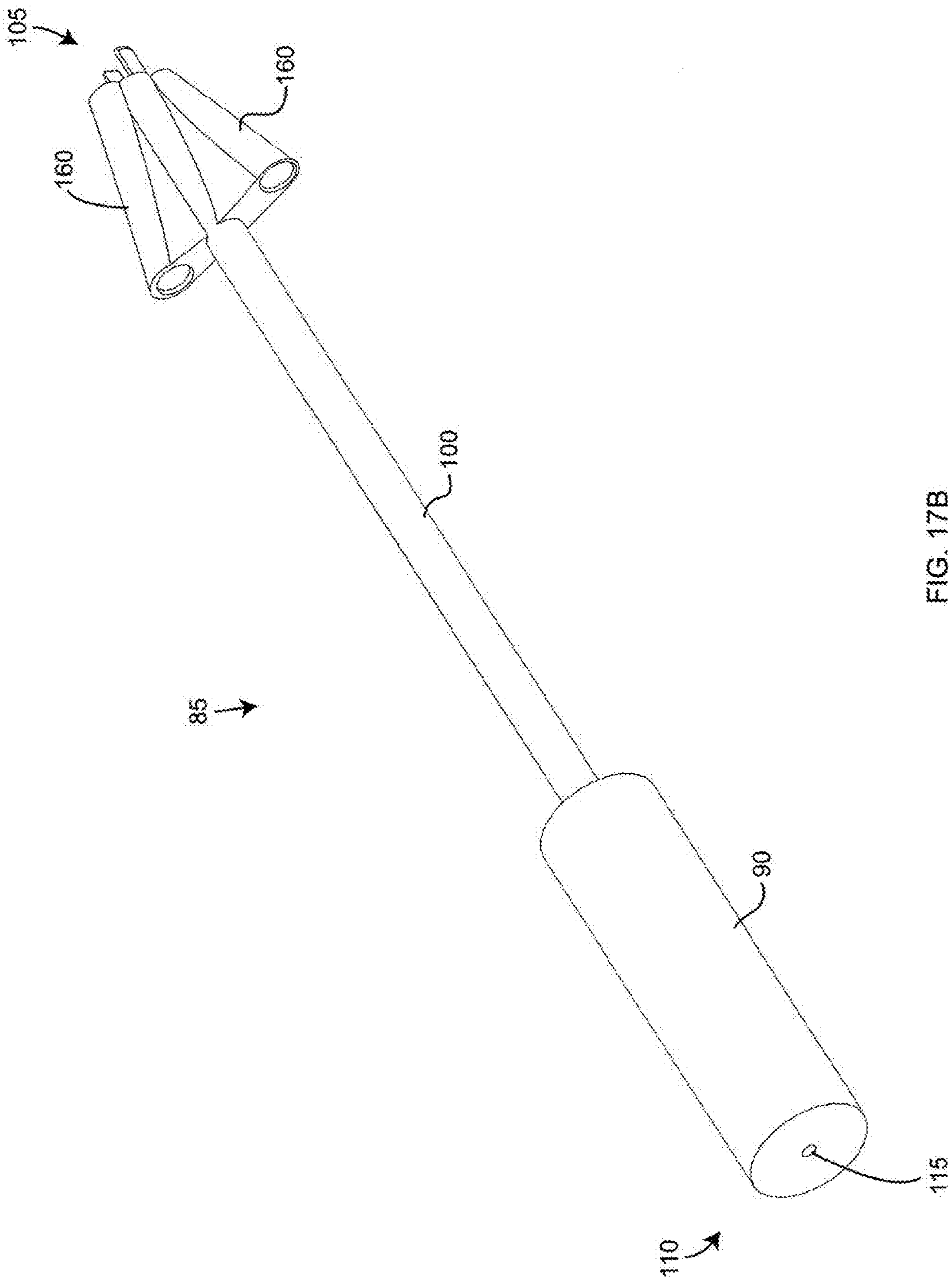

FIG. 17B

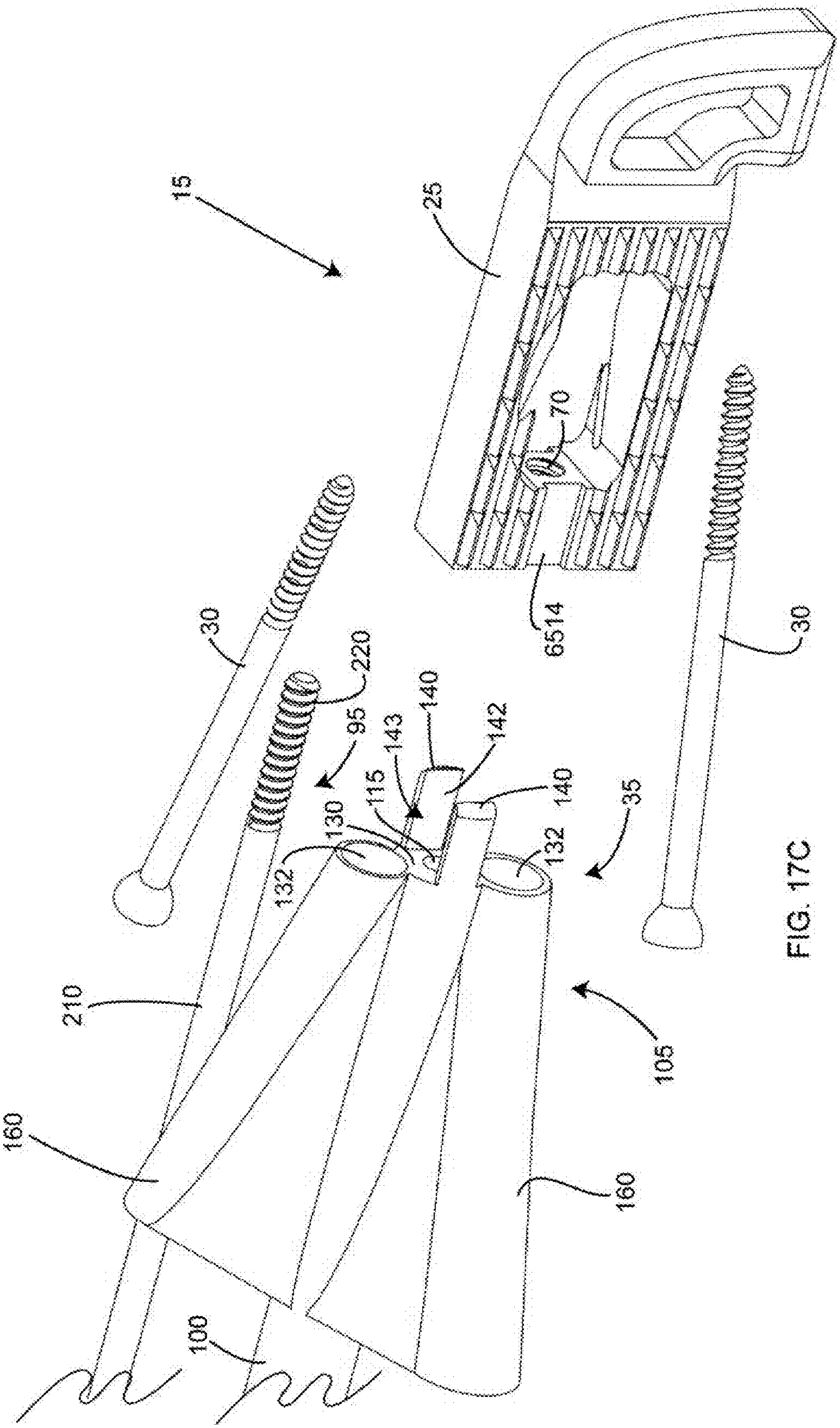
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FIG. 17C

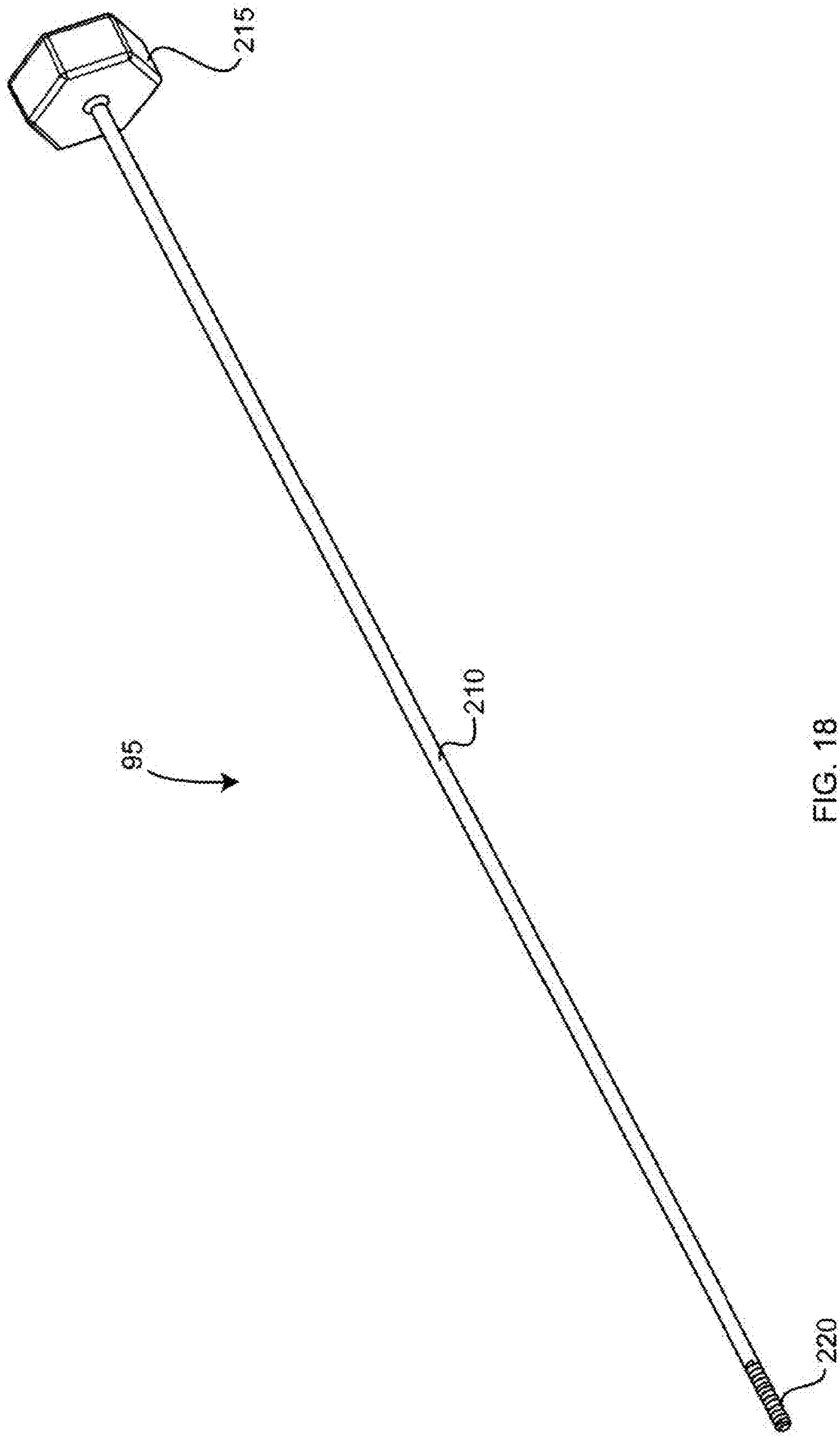

FIG. 18

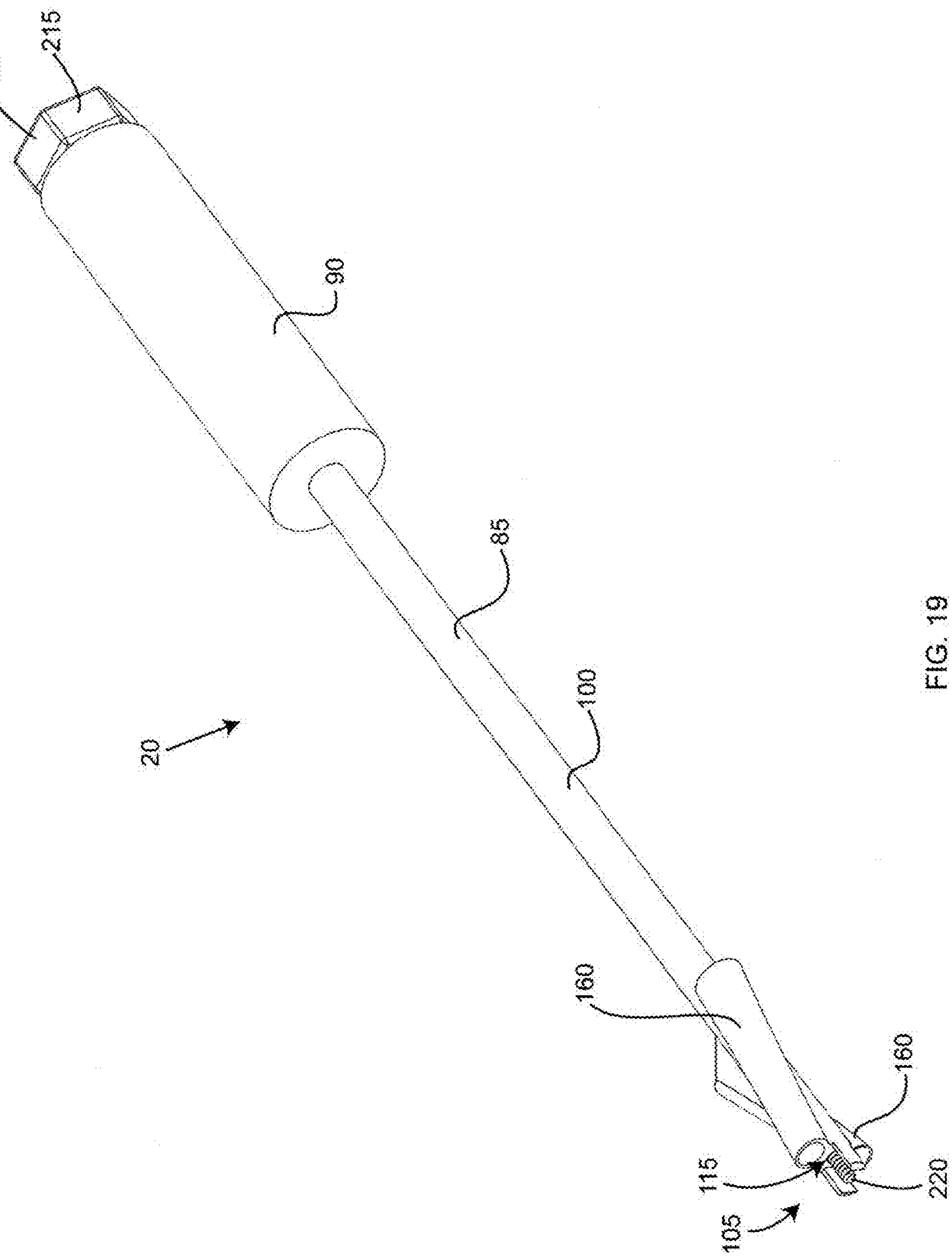

FIG. 19

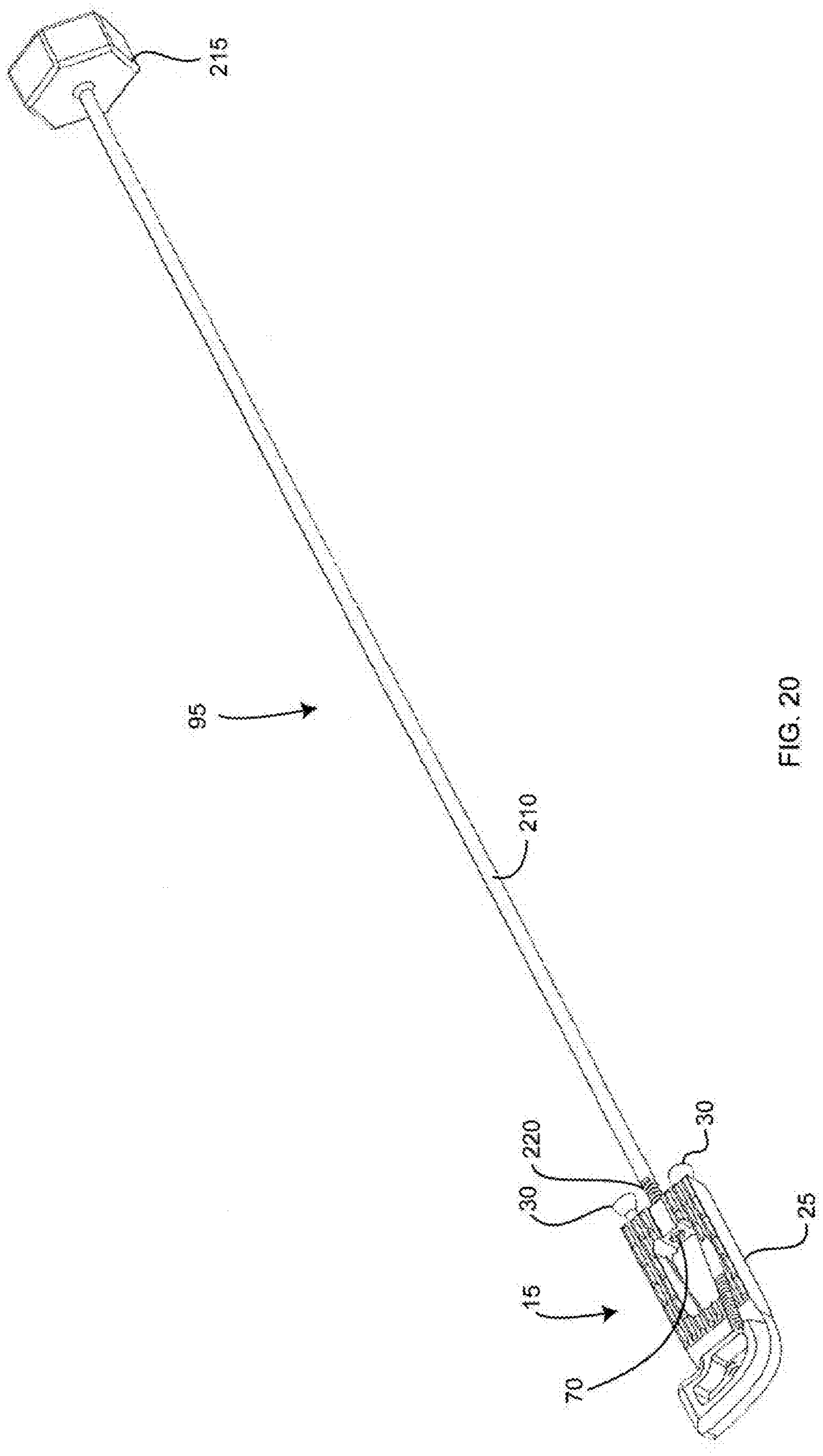

FIG. 20

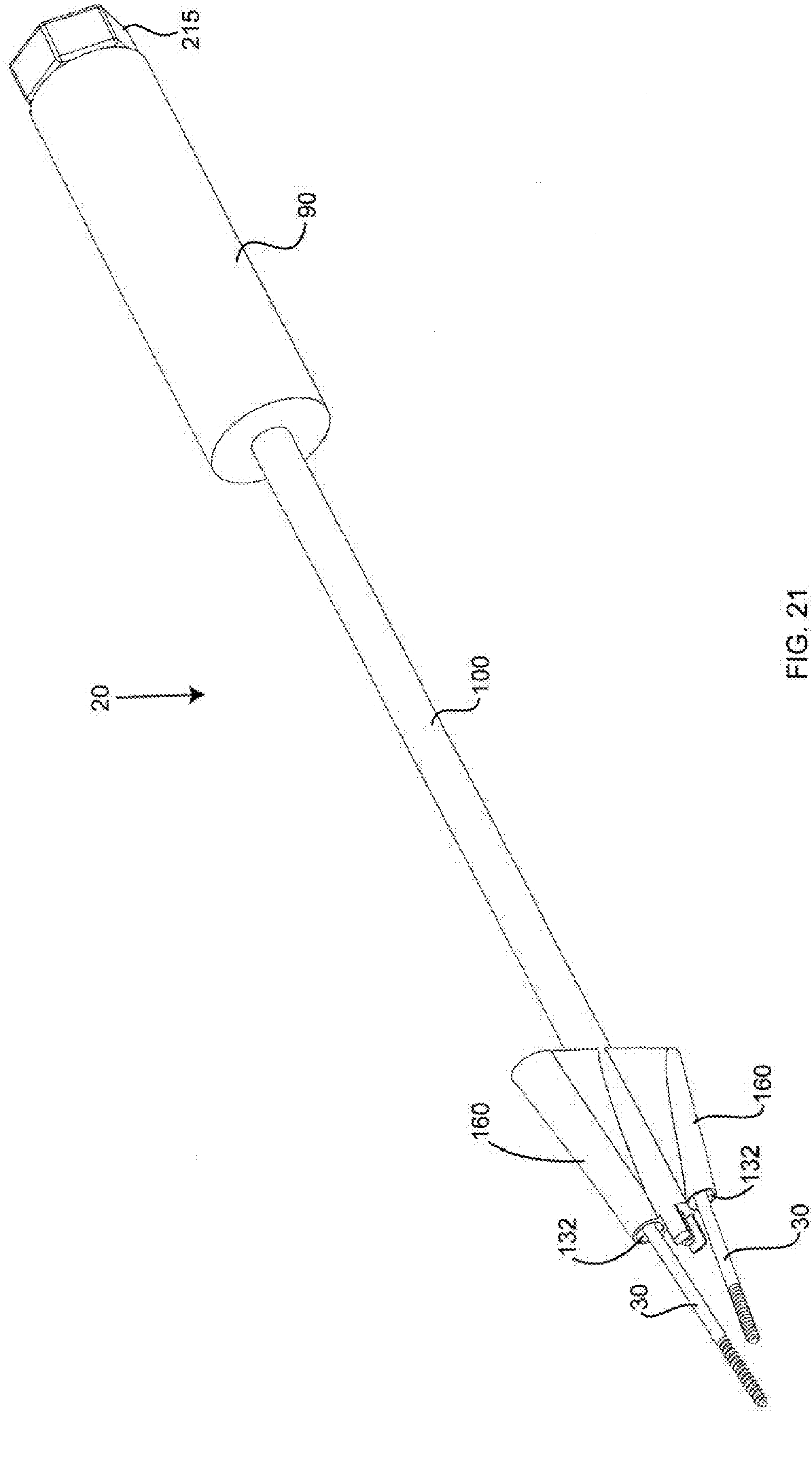

FIG. 21

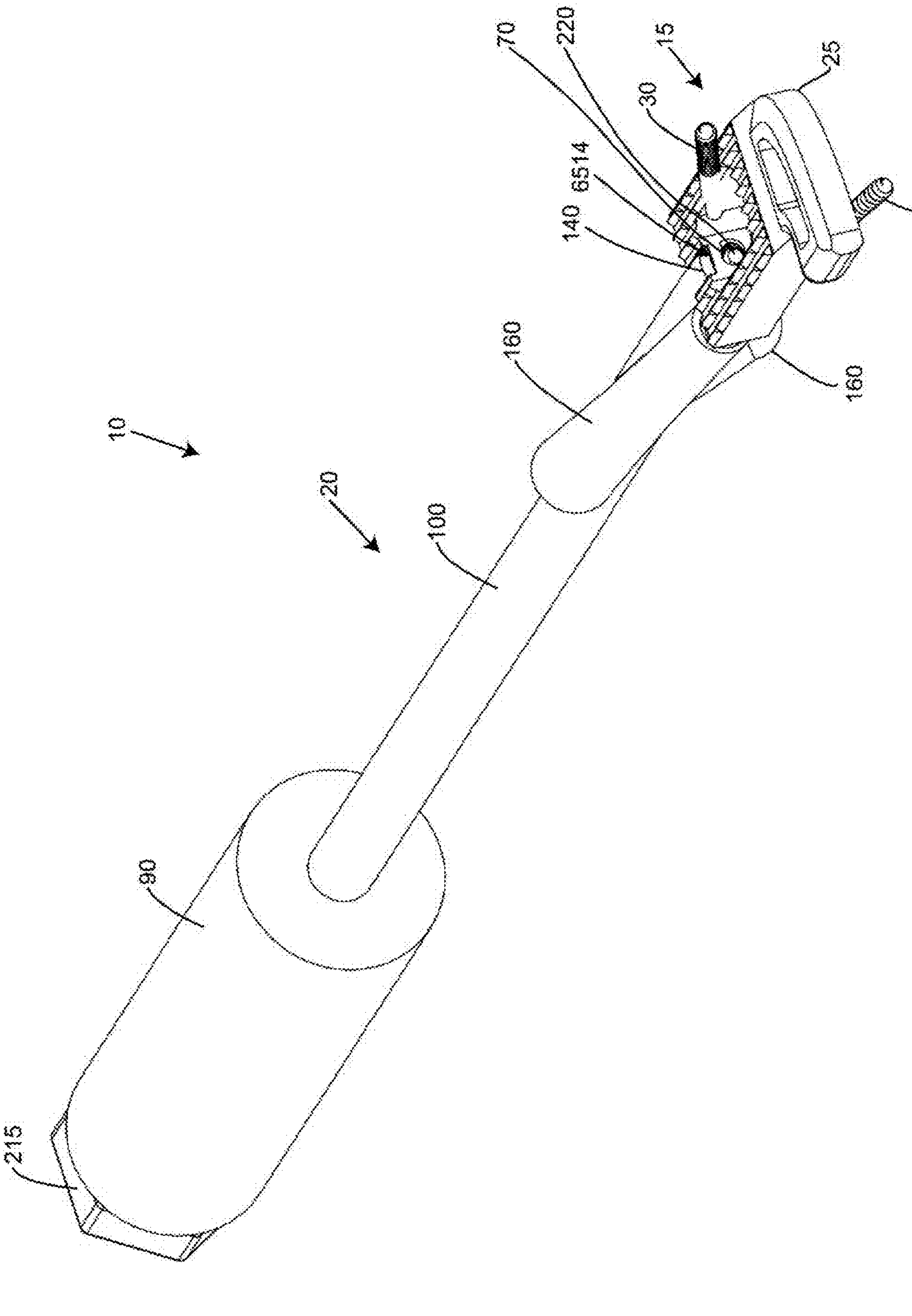

FIG. 22

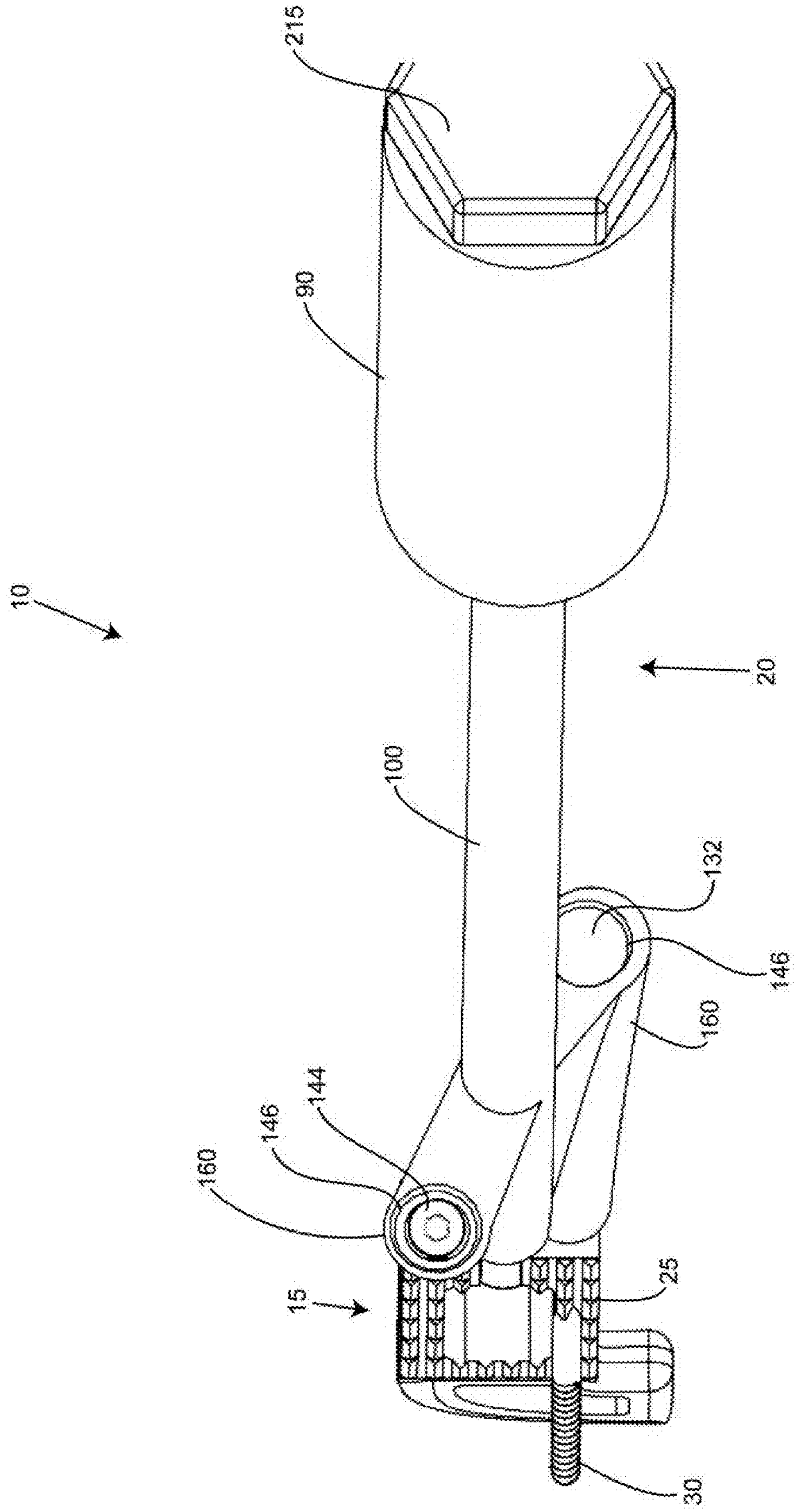

FIG. 23

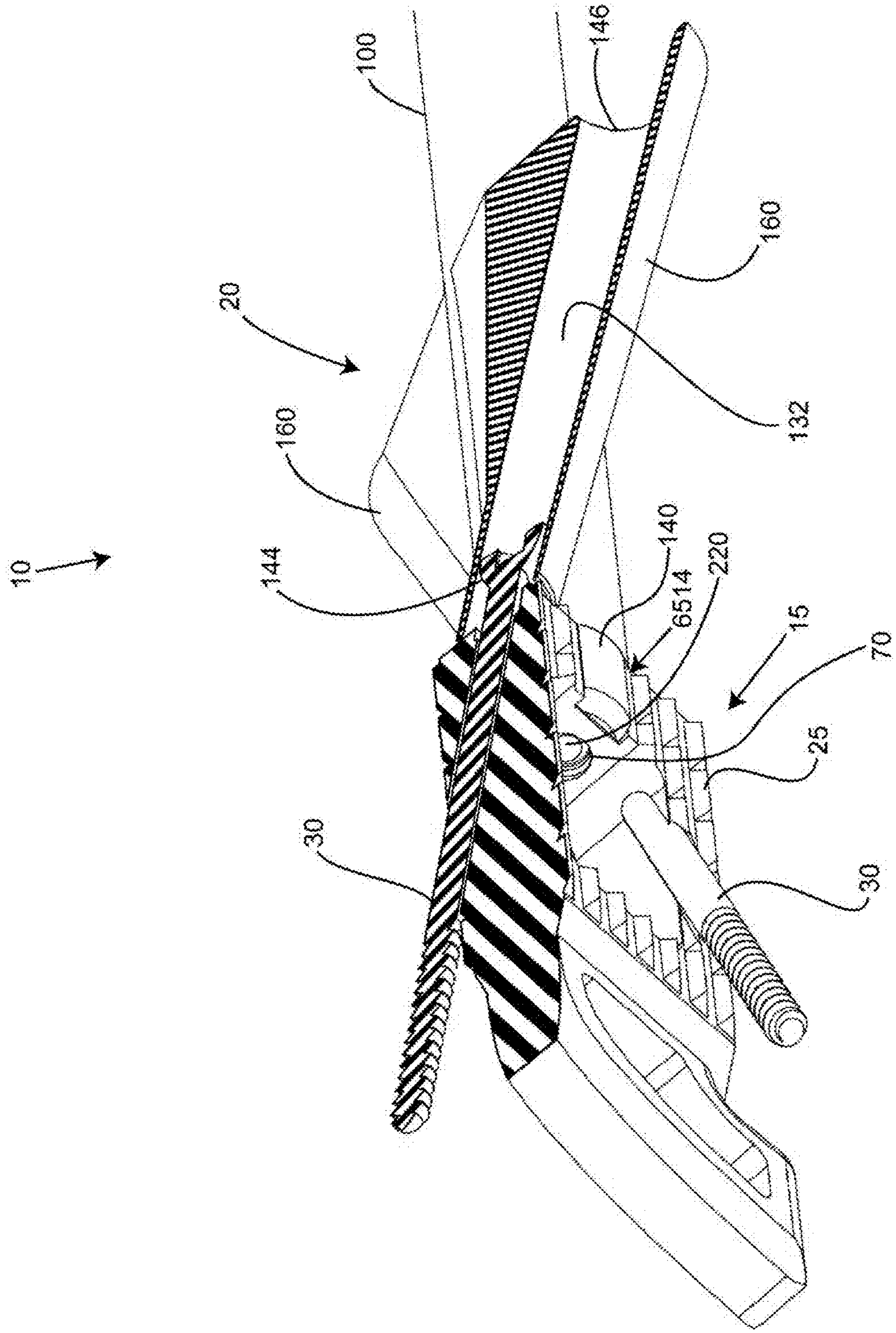

FIG. 24

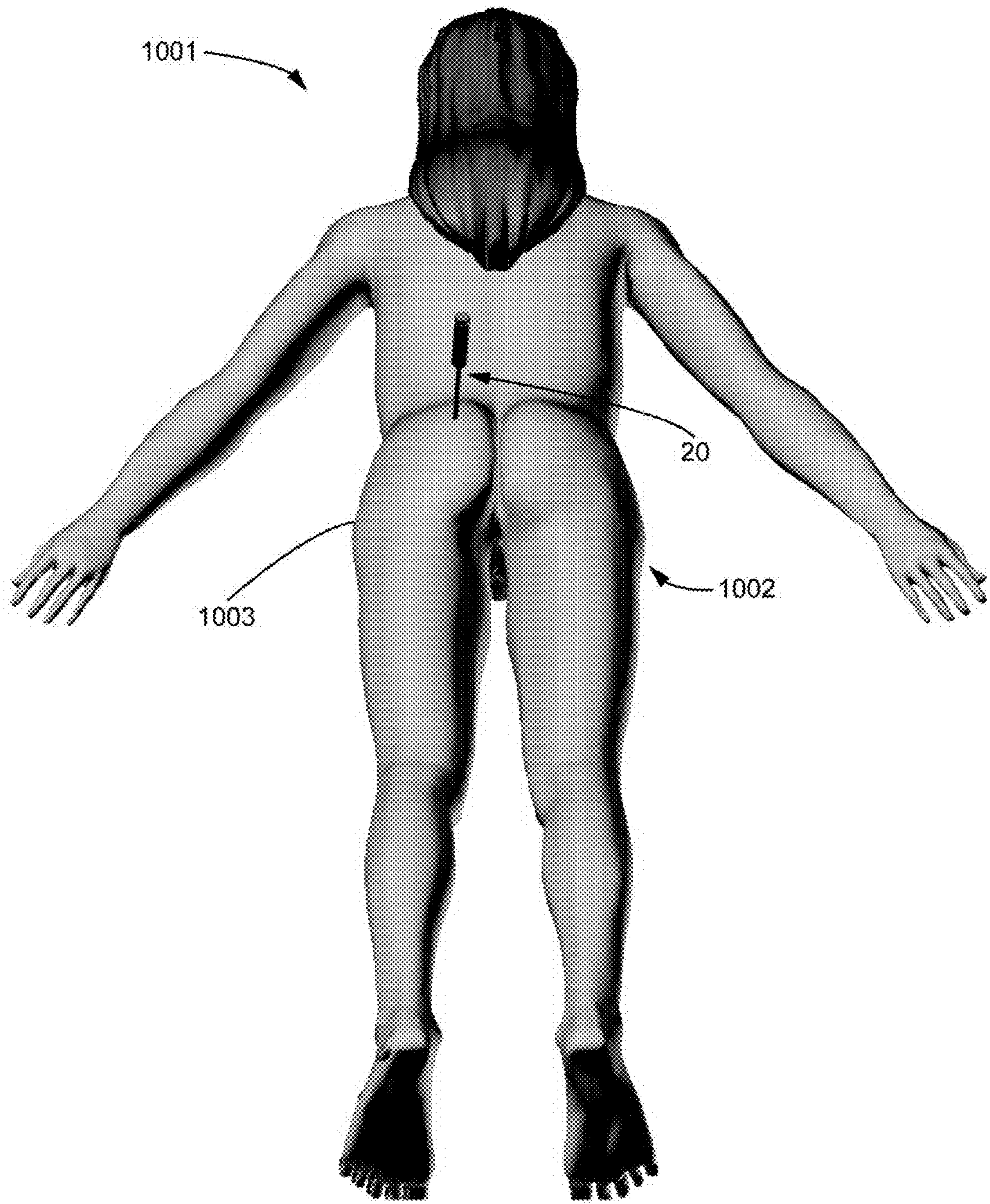

FIG. 25

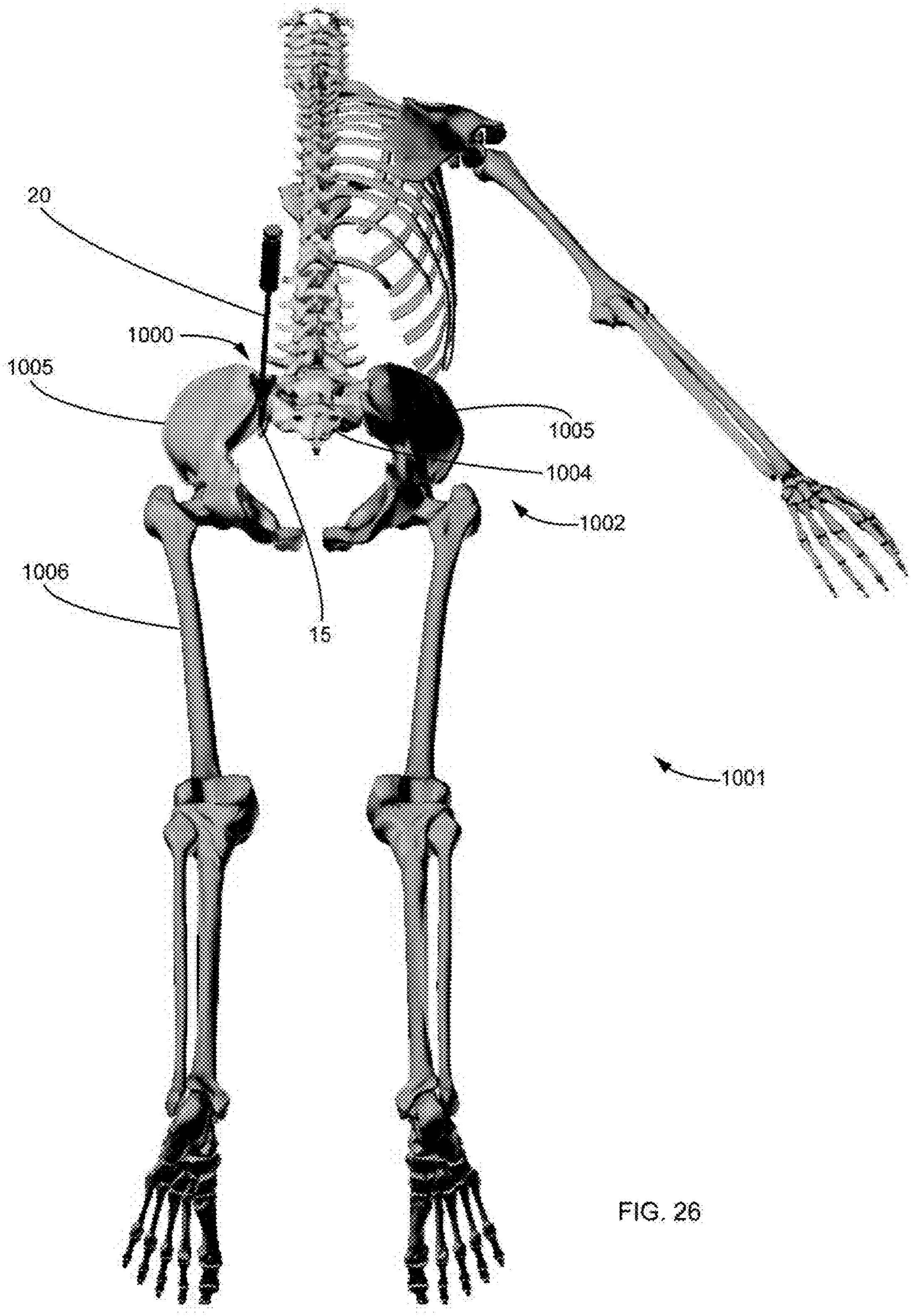

FIG. 26

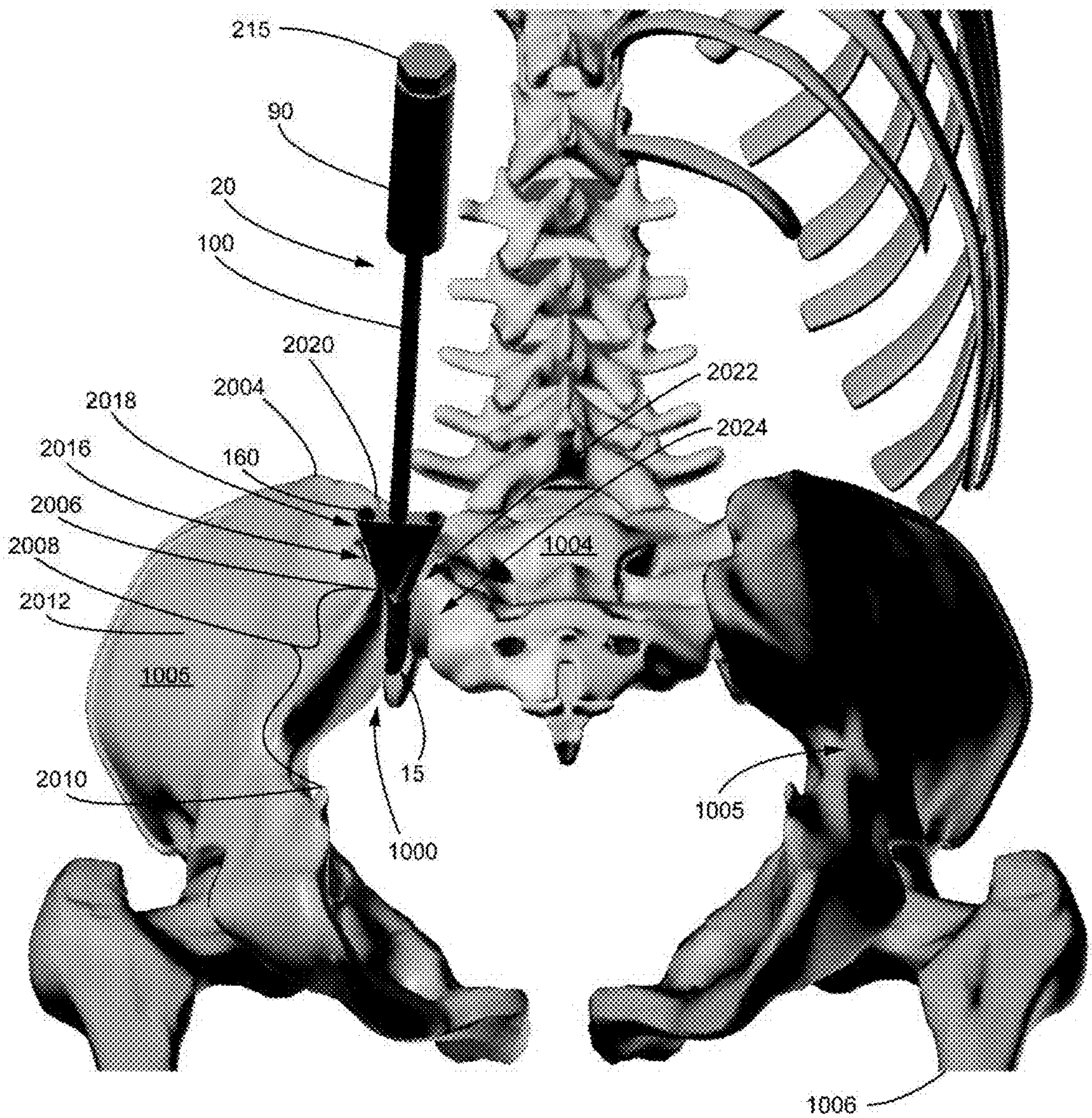
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FIG. 27

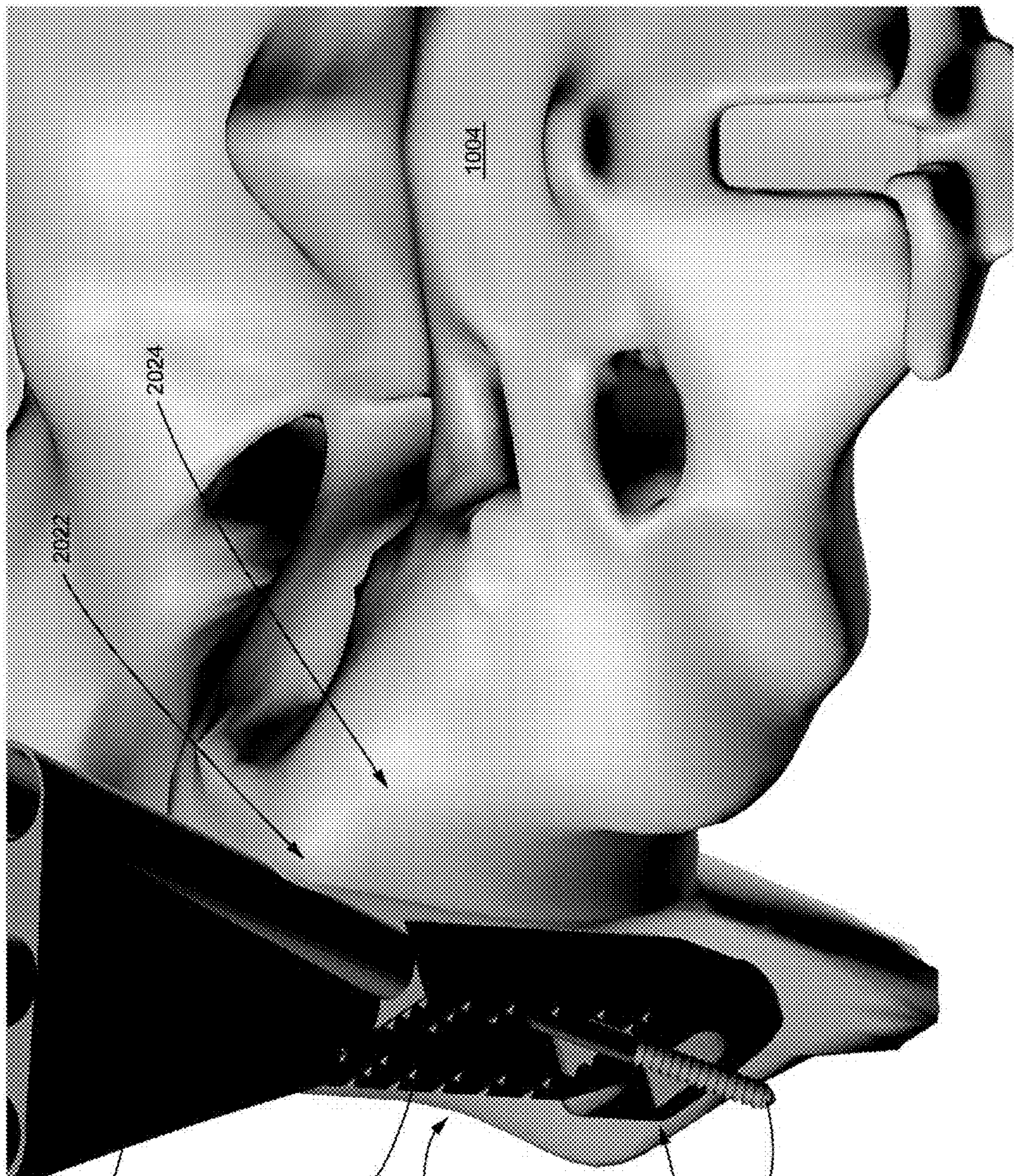

FIG. 28

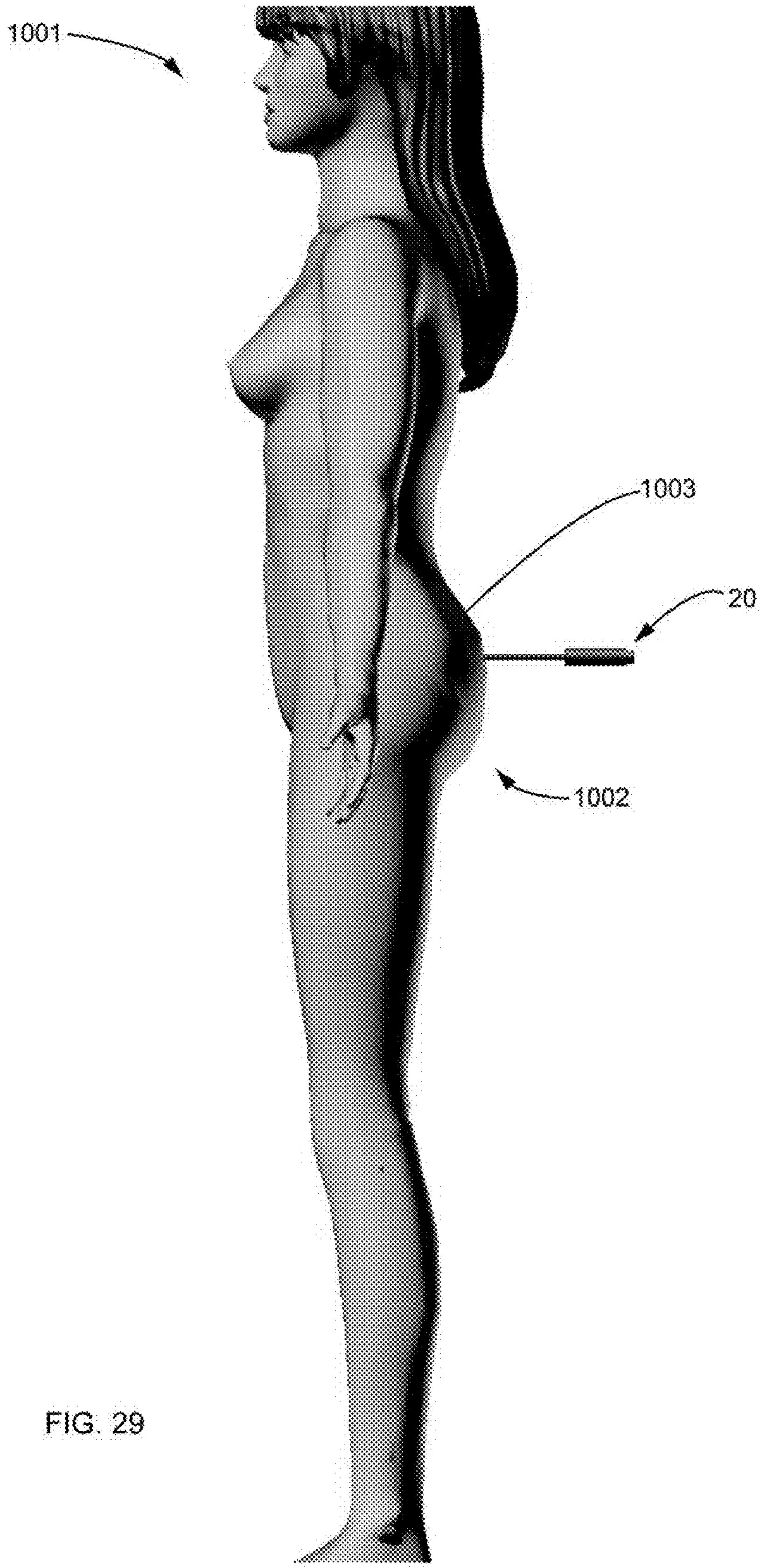

FIG. 29

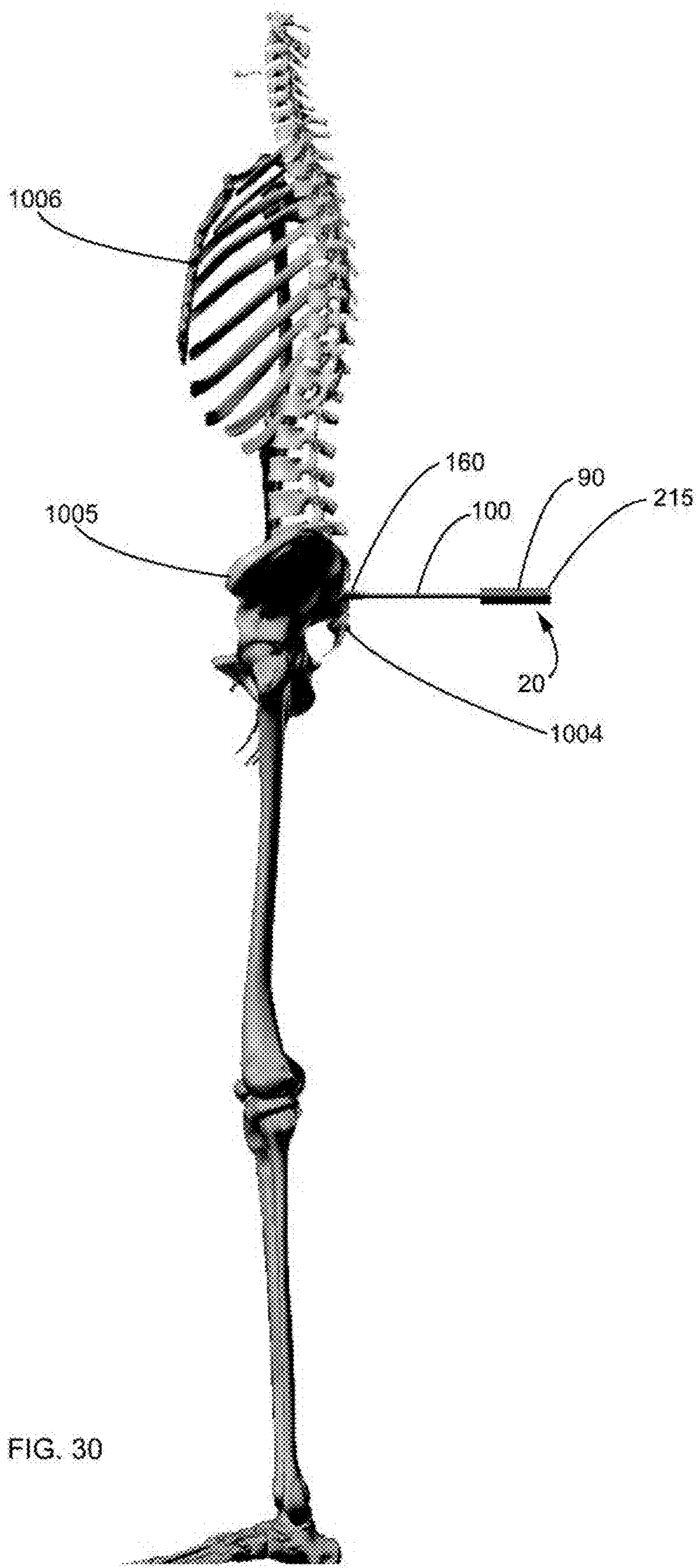

FIG. 30

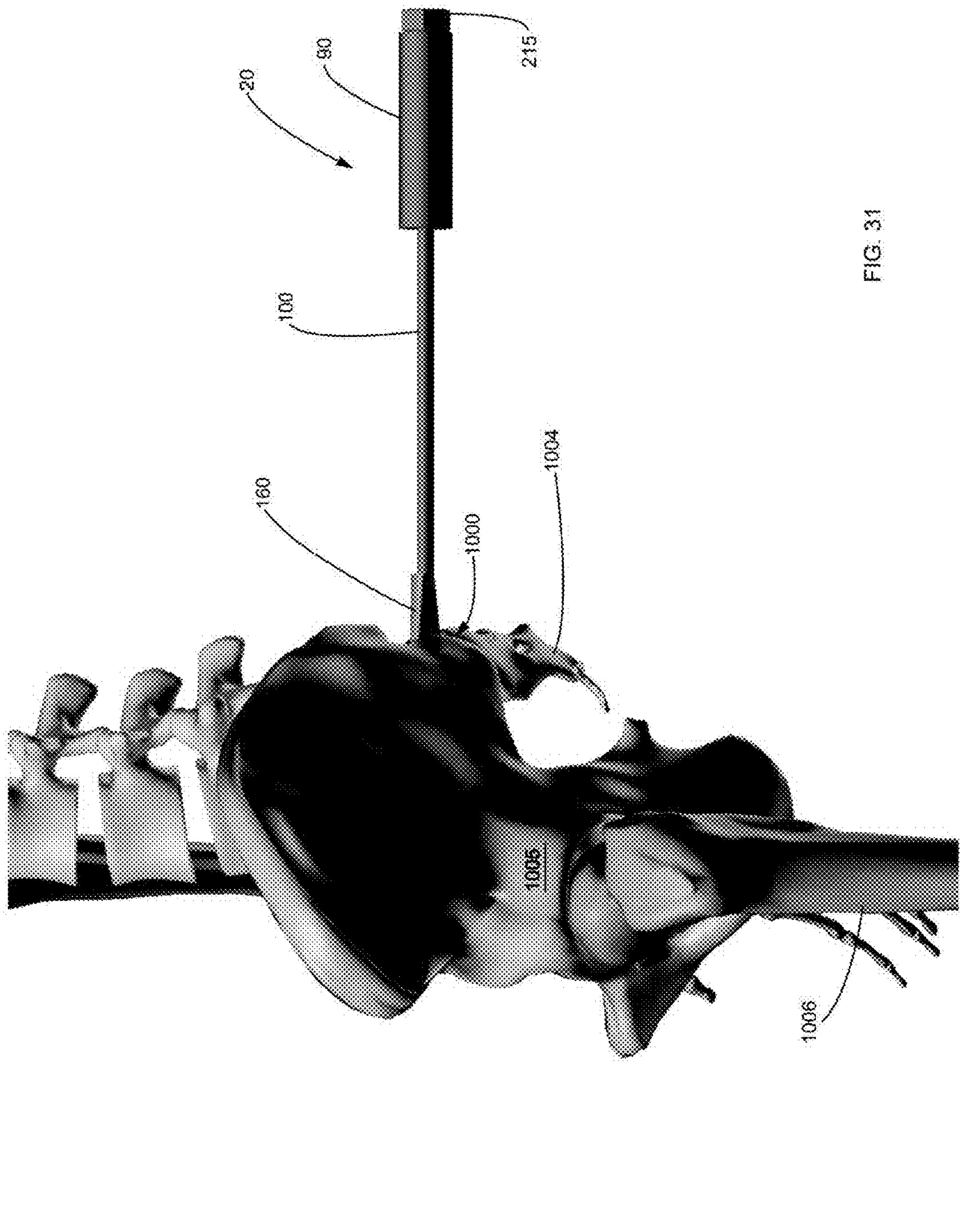

FIG. 31

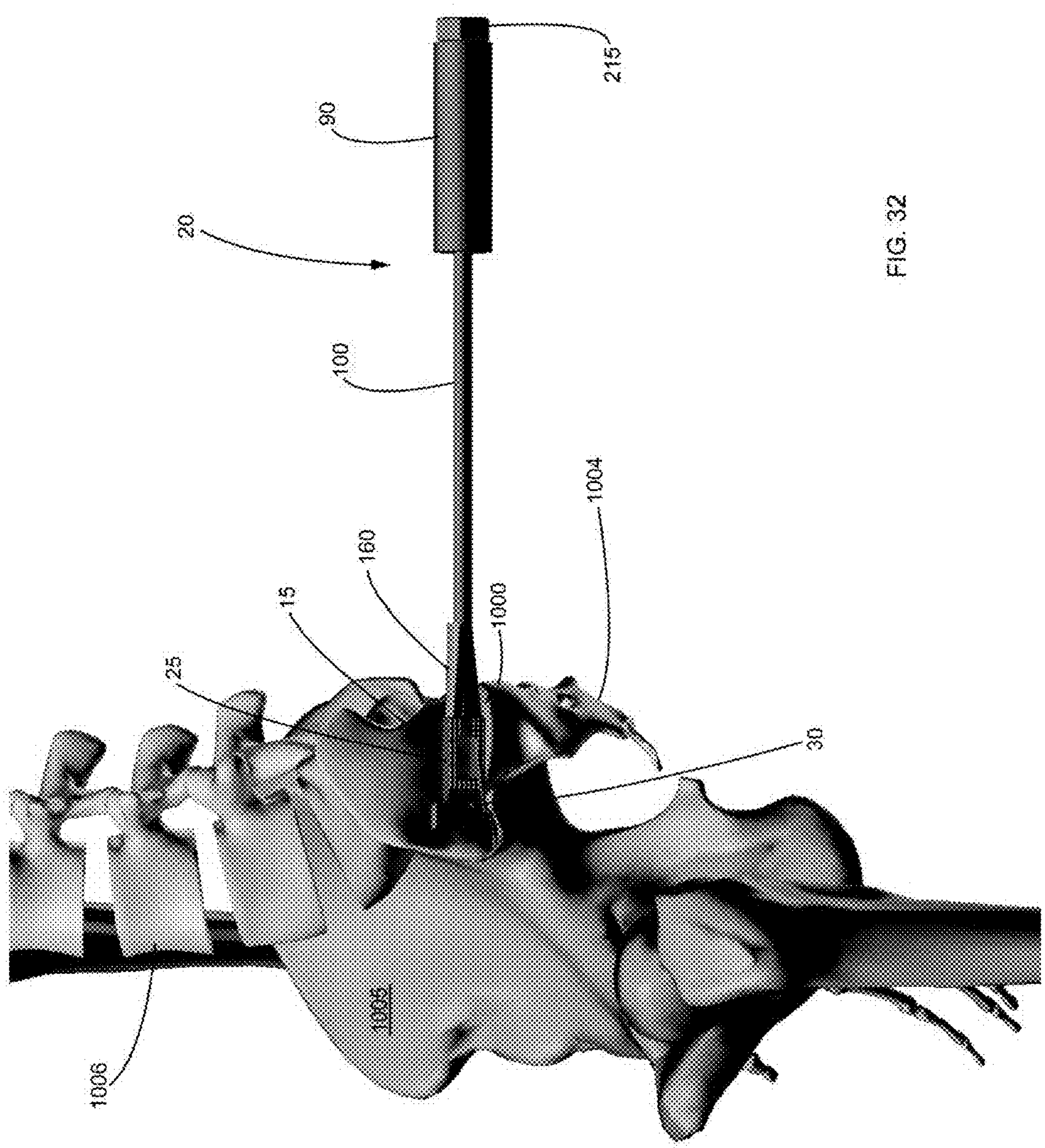

FIG. 32

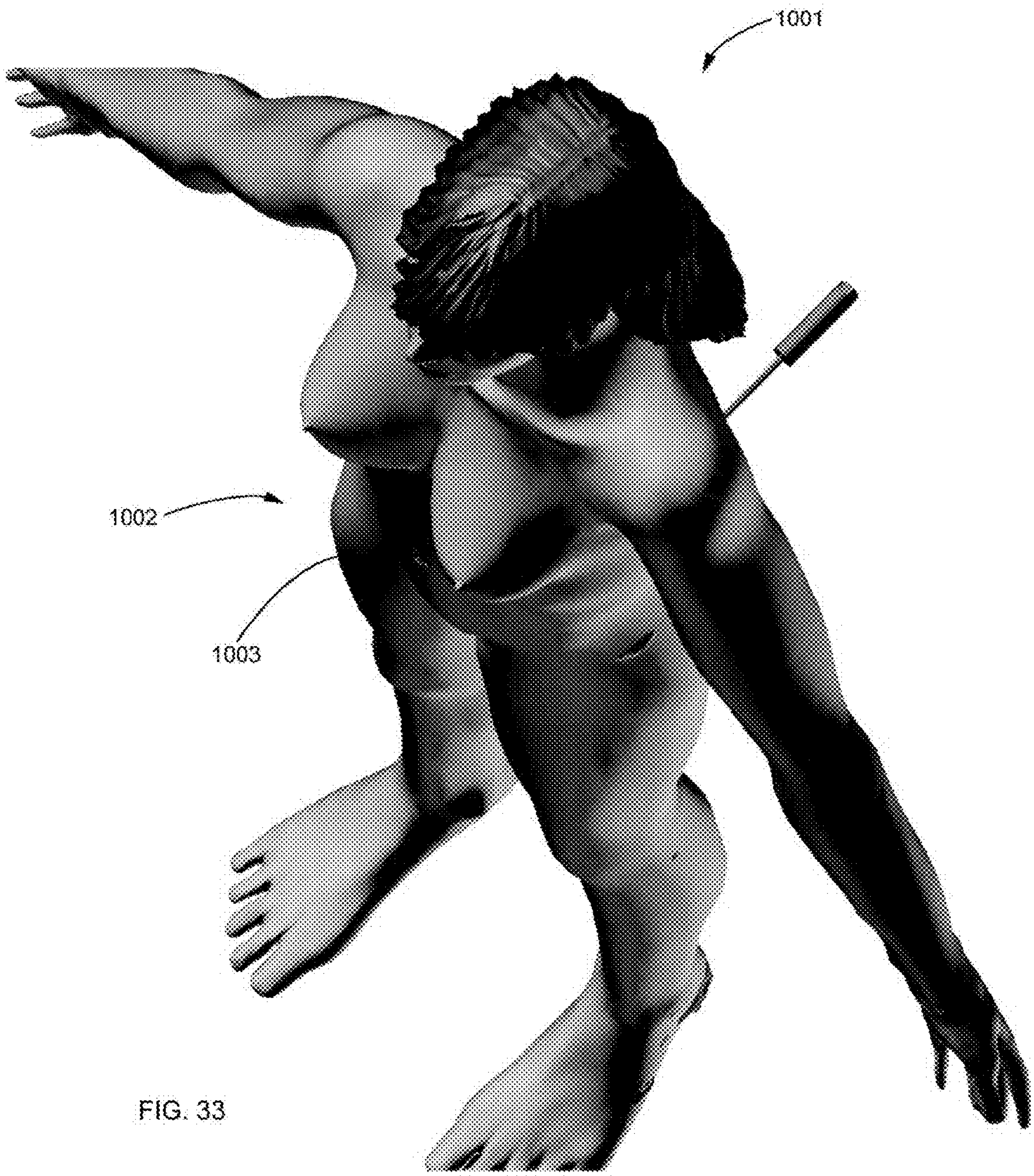

FIG. 33

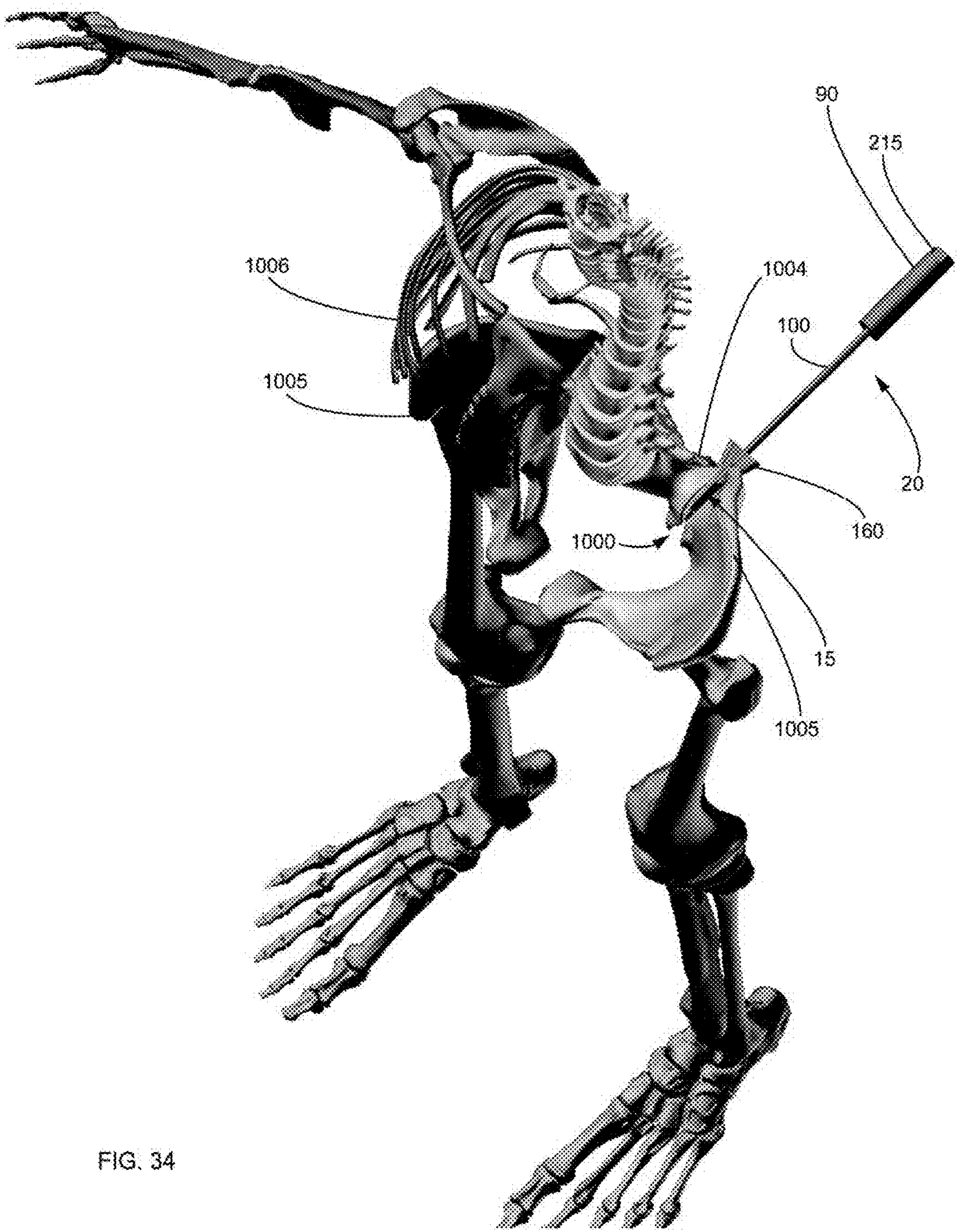

FIG. 34

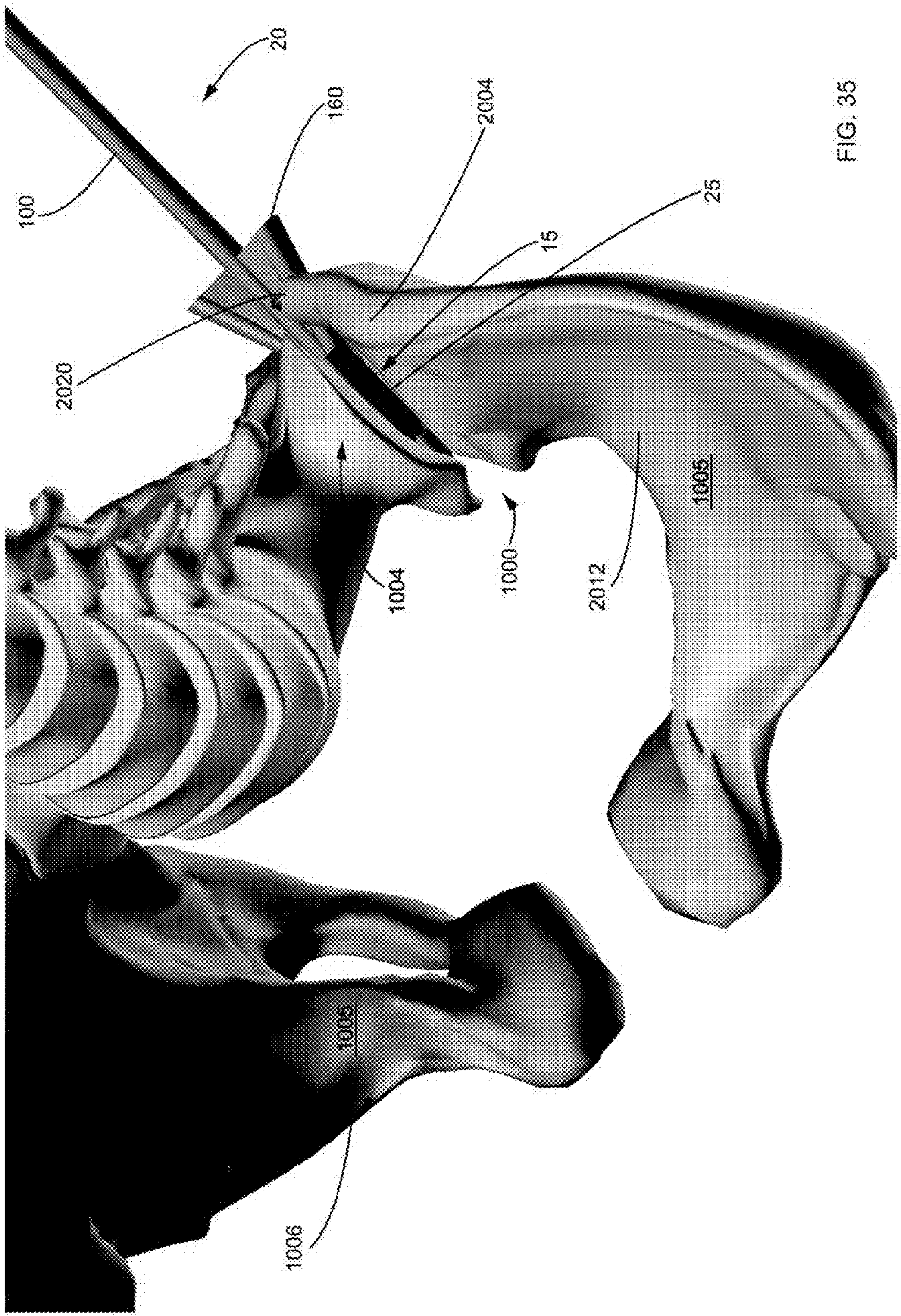

FIG. 35

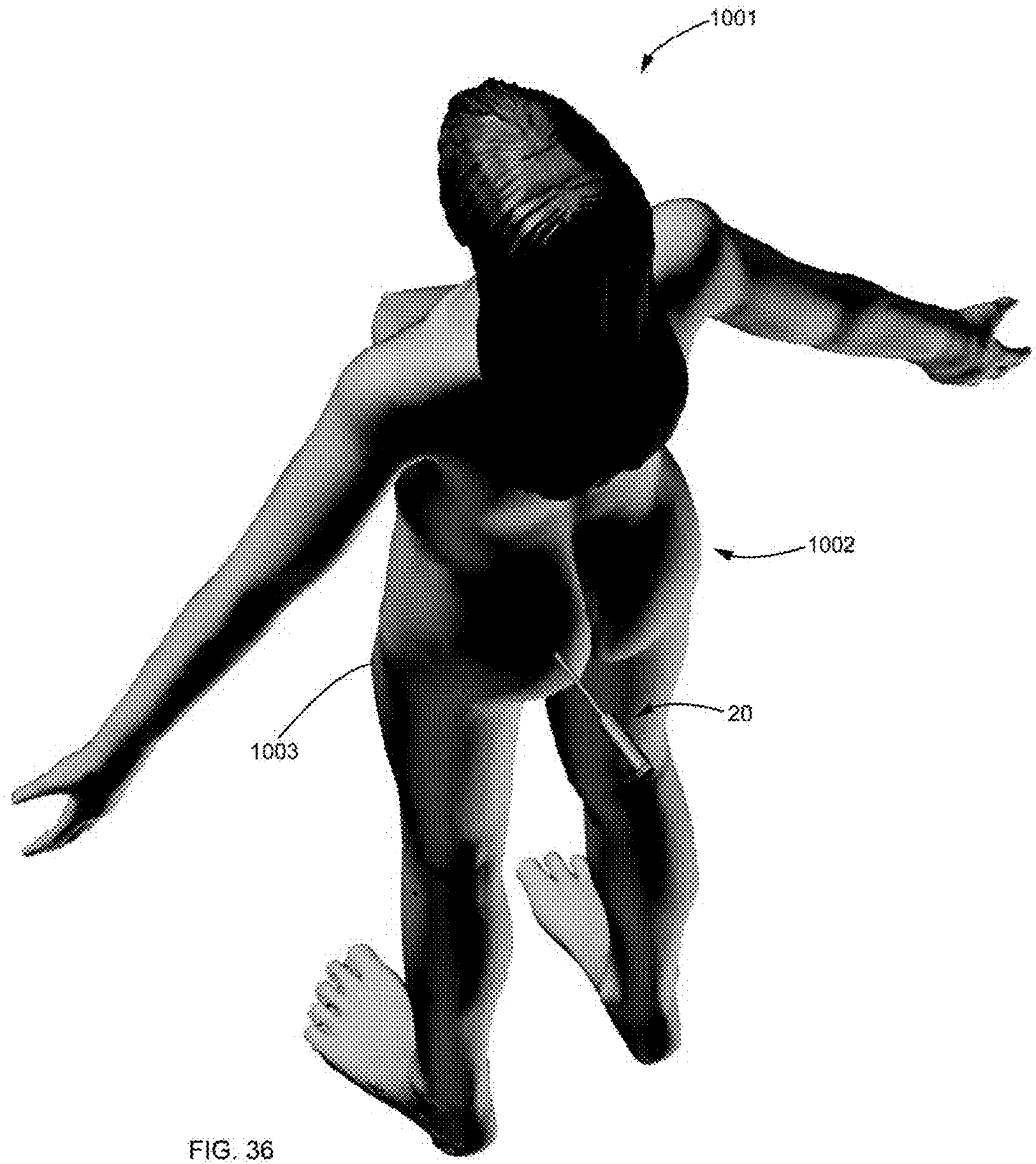

FIG. 36

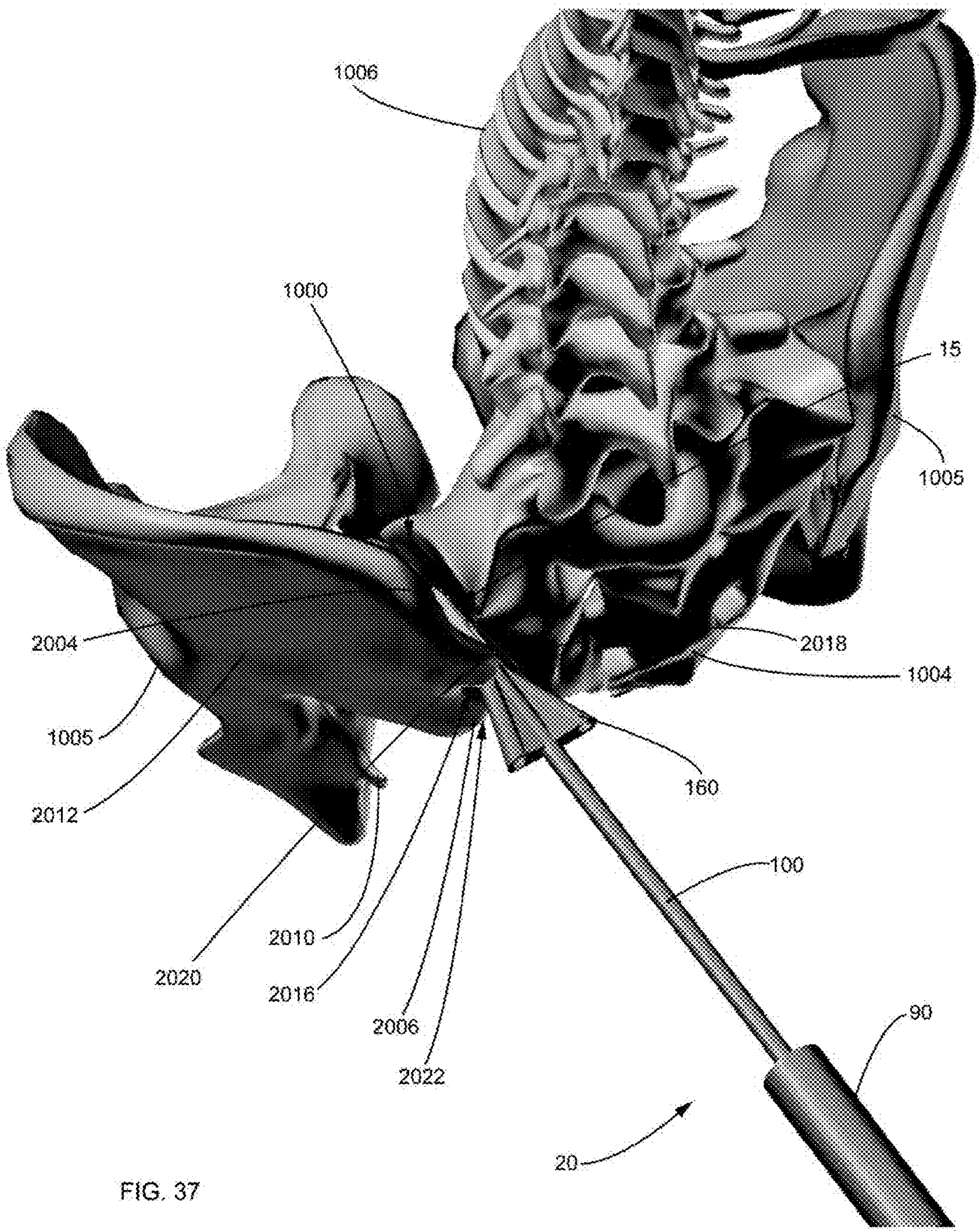
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FIG. 37

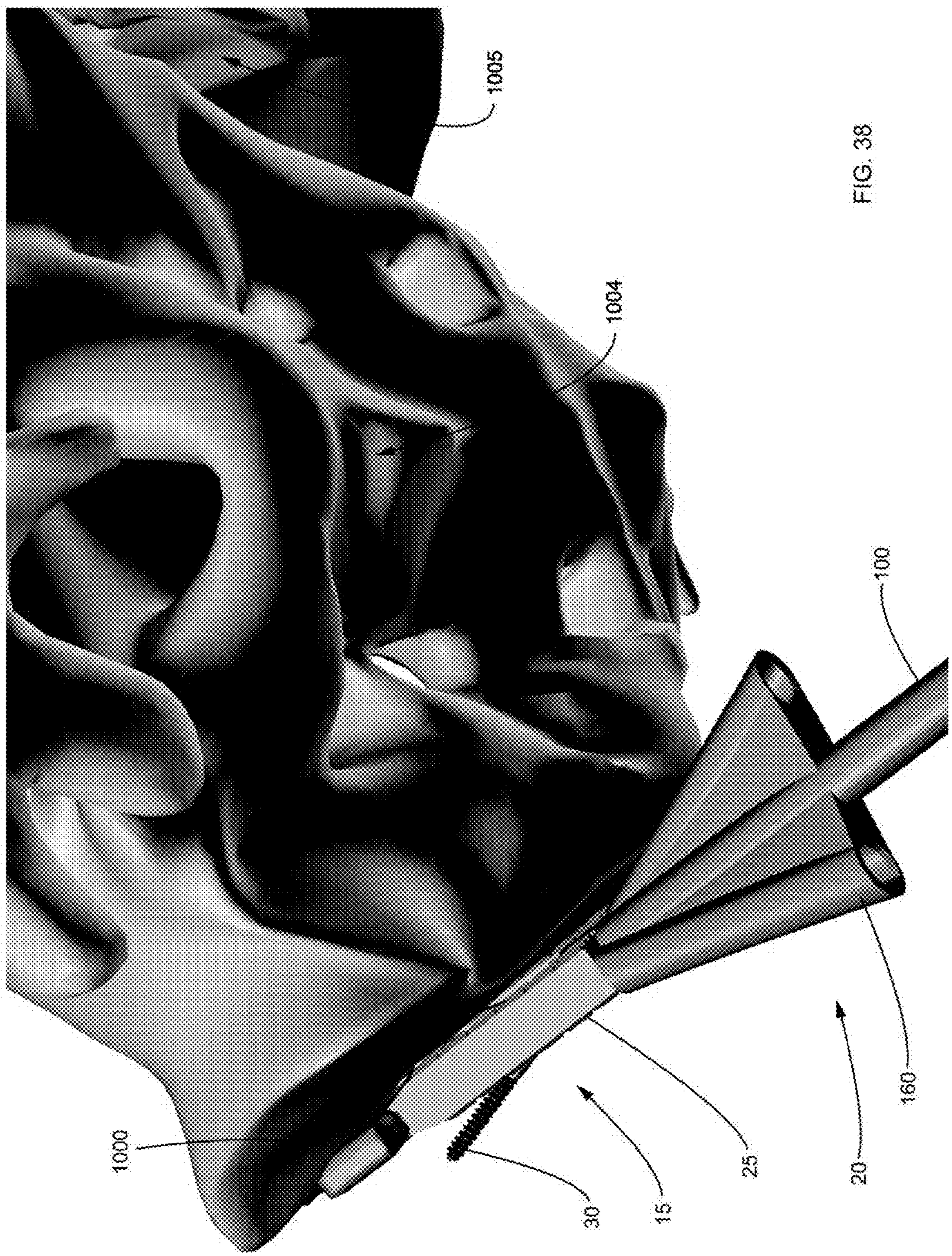

FIG. 38

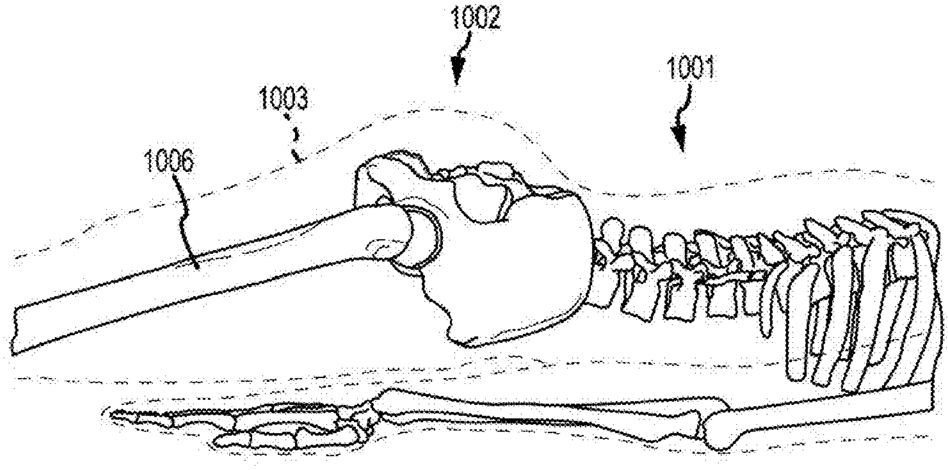

FIG. 39A

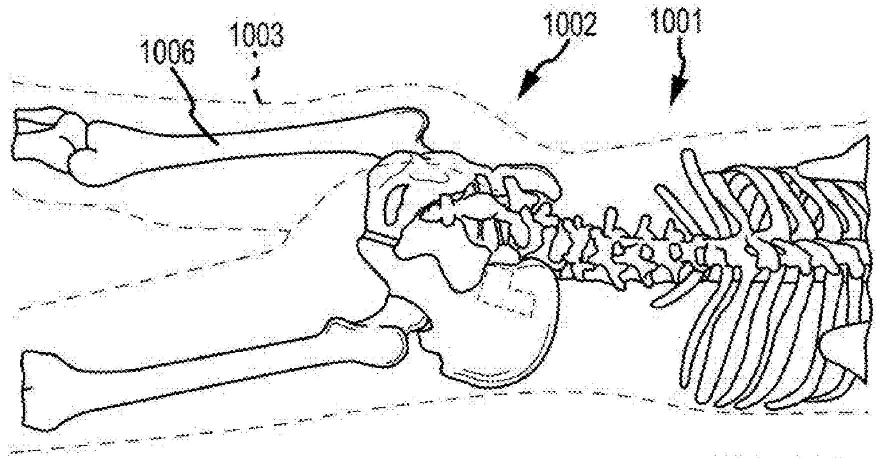

FIG. 40A

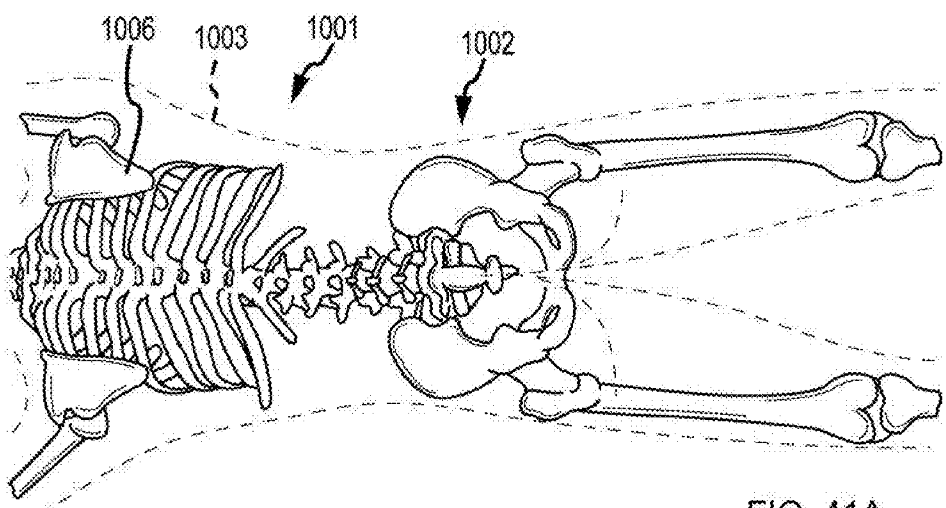

FIG. 41A

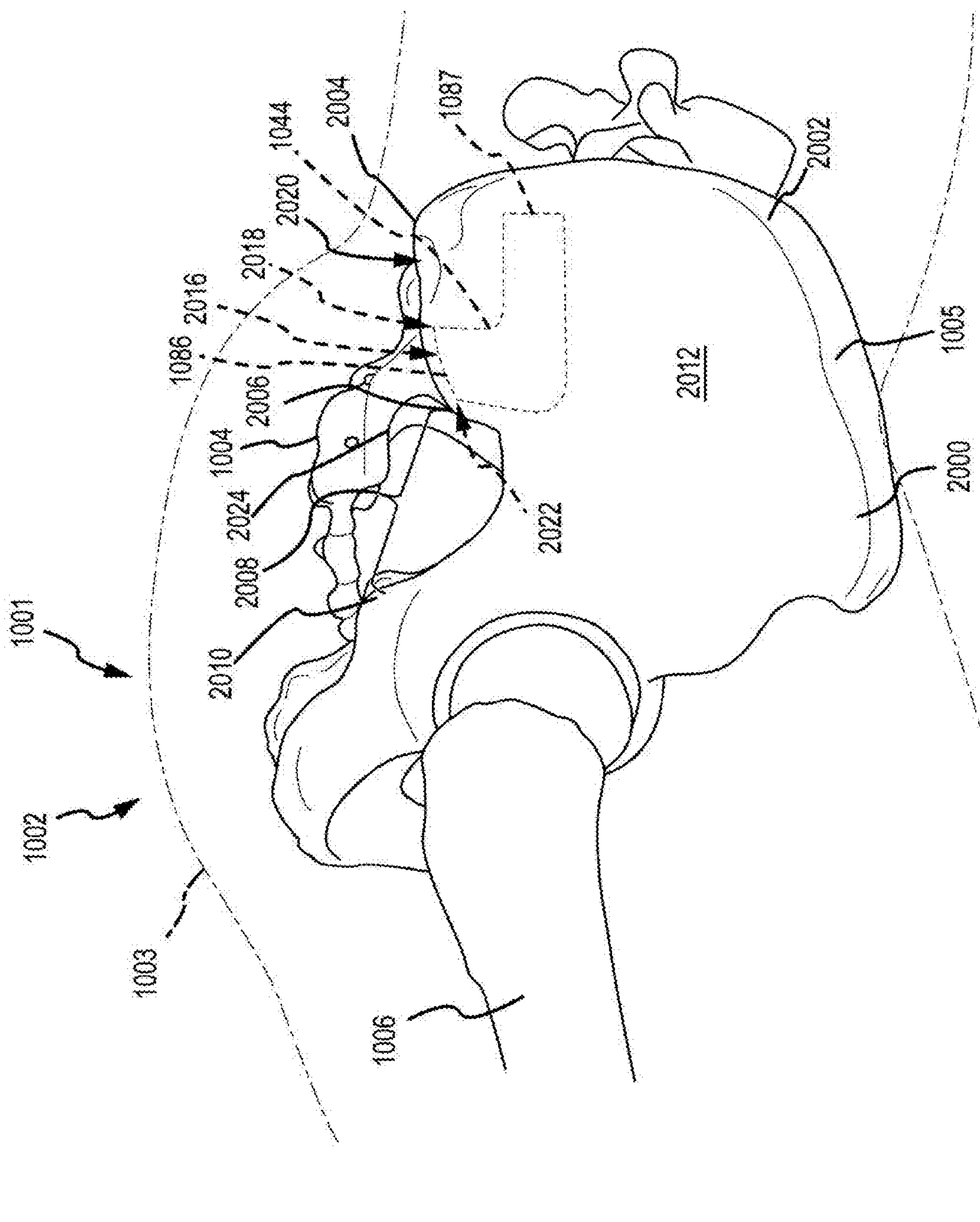
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FIG. 39B

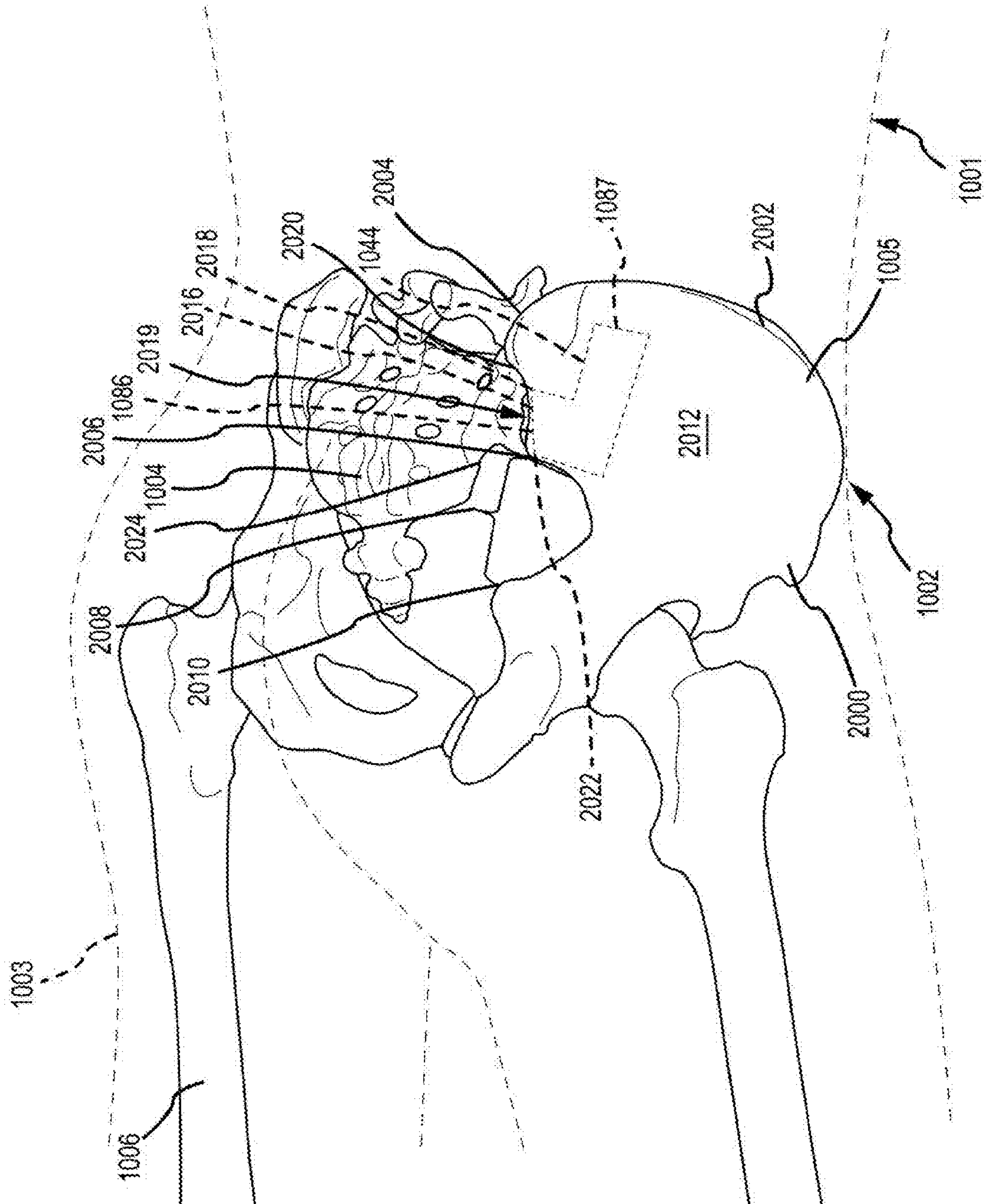
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FIG. 40B

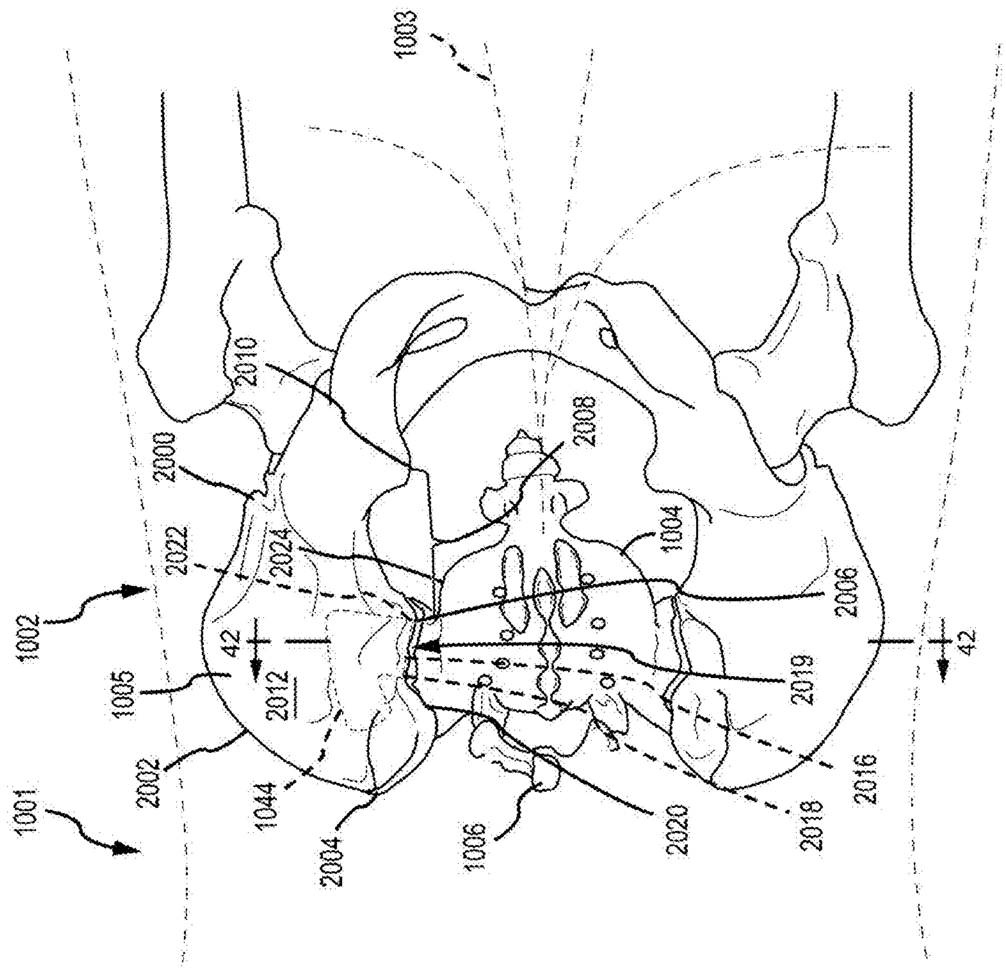
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FIG. 41B

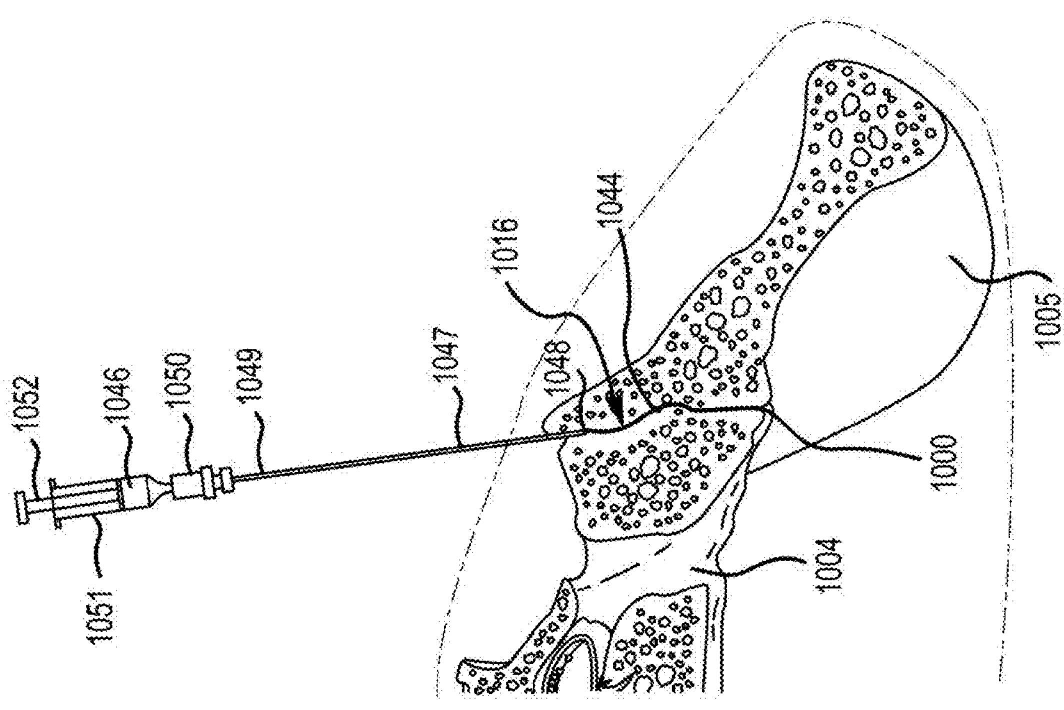

FIG. 42A

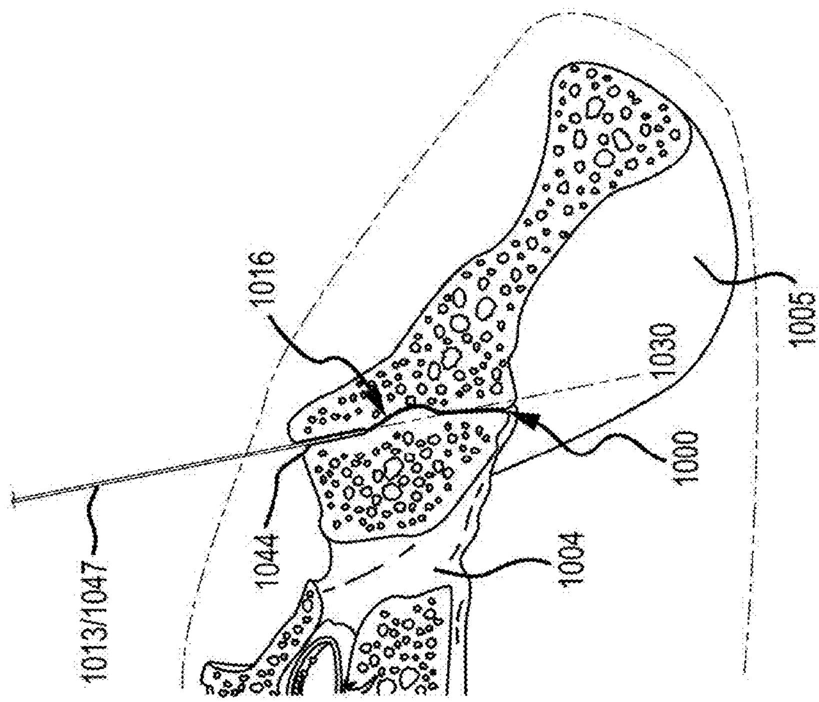

FIG. 42B

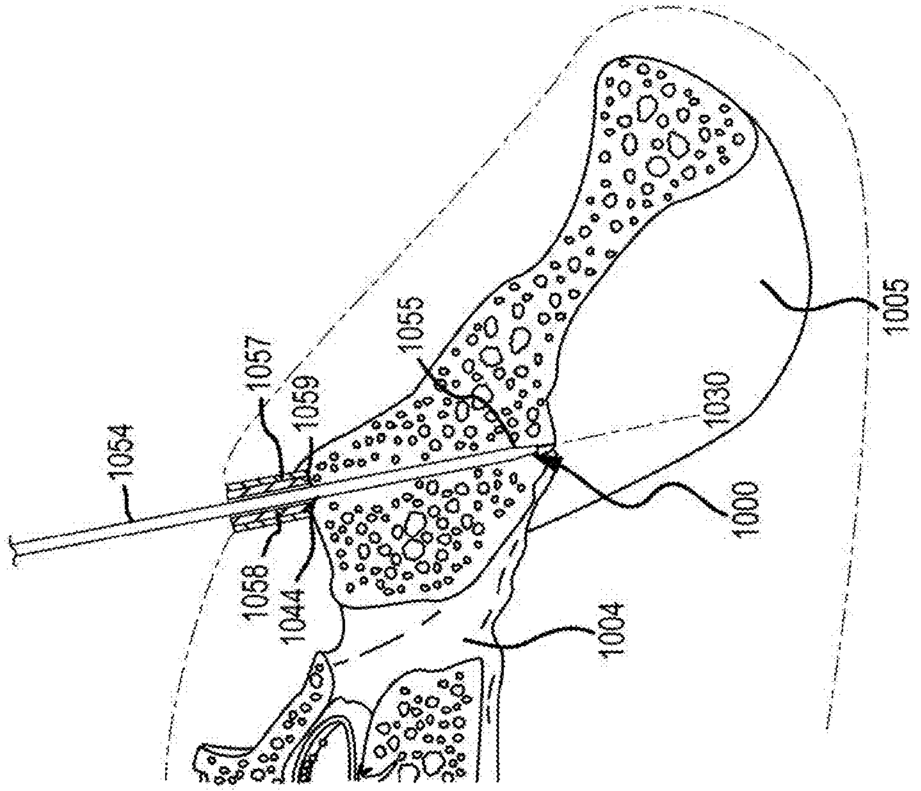

FIG. 42D

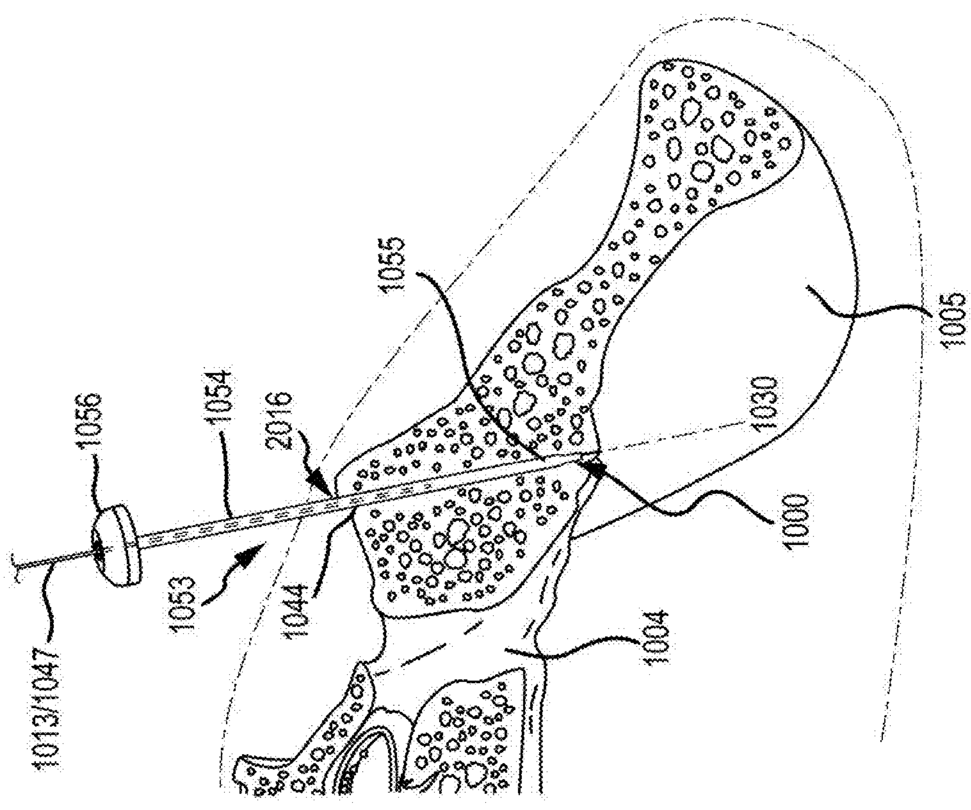

FIG. 42C

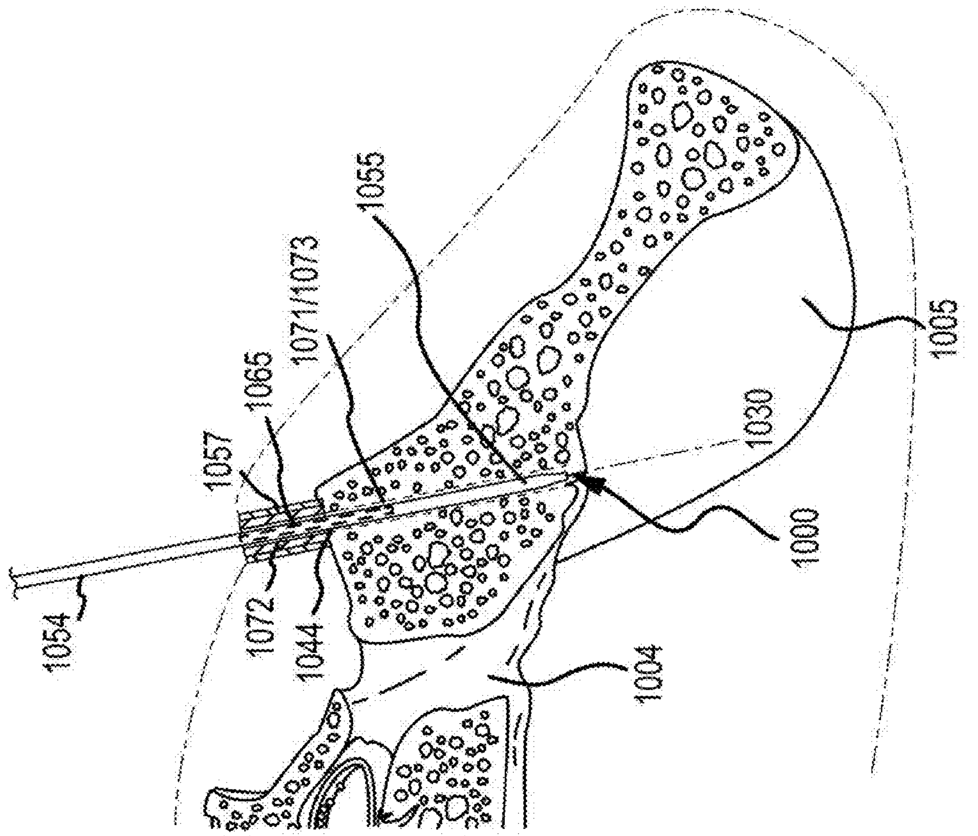

FIG. 42F

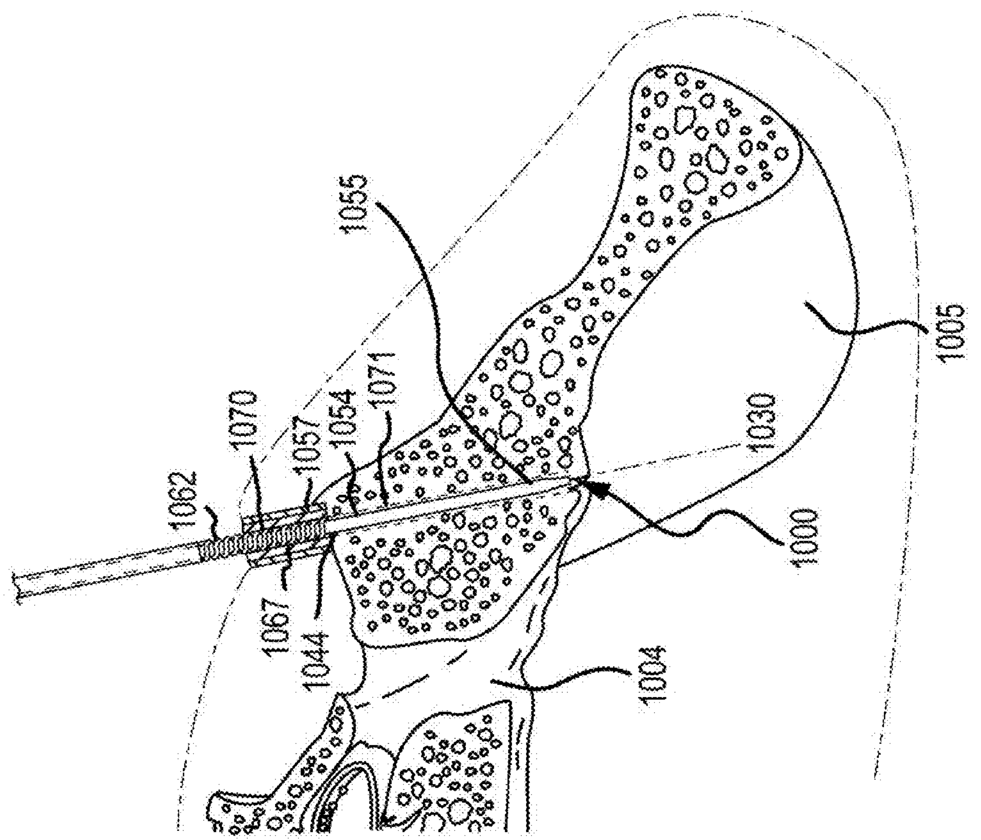

FIG. 42E

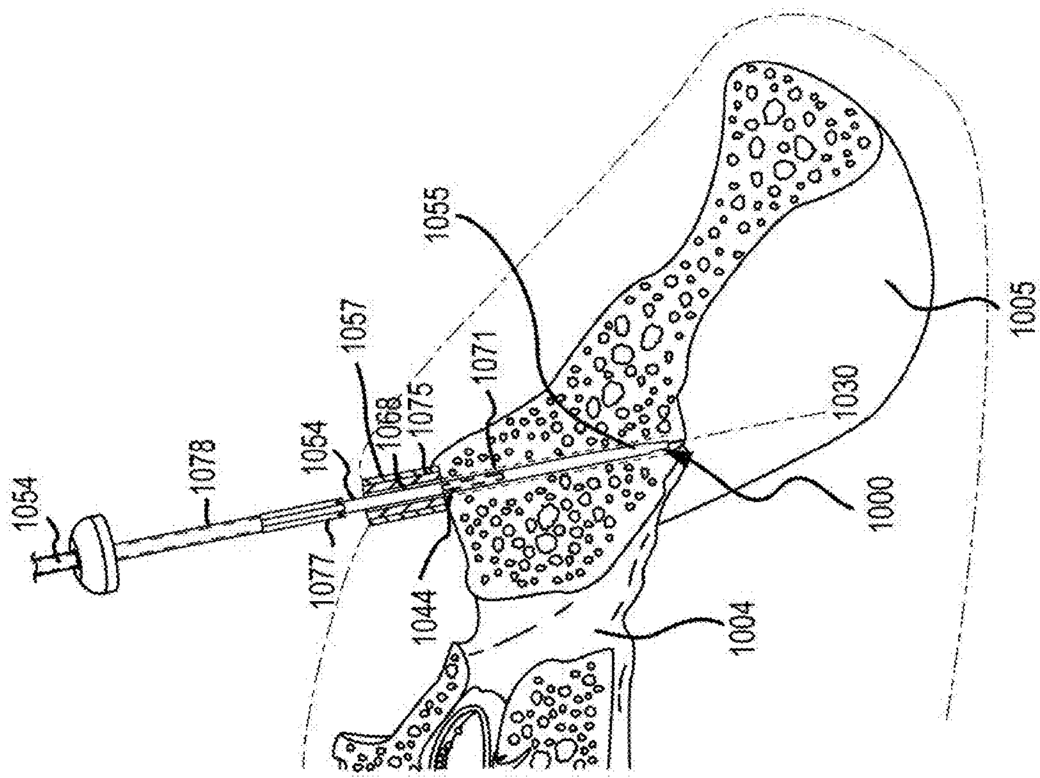

FIG. 42G

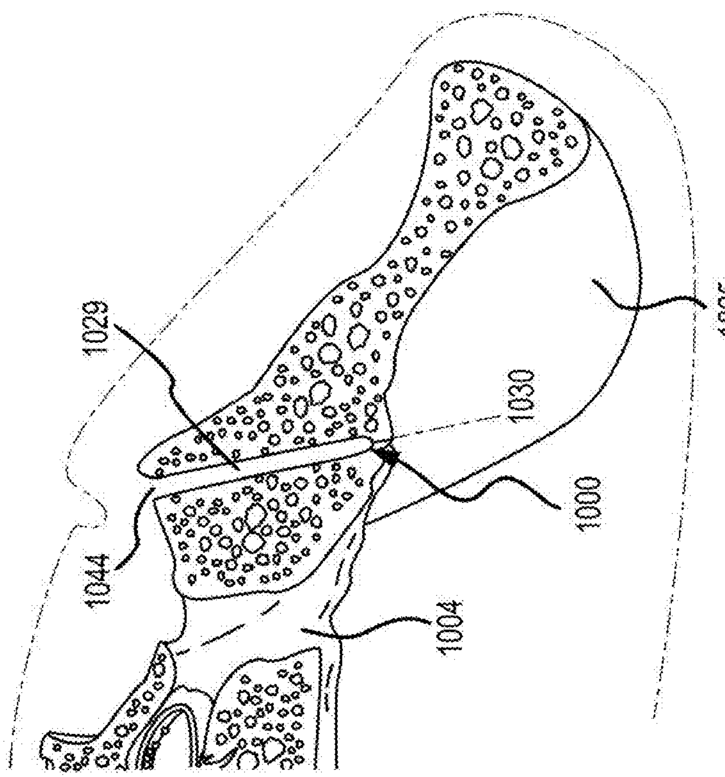

FIG. 42H

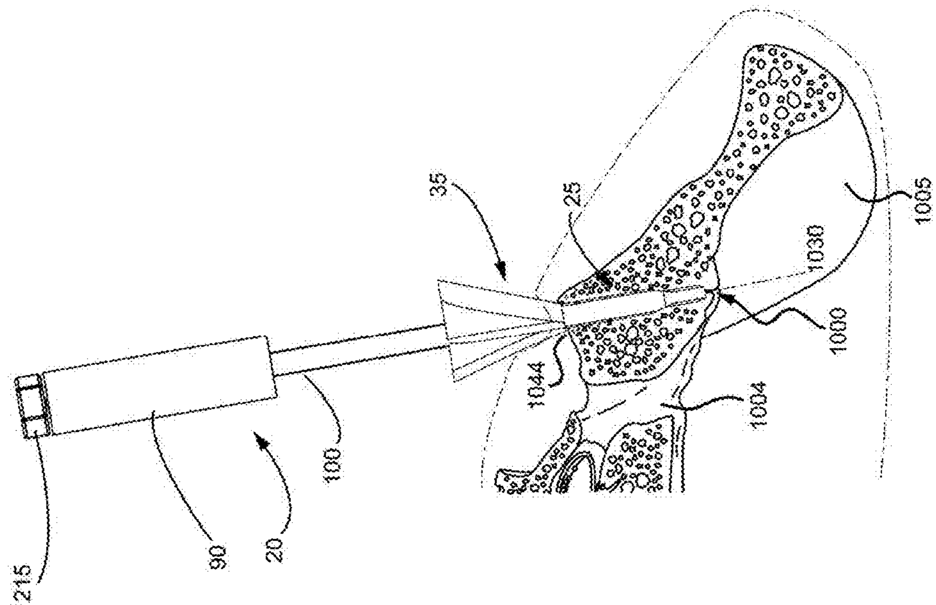

FIG. 42J

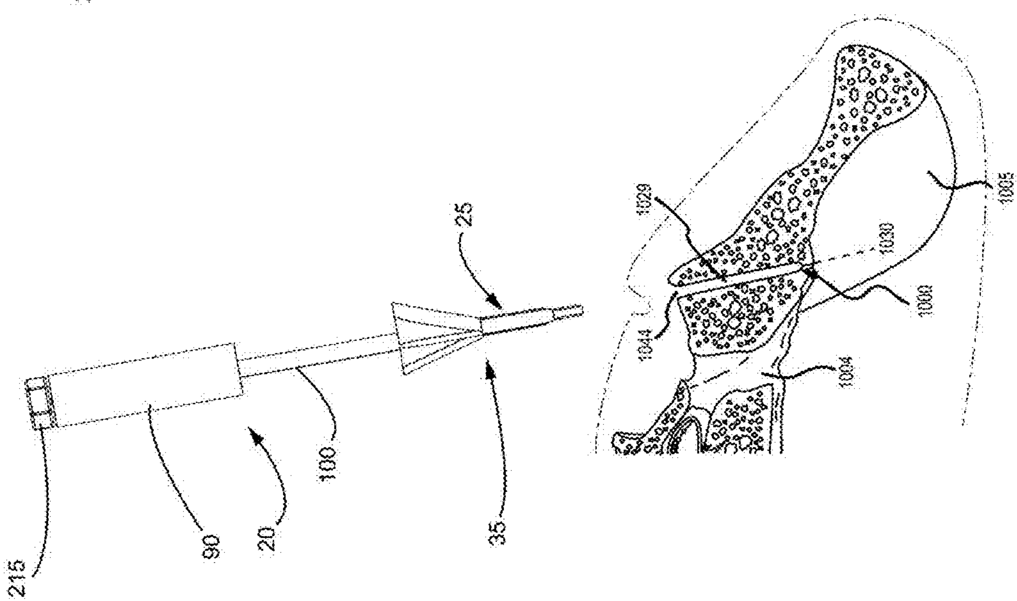

FIG. 42I

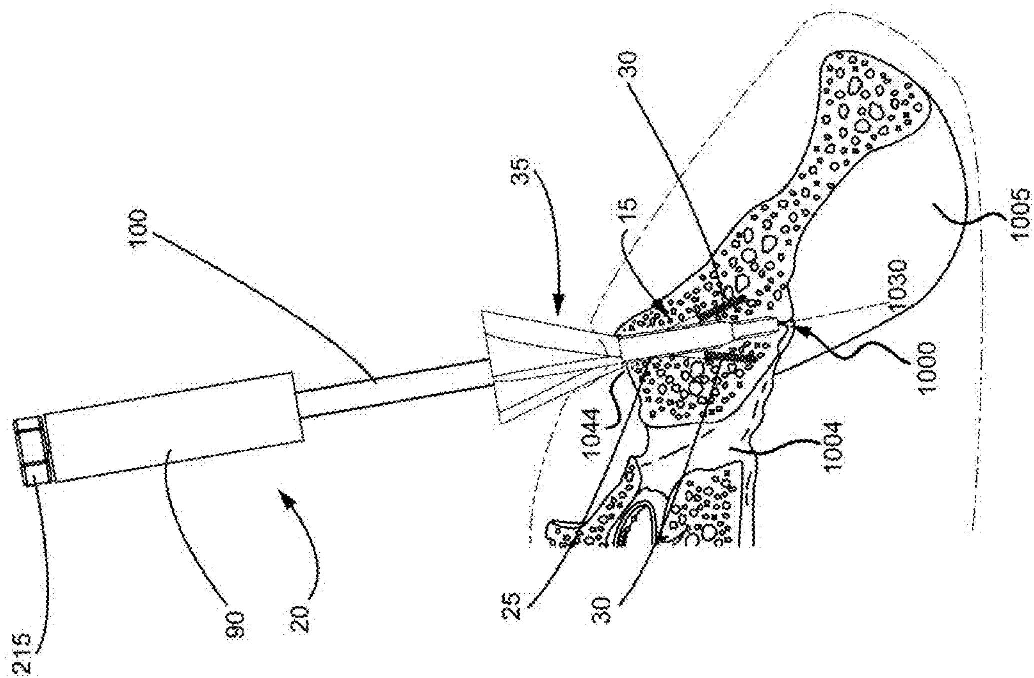

FIG. 42L

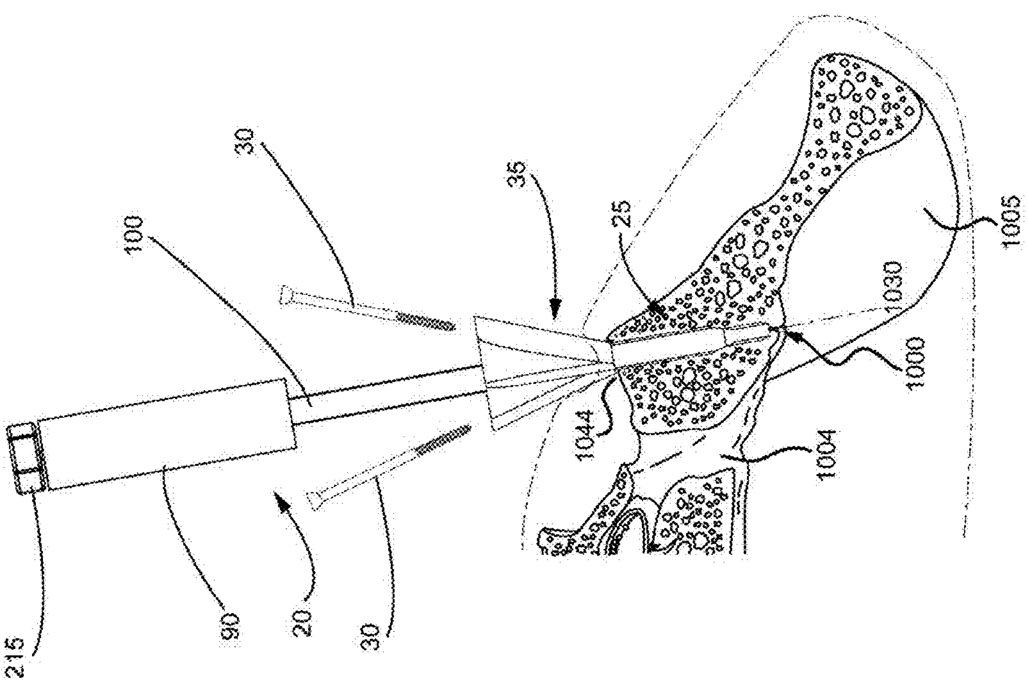

FIG. 42K

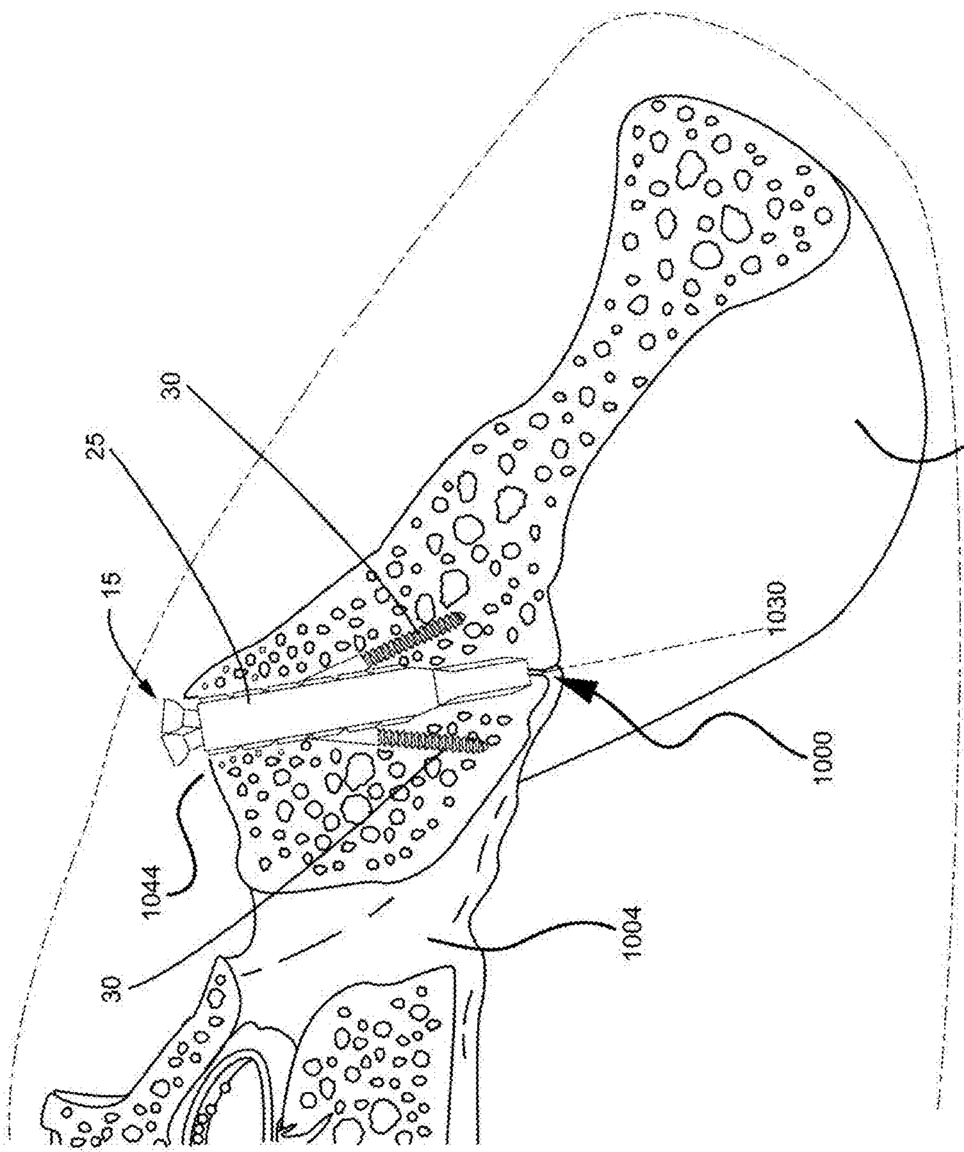

FIG. 42M

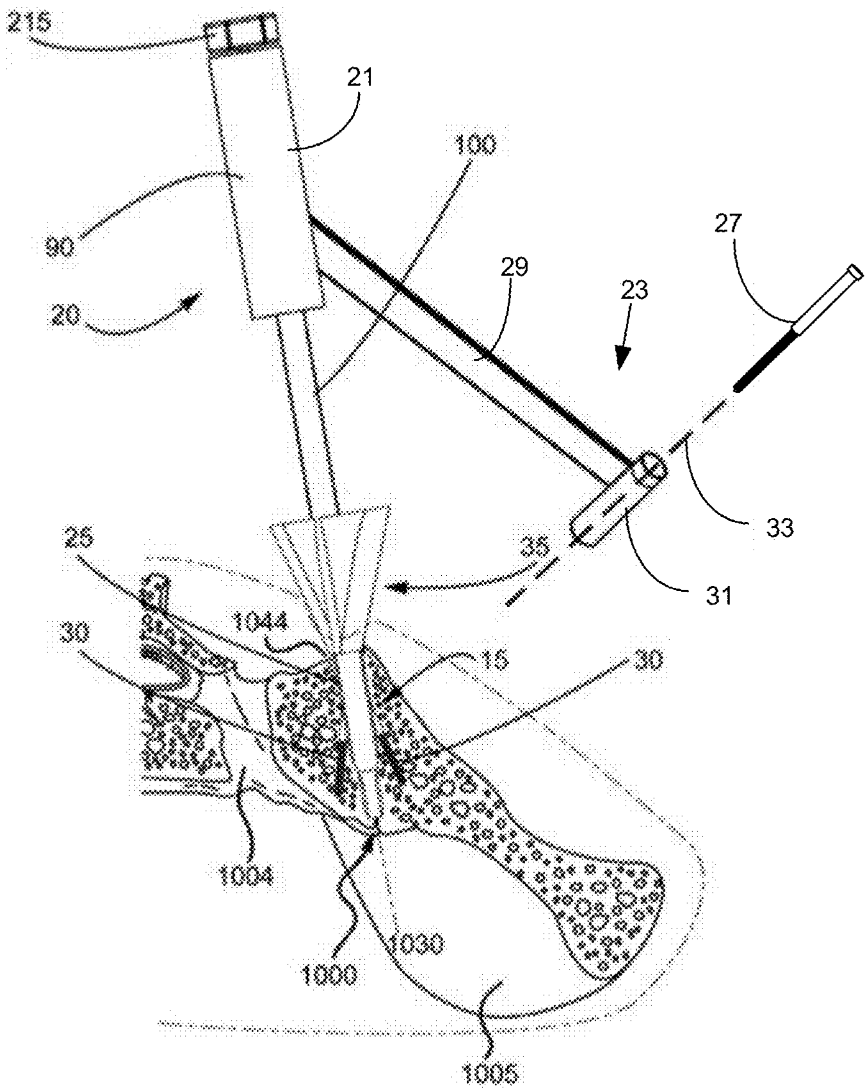

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FIG. 42N

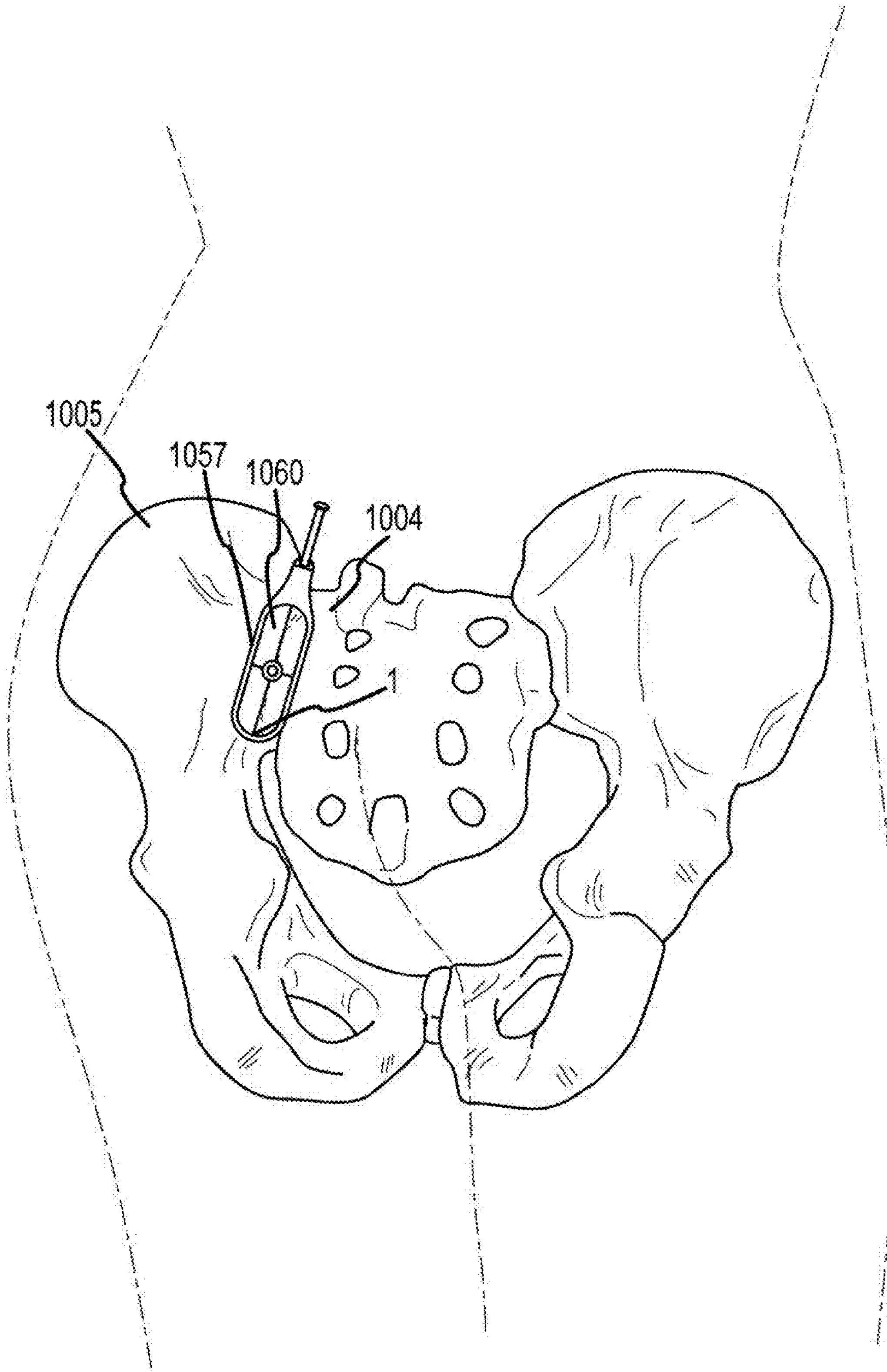

FIG. 43A

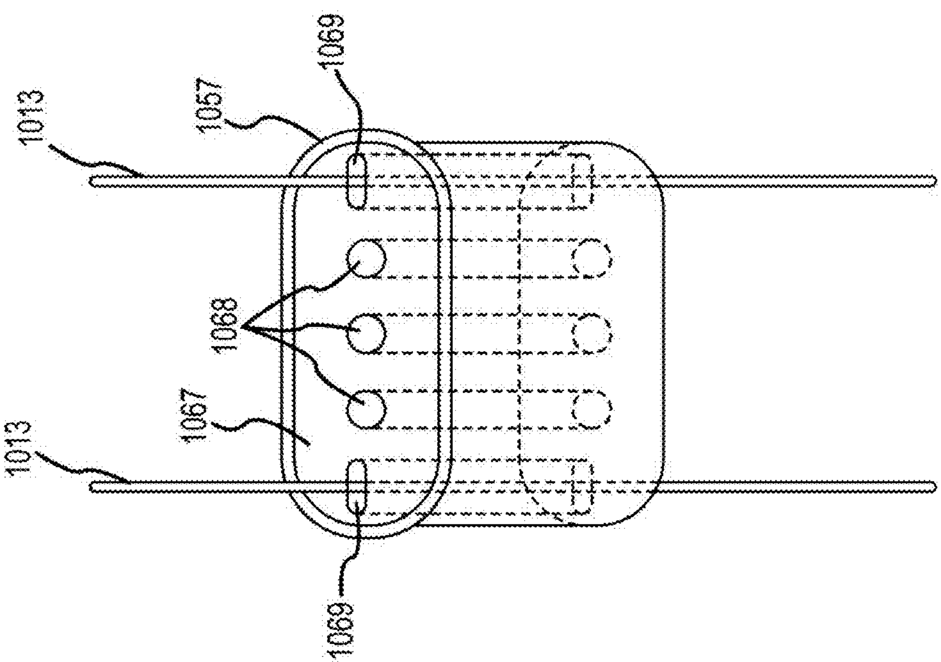

FIG. 44B

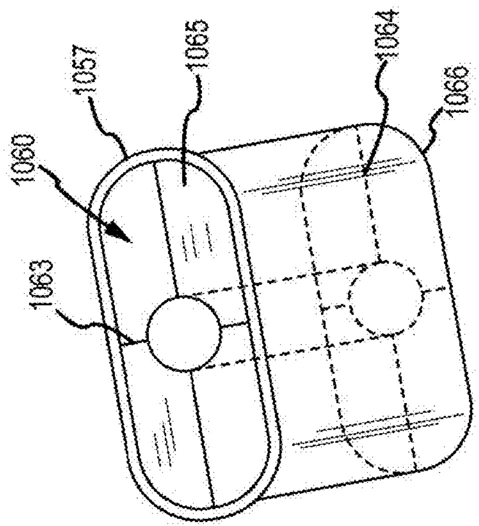

FIG. 43B

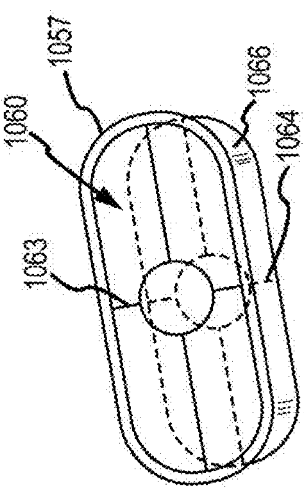

FIG. 43C

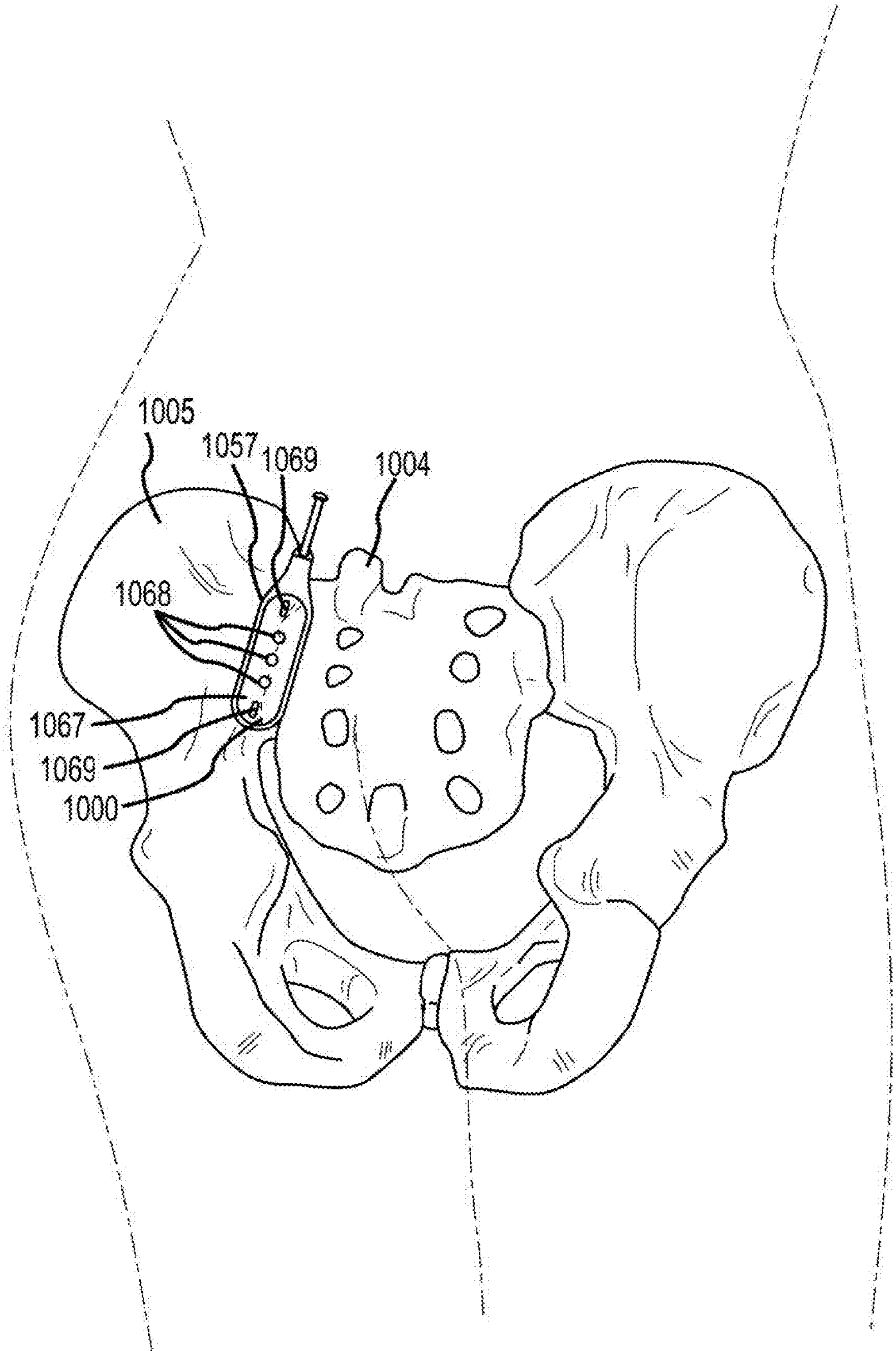

FIG. 44A

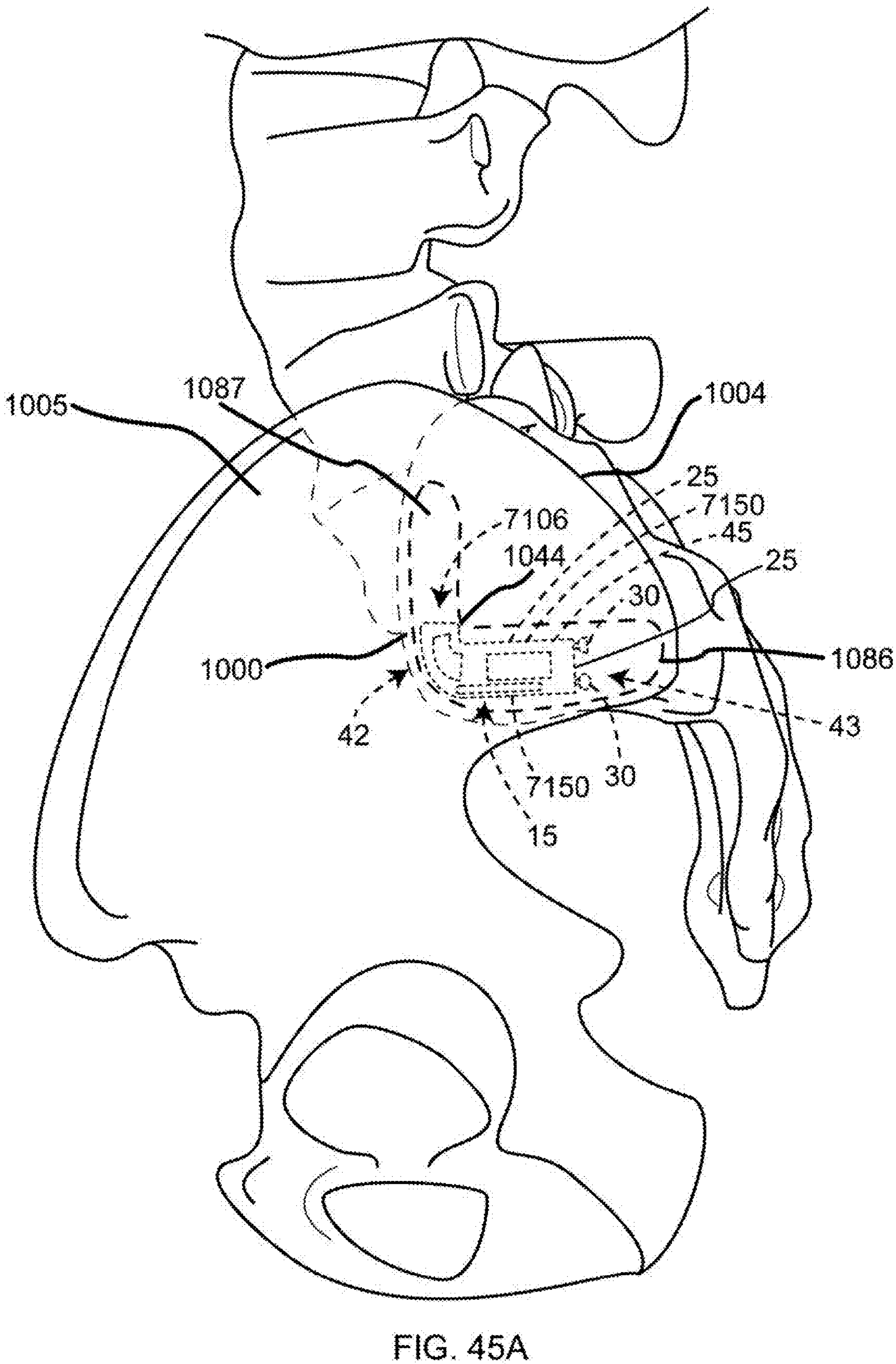
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FIG. 45A

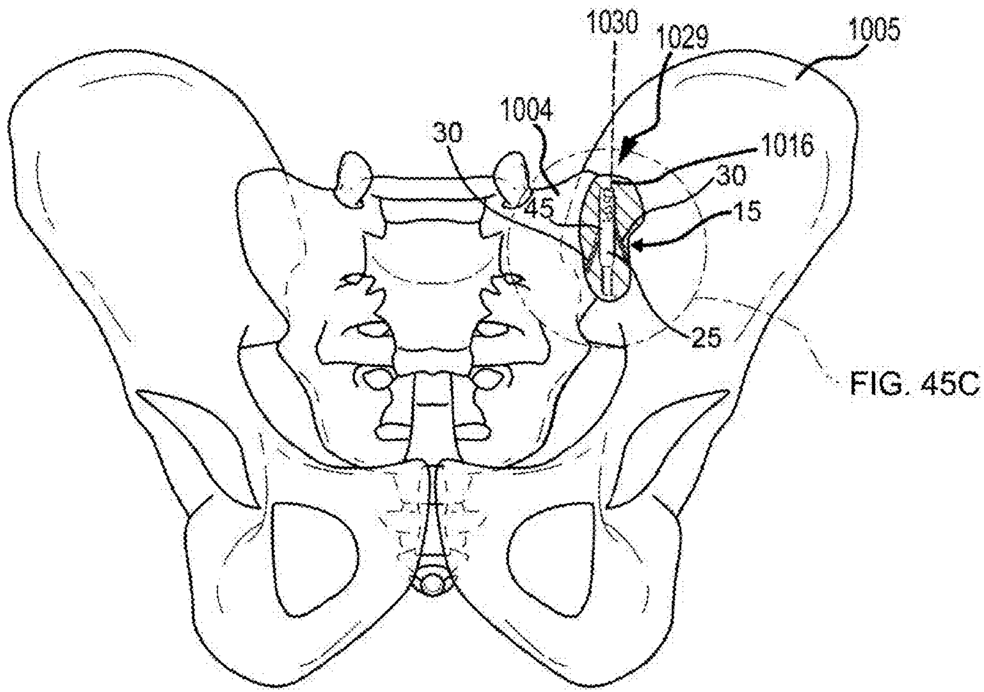

FIG. 45B

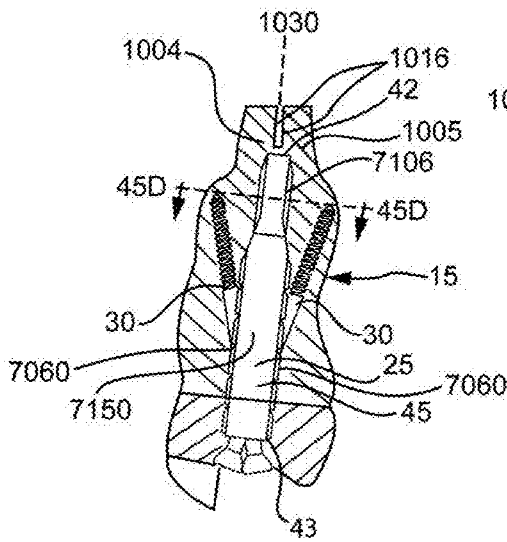

FIG. 45C

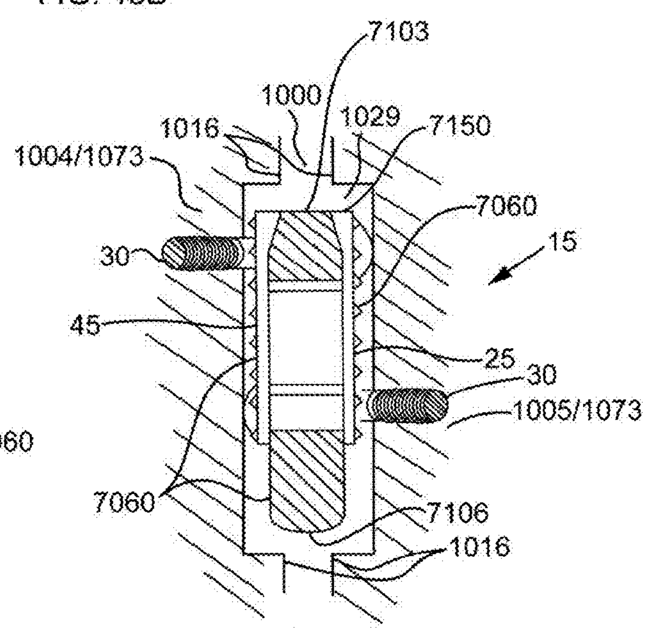

FIG. 45D

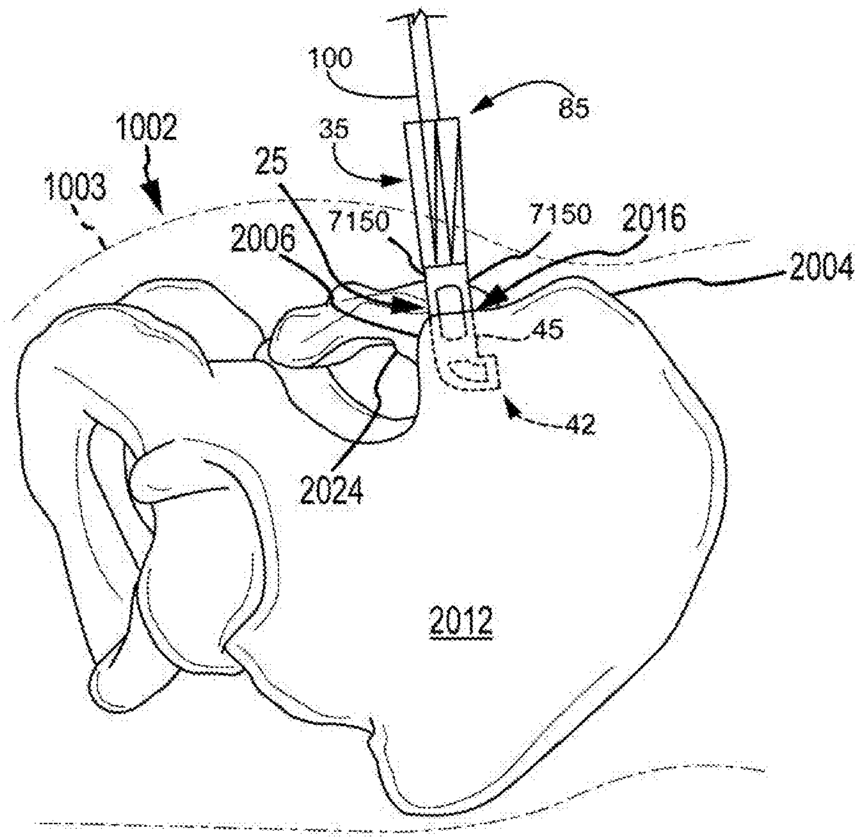
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FIG. 46

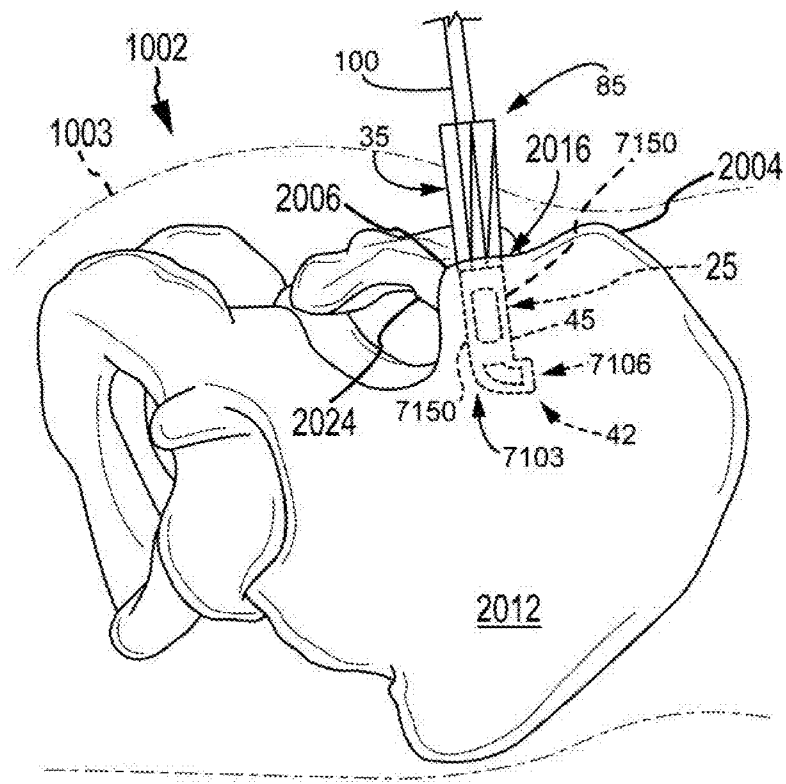
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FIG. 47

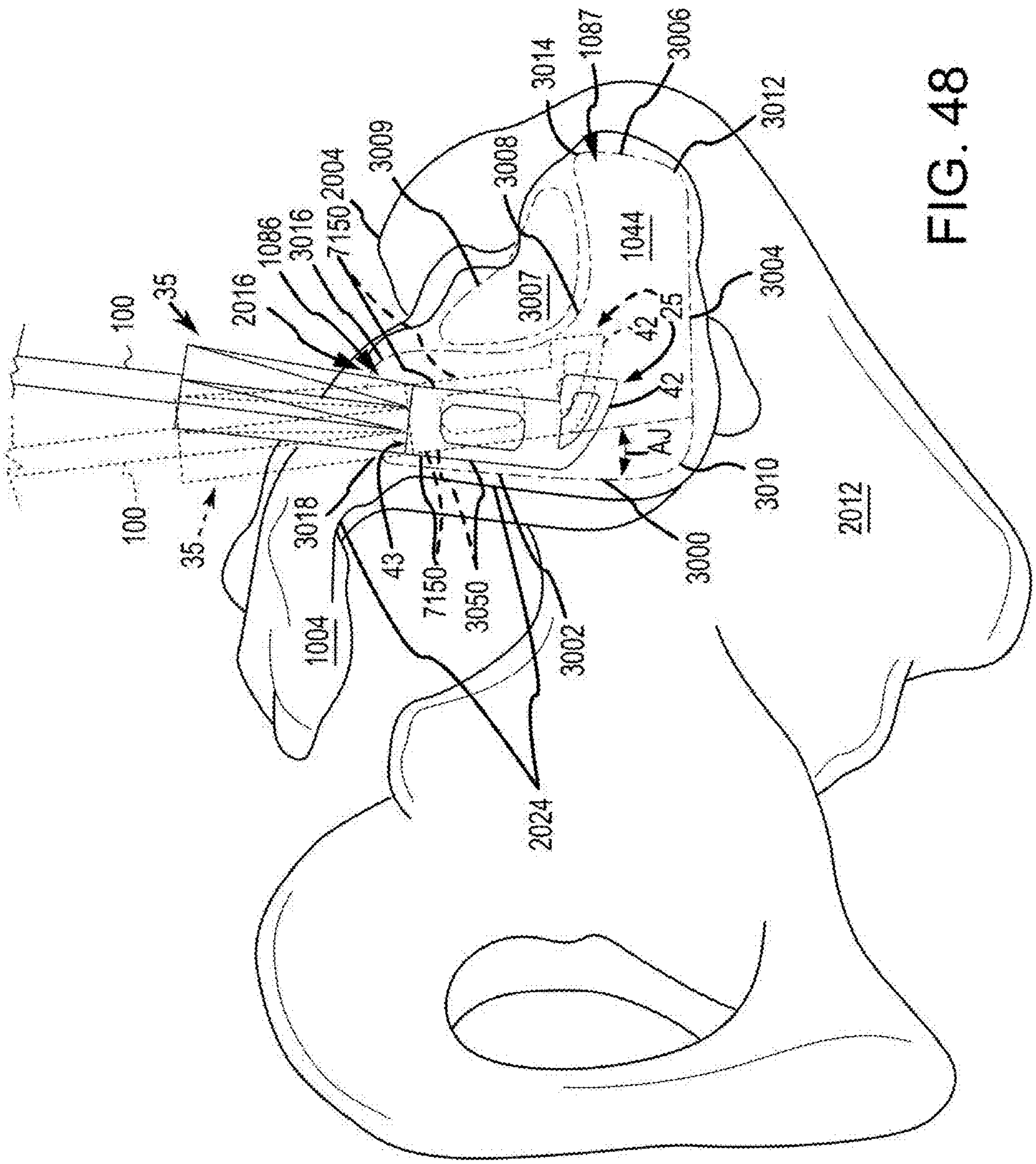
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FIG. 48

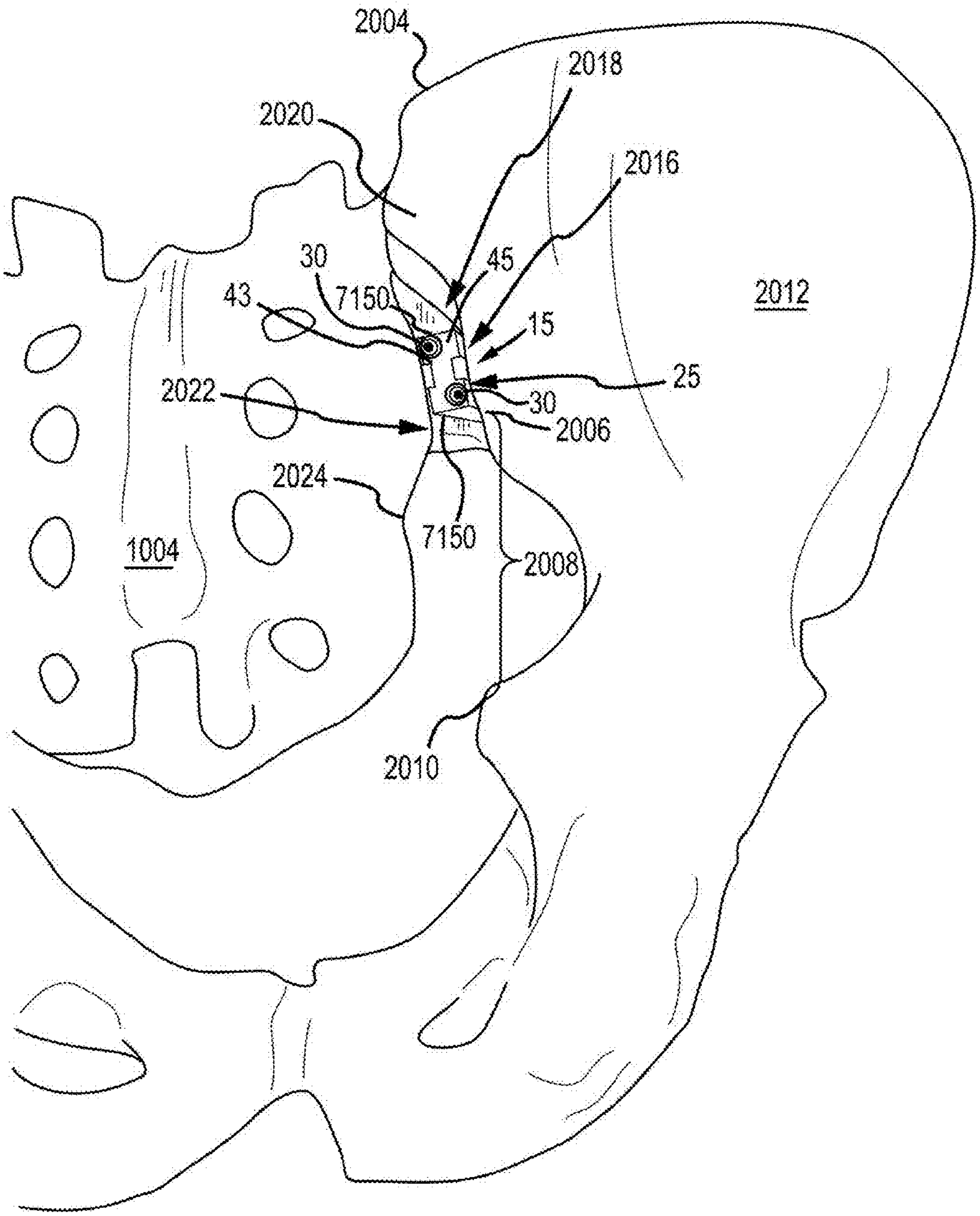
2004
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FIG. 49A

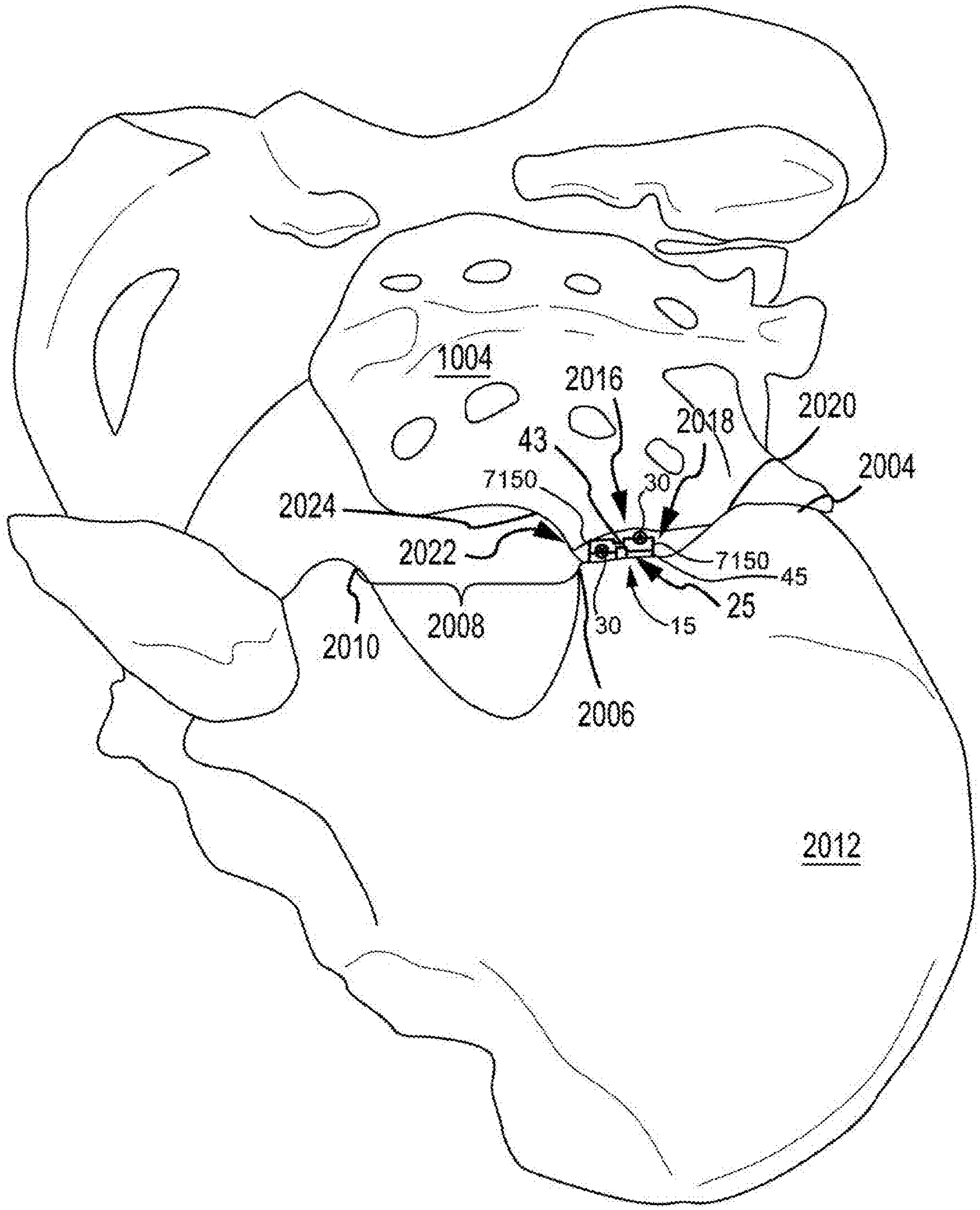
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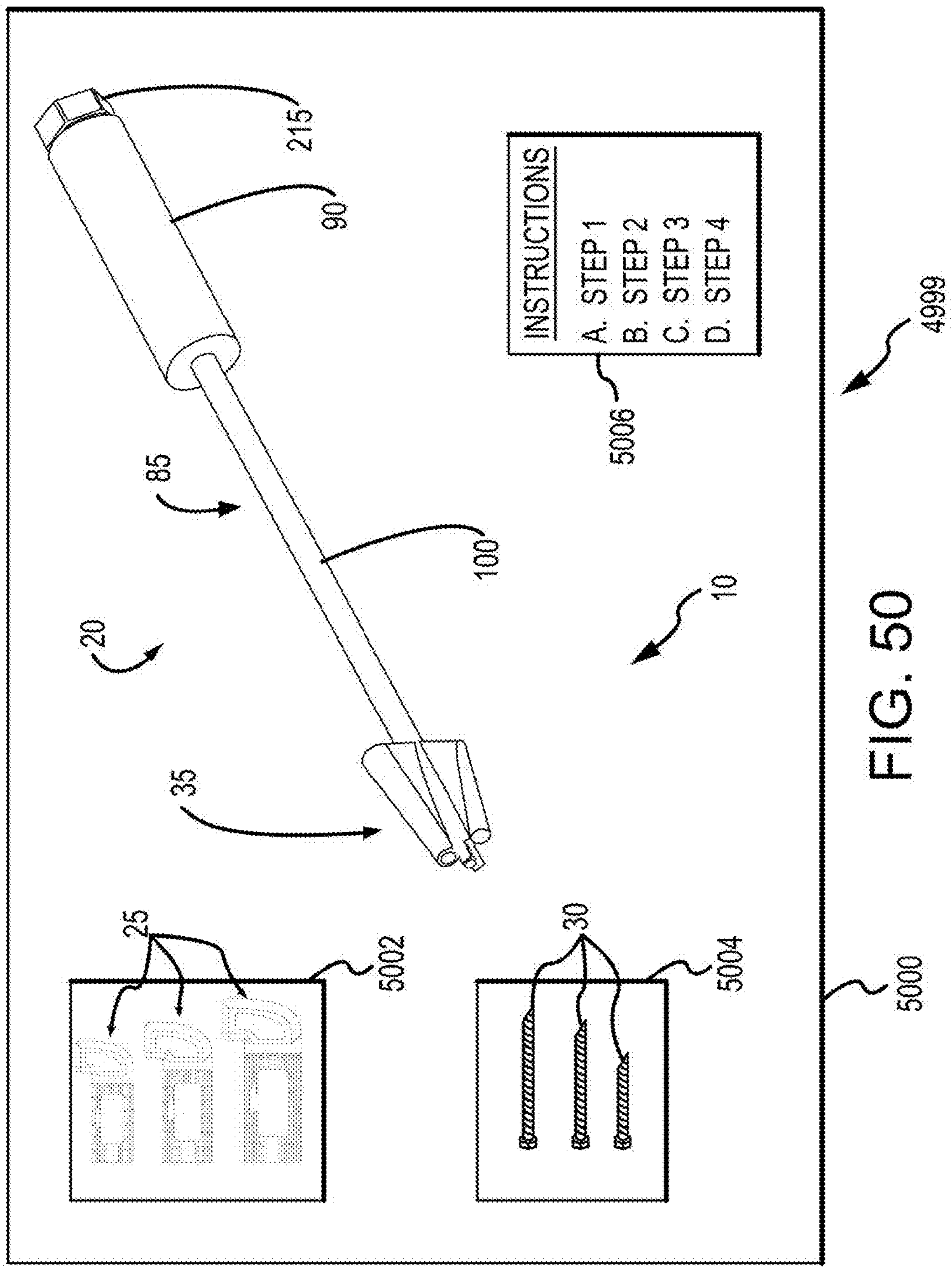
FIG. 49B


215
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INSTRUCTIONS
A. STEP 1
B. STEP 2
C. STEP 3
D. STEP 4
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5002
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5004
5000

FIG. 50

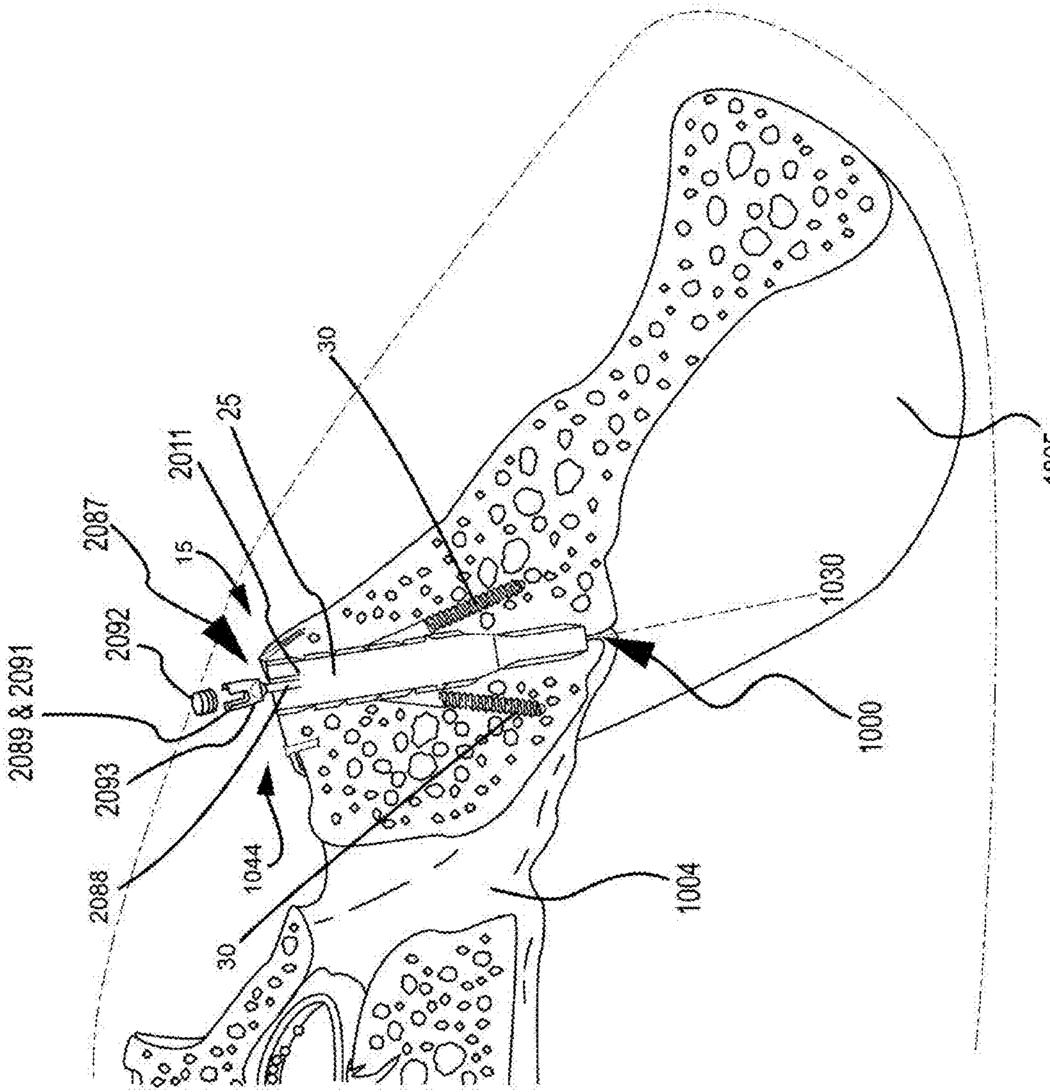
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FIG. 51

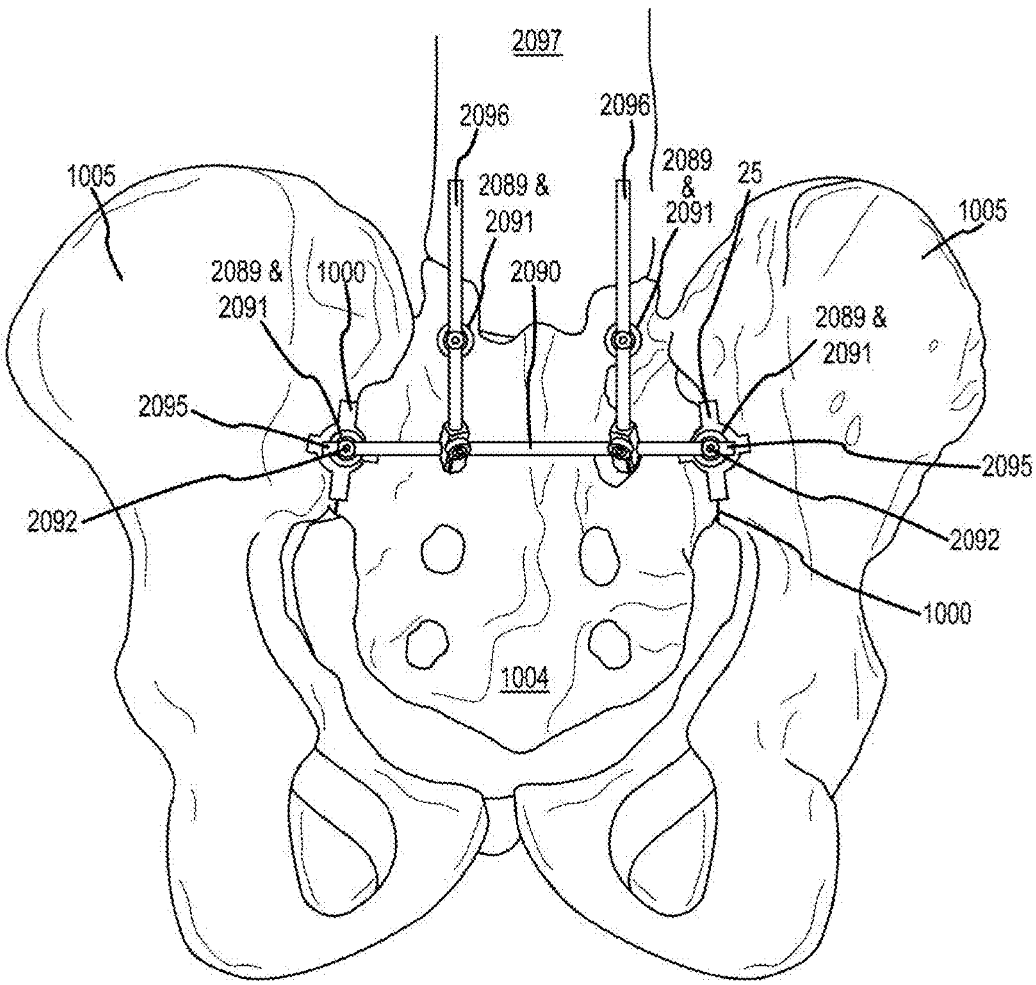
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FIG. 52

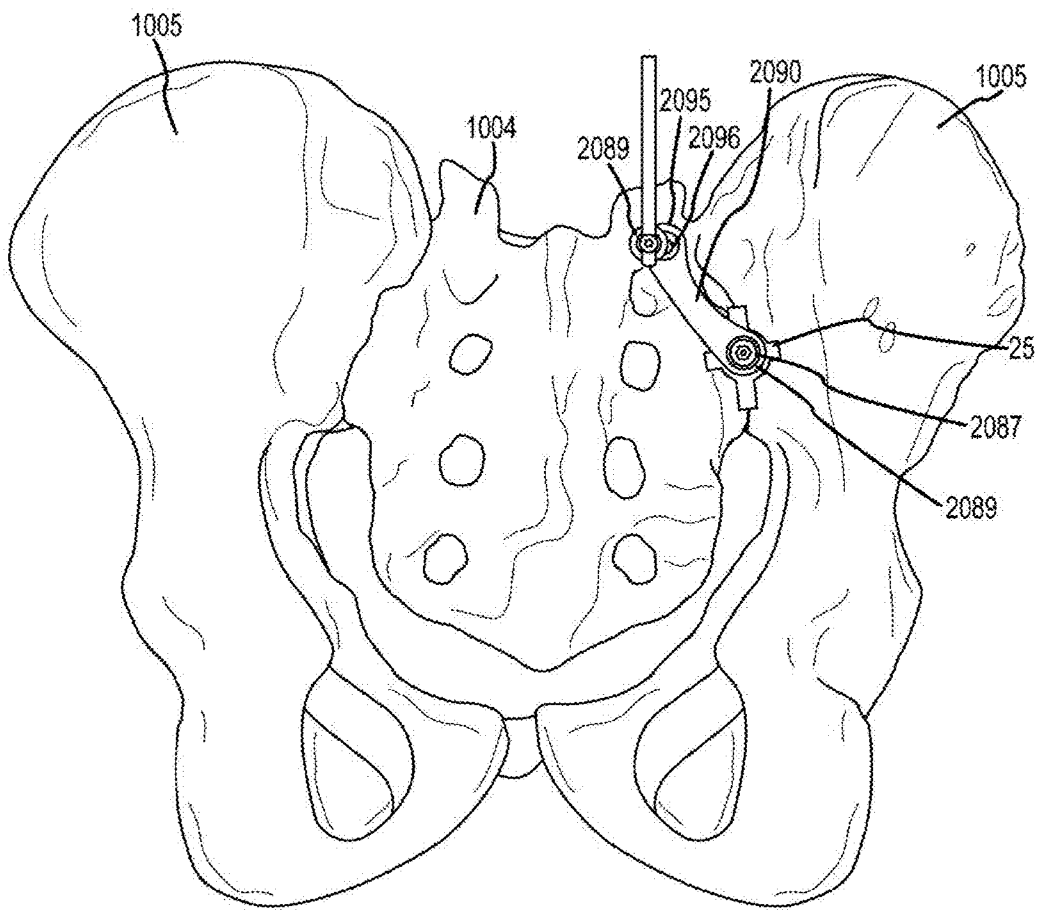

FIG. 53

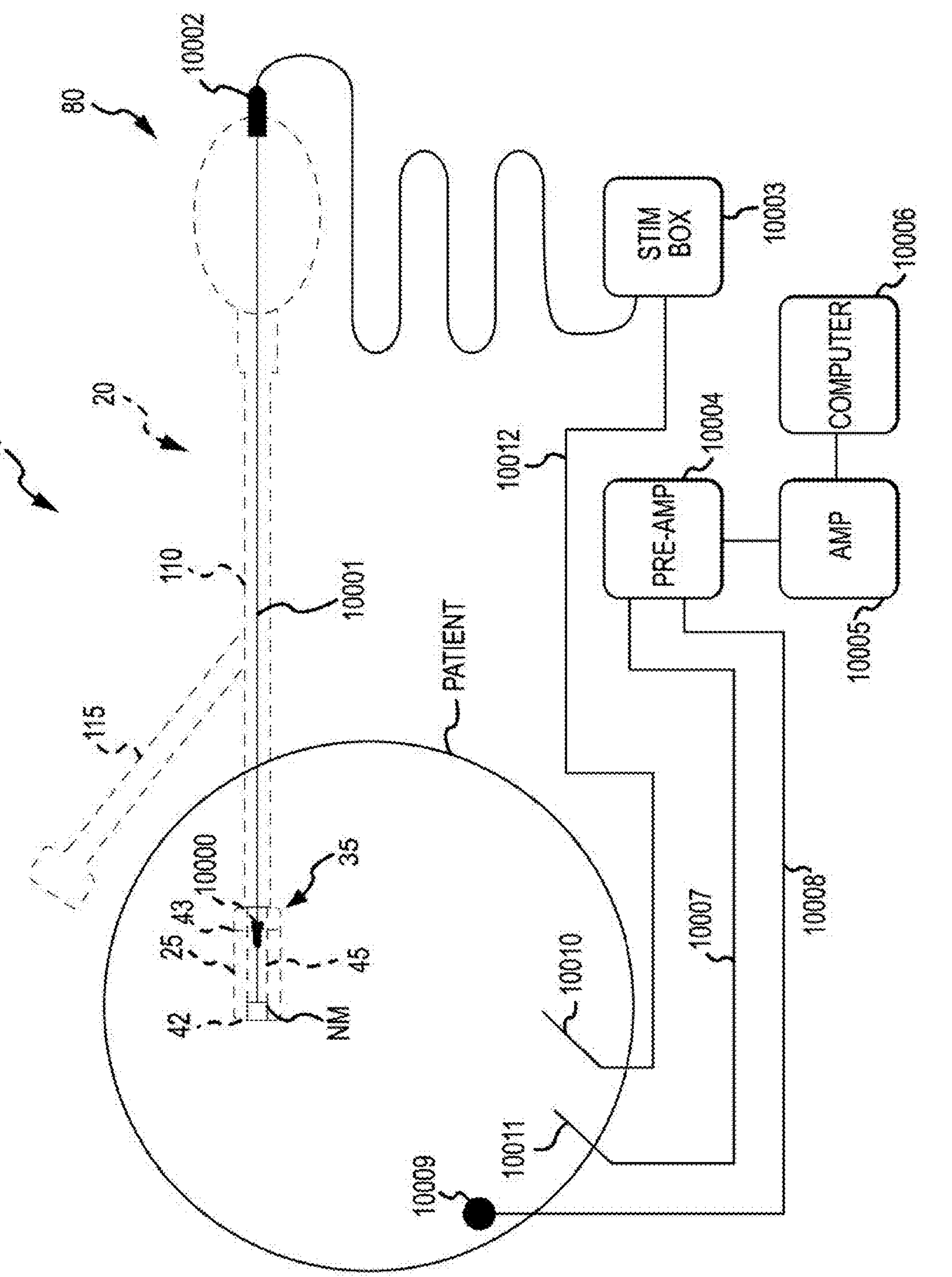

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FIG. 54

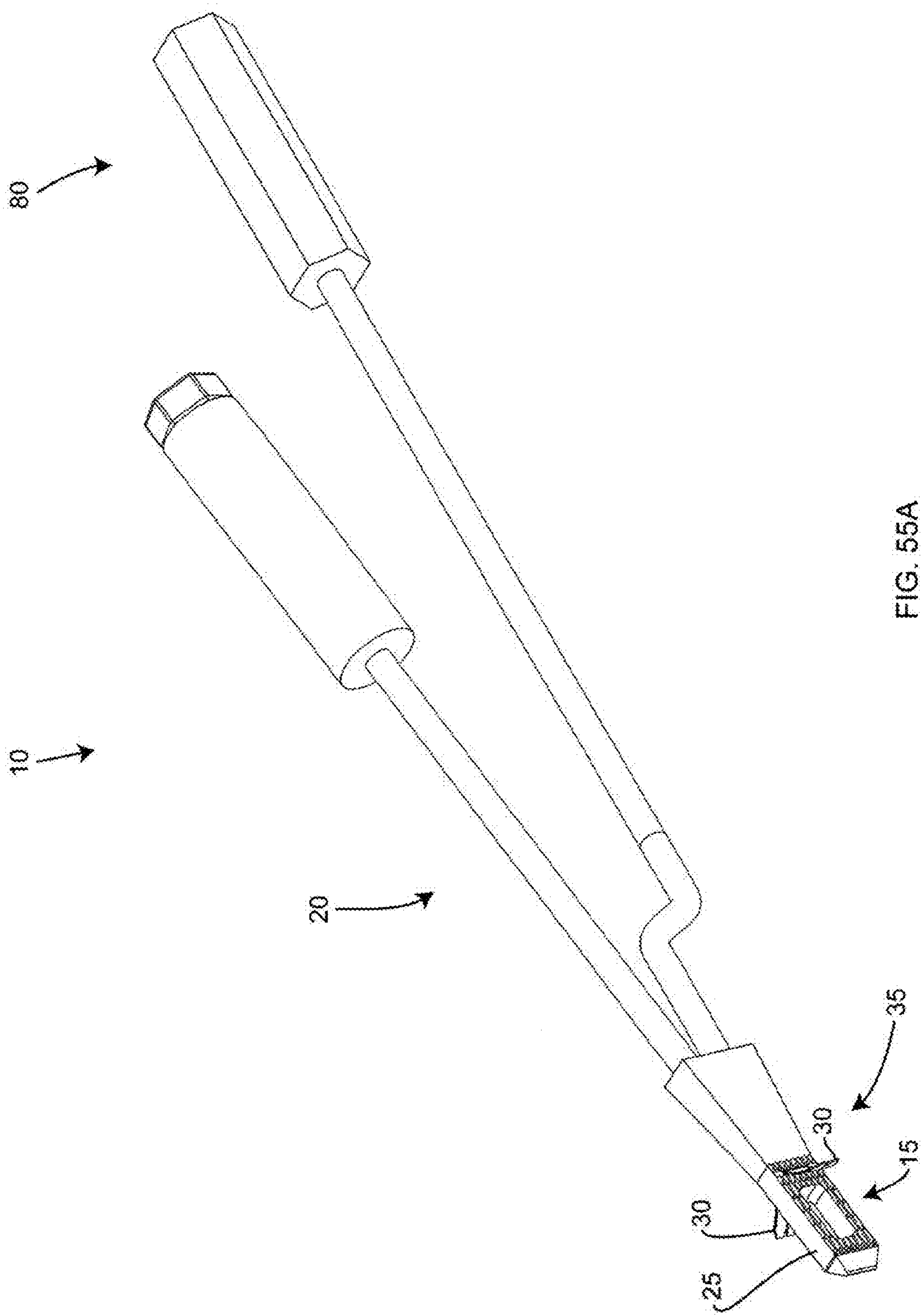

FIG. 55A

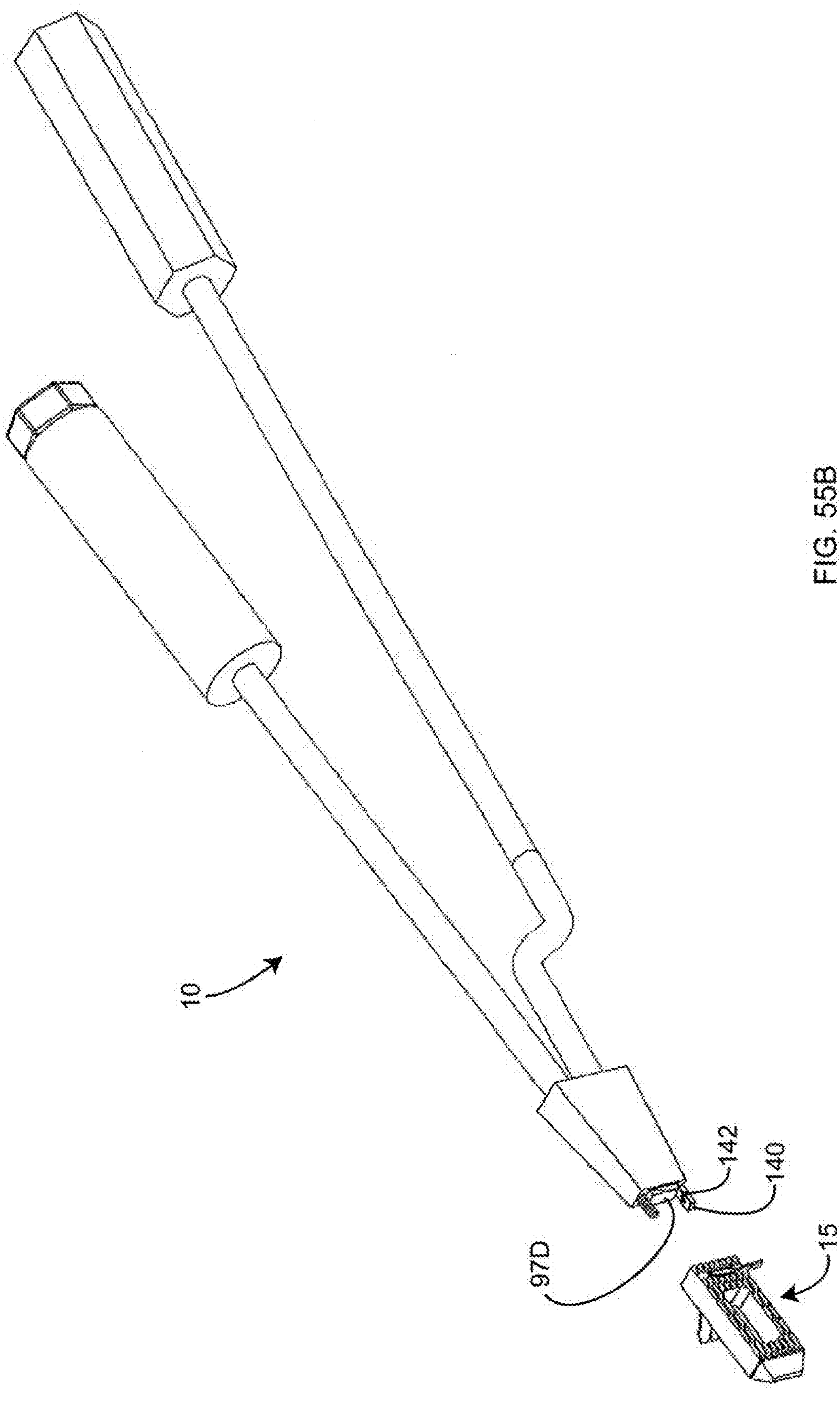

FIG. 55B

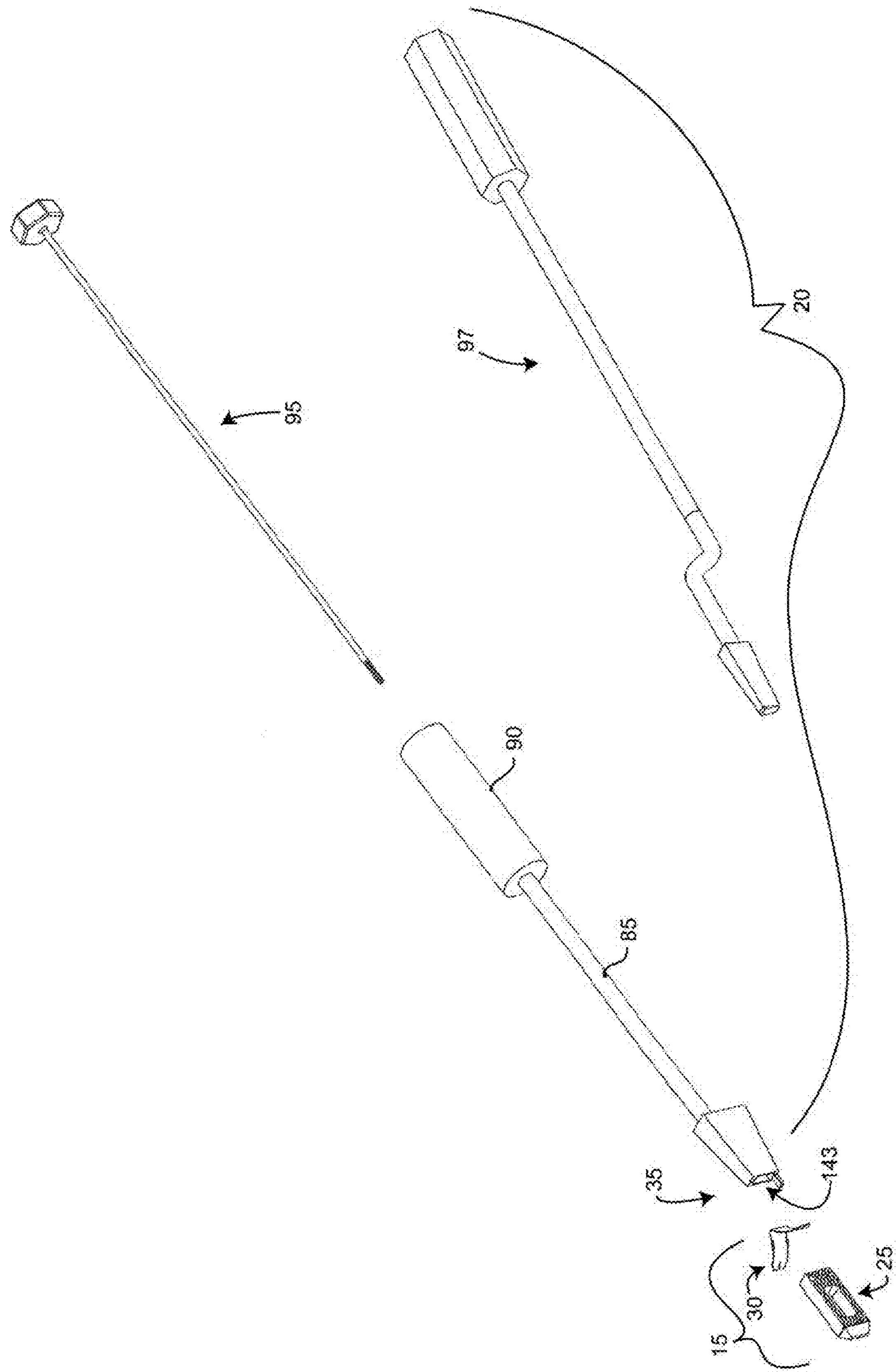

FIG. 56

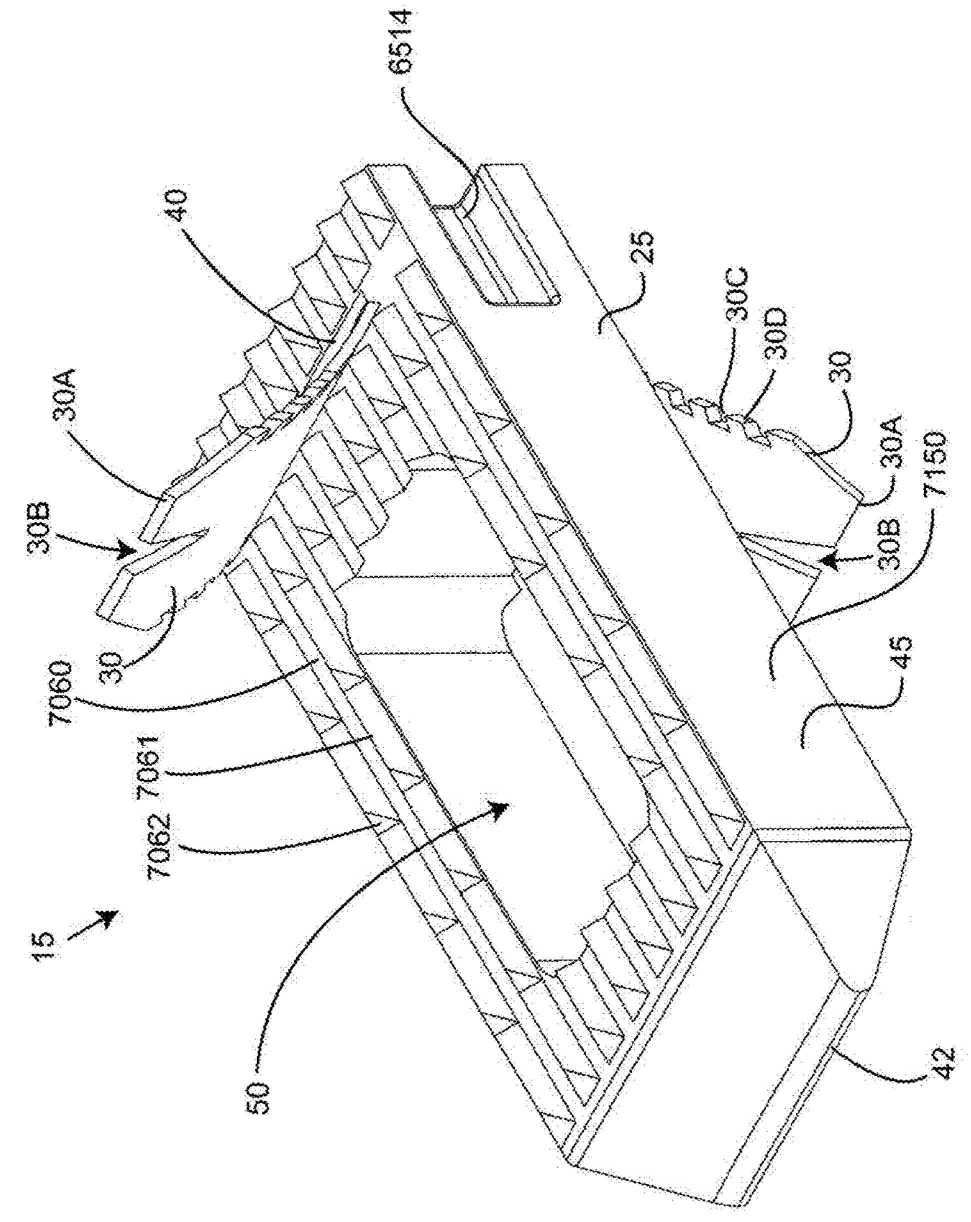
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FIG. 57A

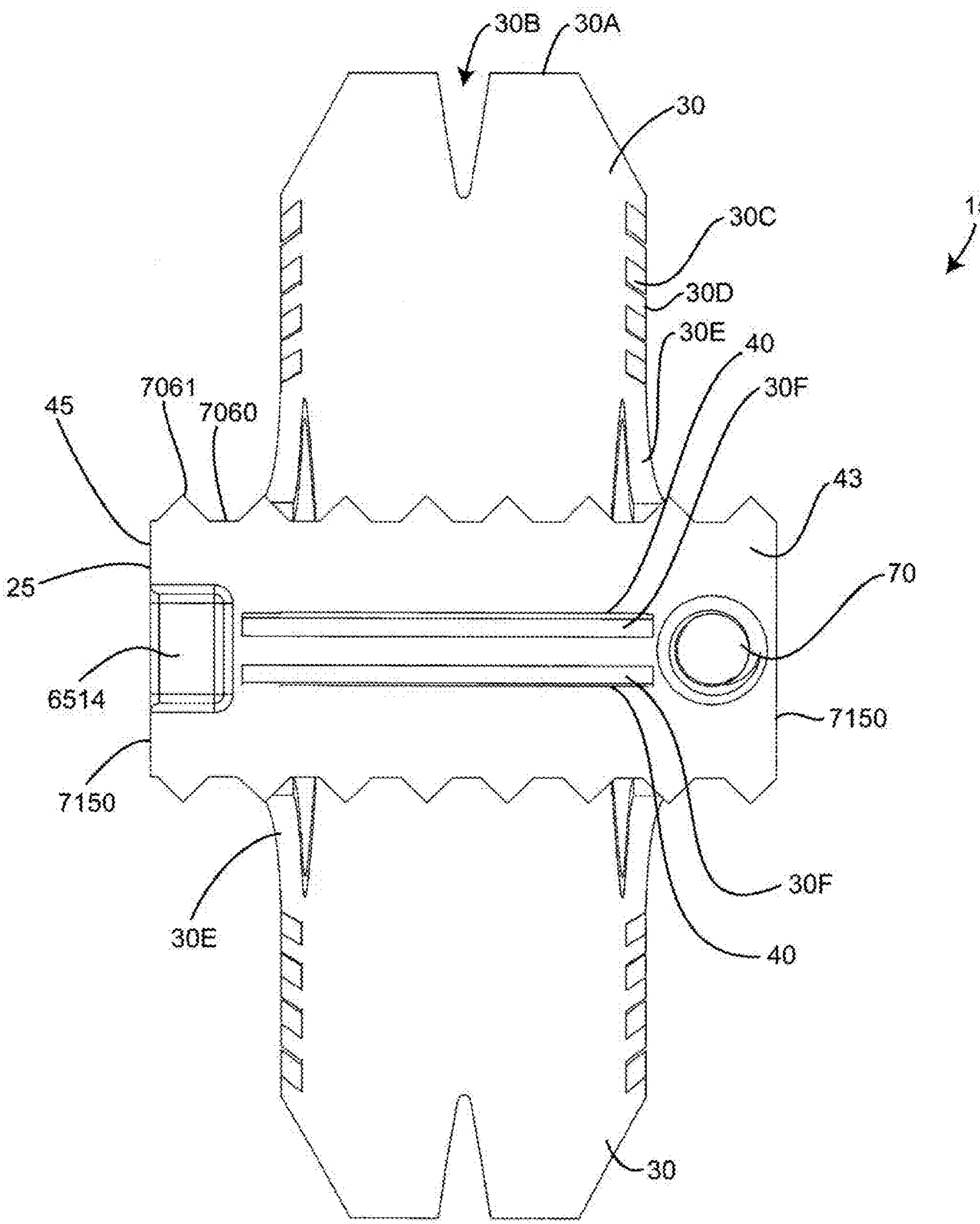
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FIG. 57B

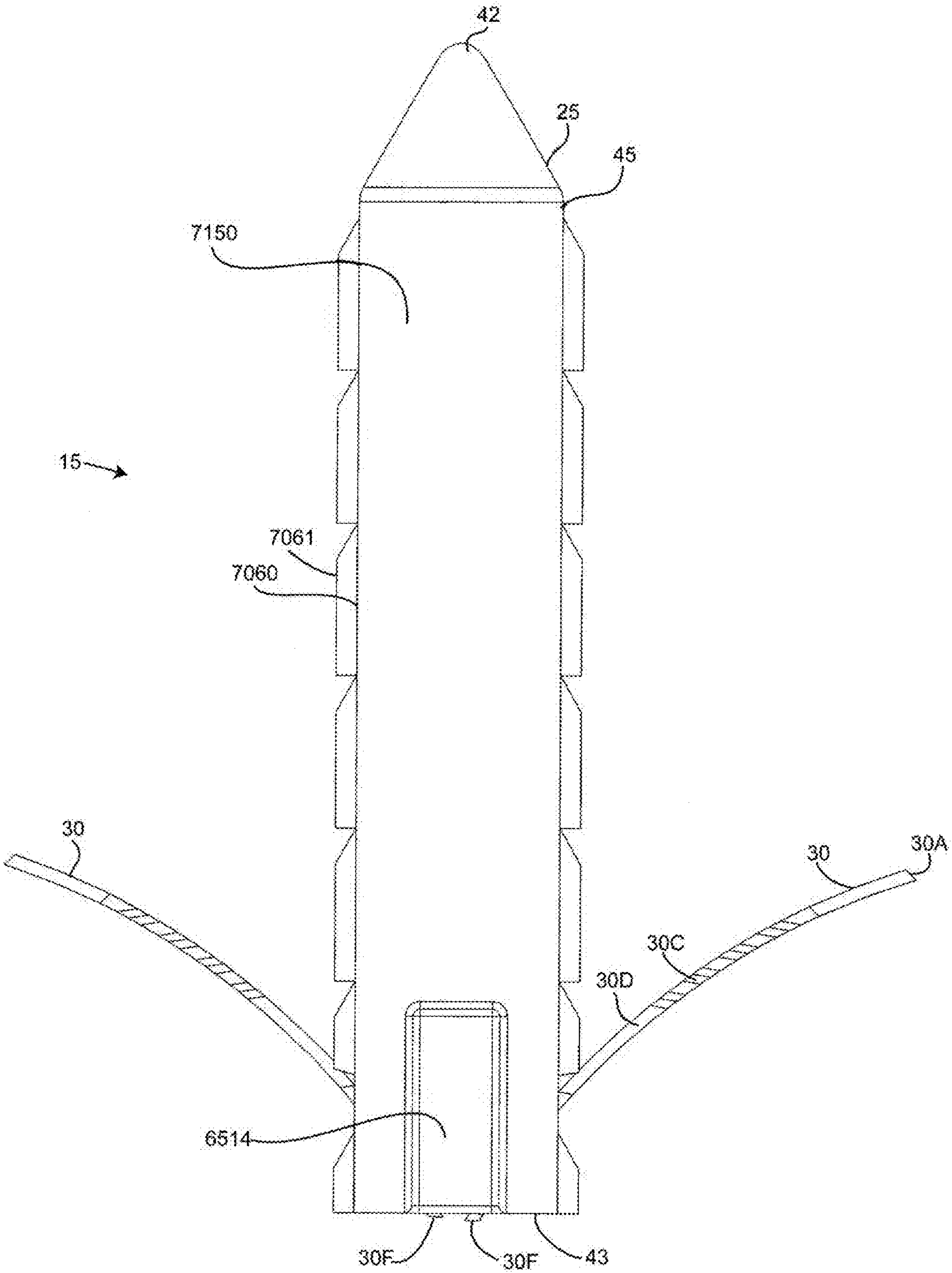

FIG. 57C

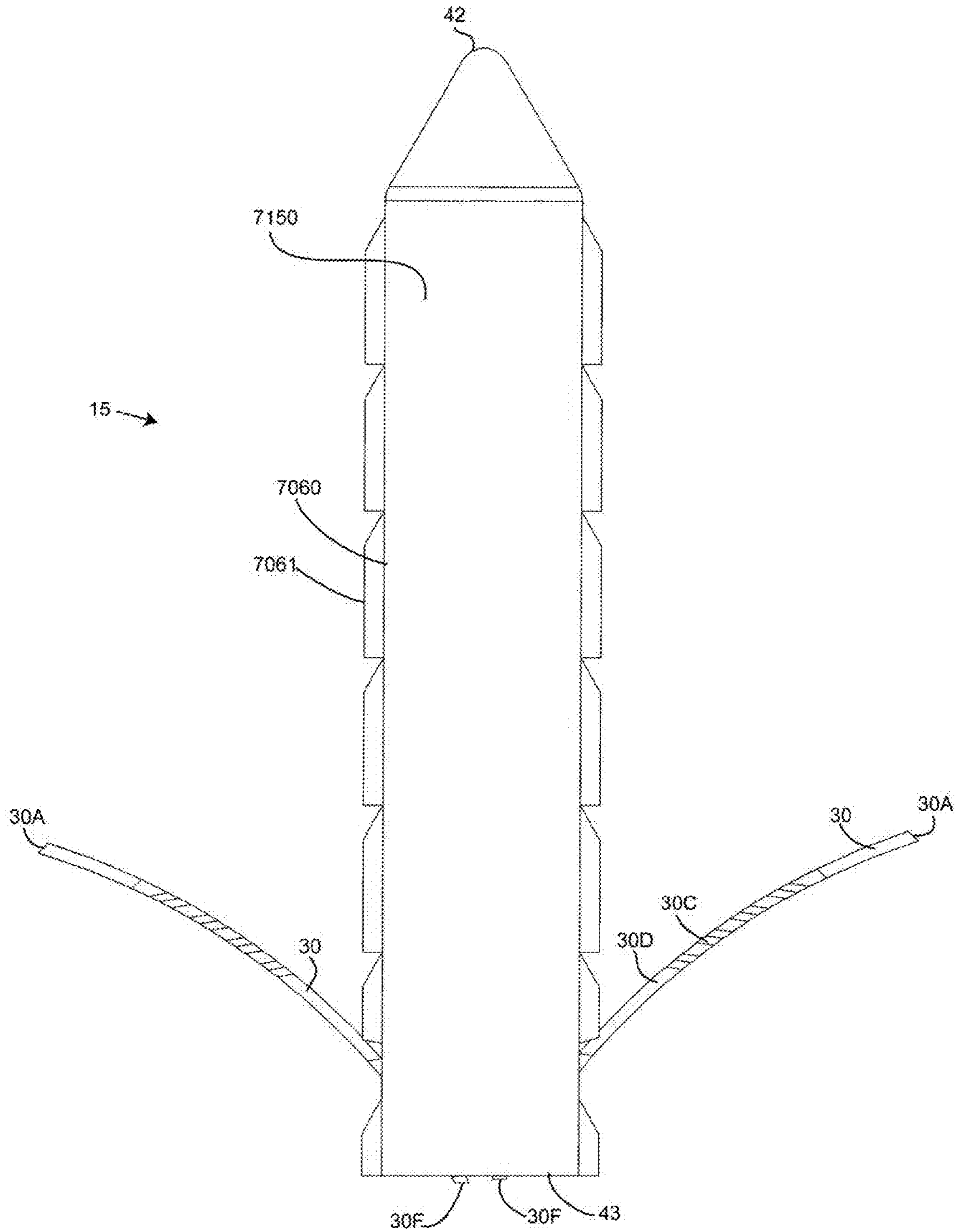

FIG. 57D

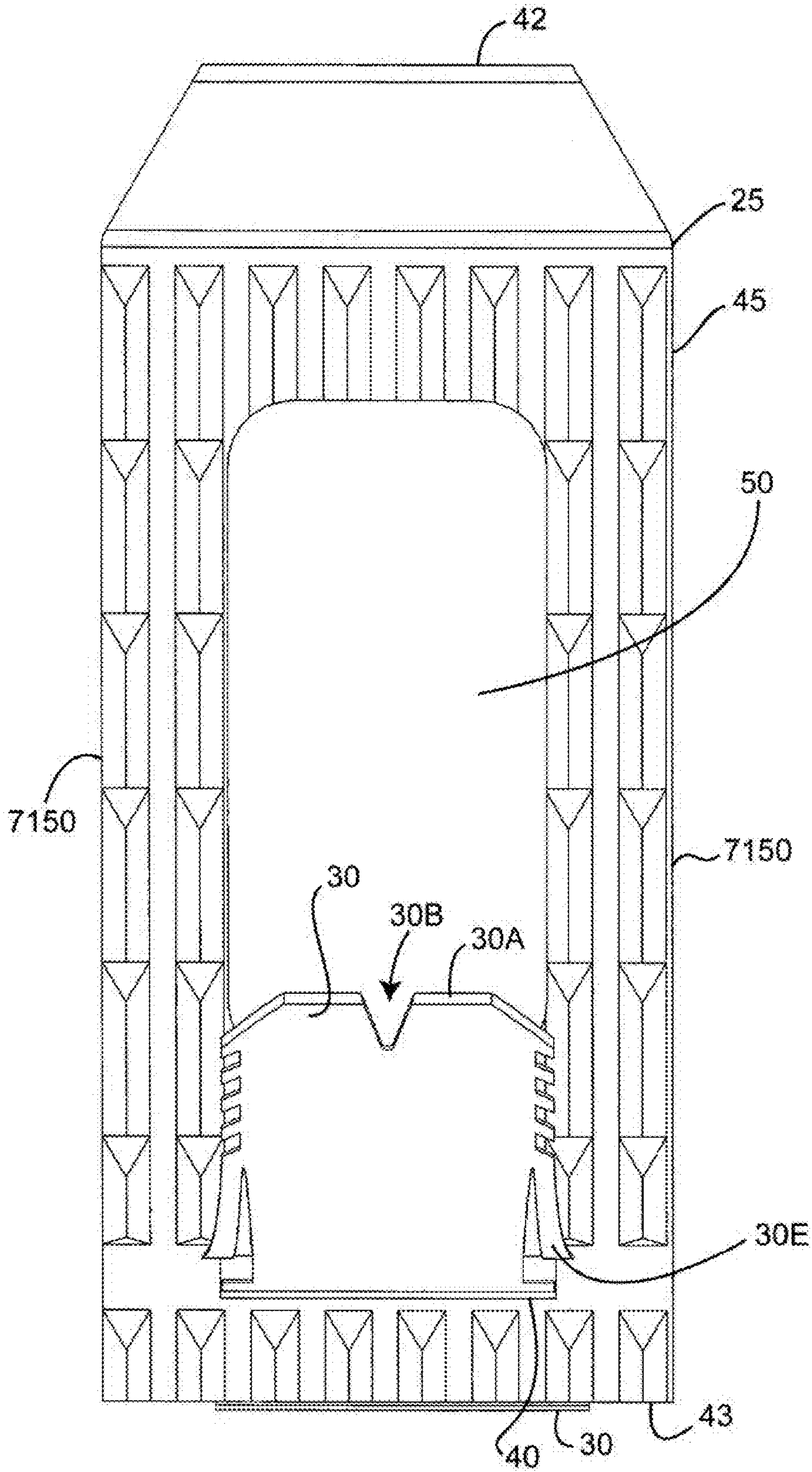

FIG. 57E

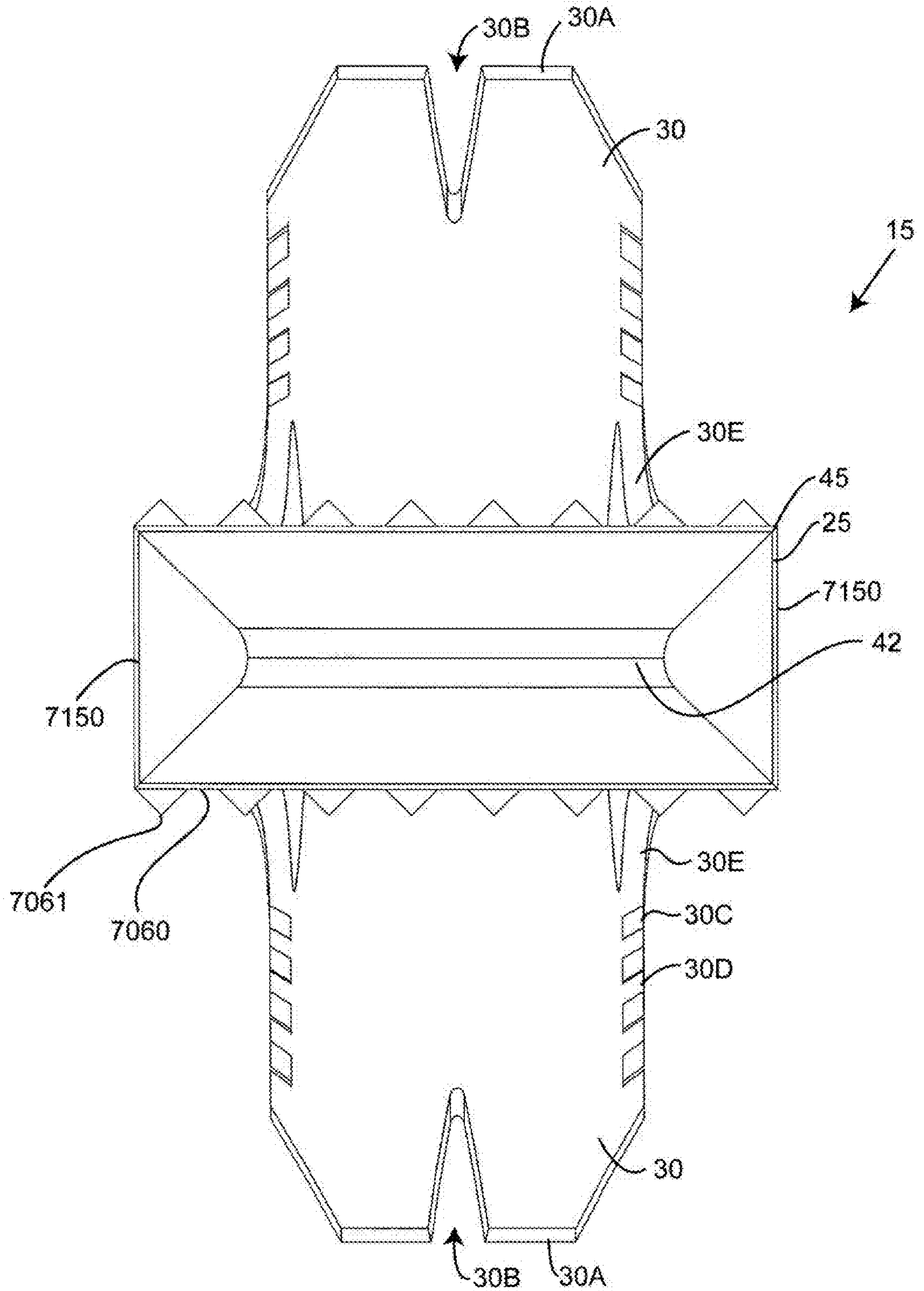
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FIG. 57F

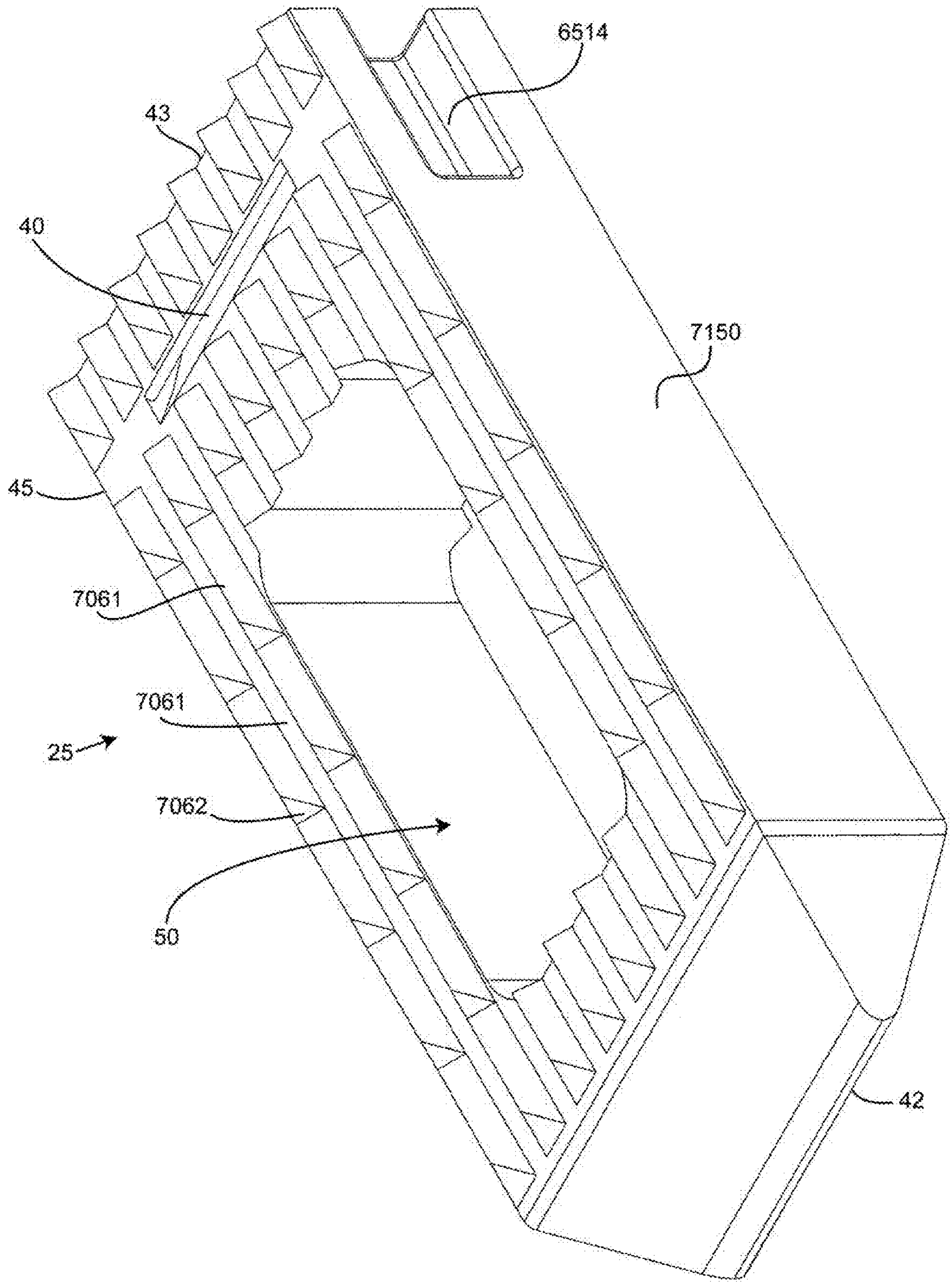

FIG. 58

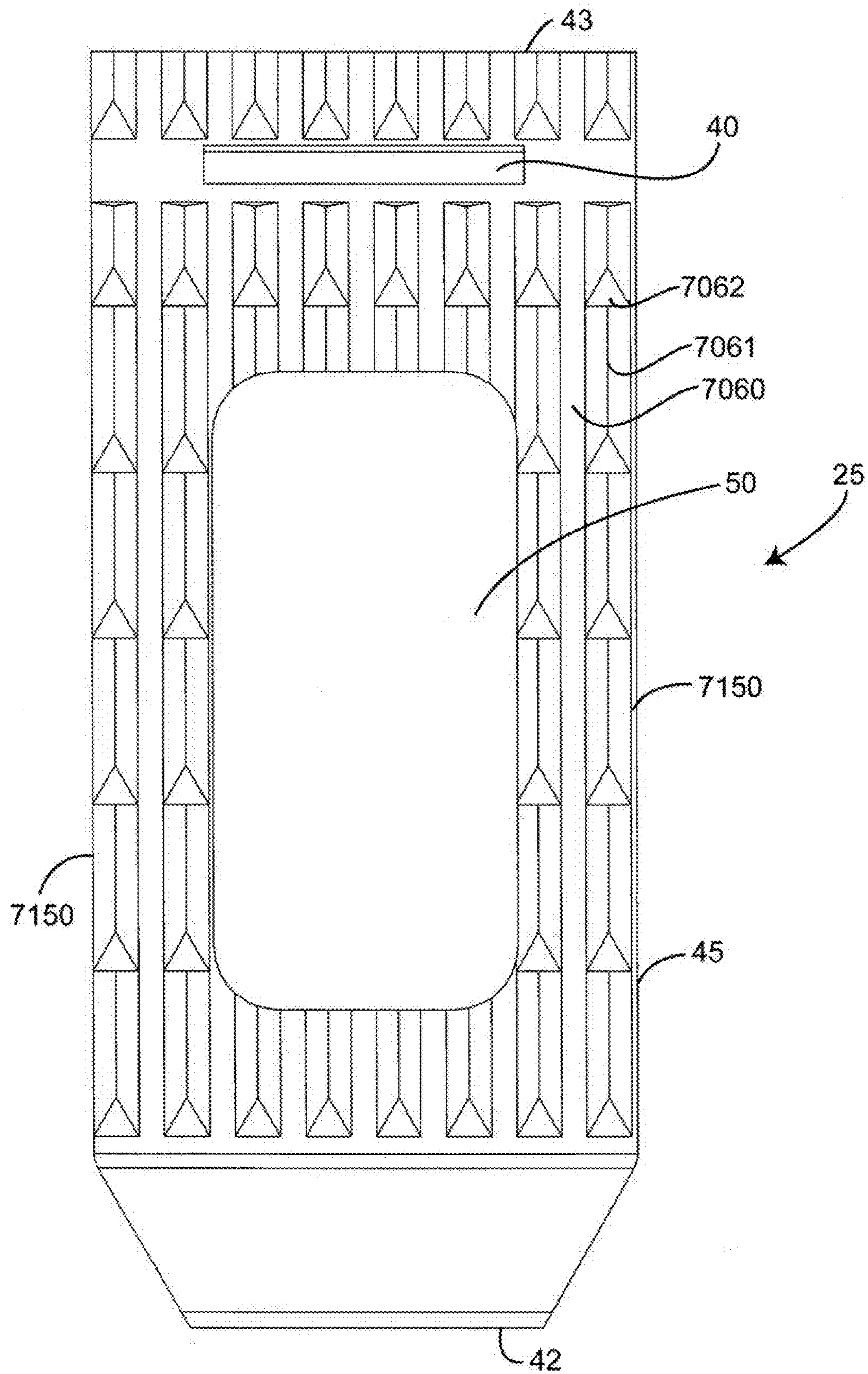

FIG. 59

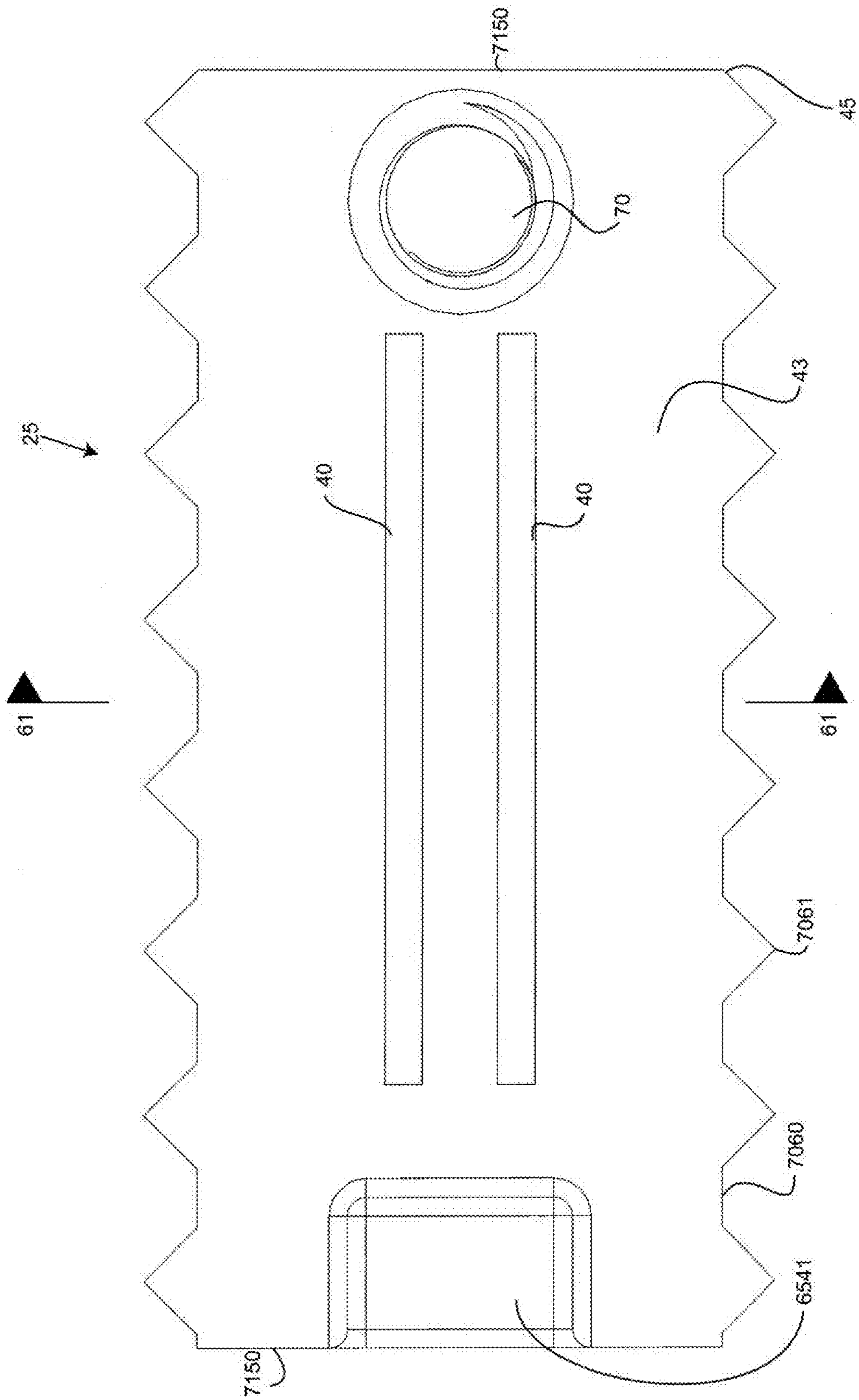

FIG. 60

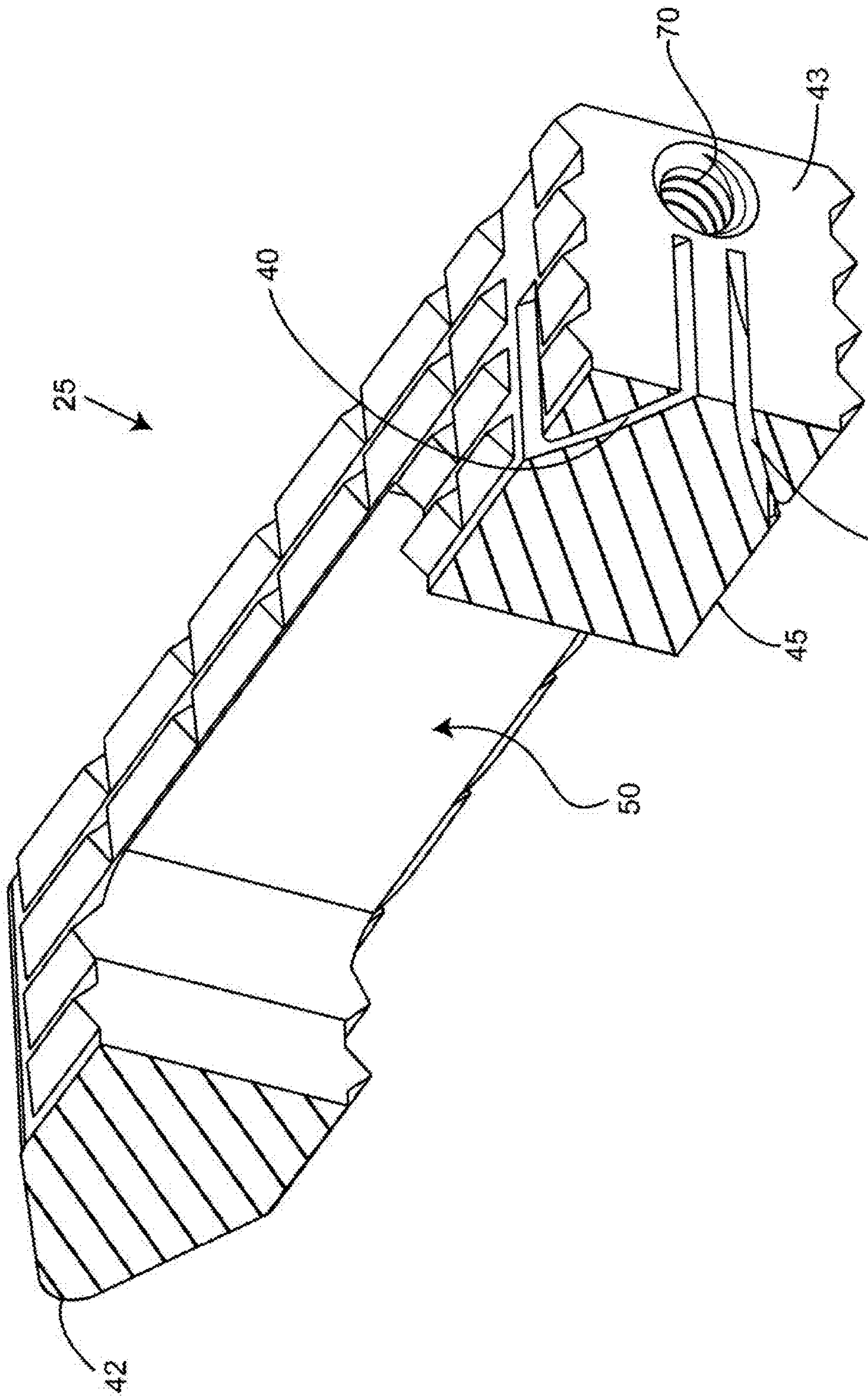

FIG. 61

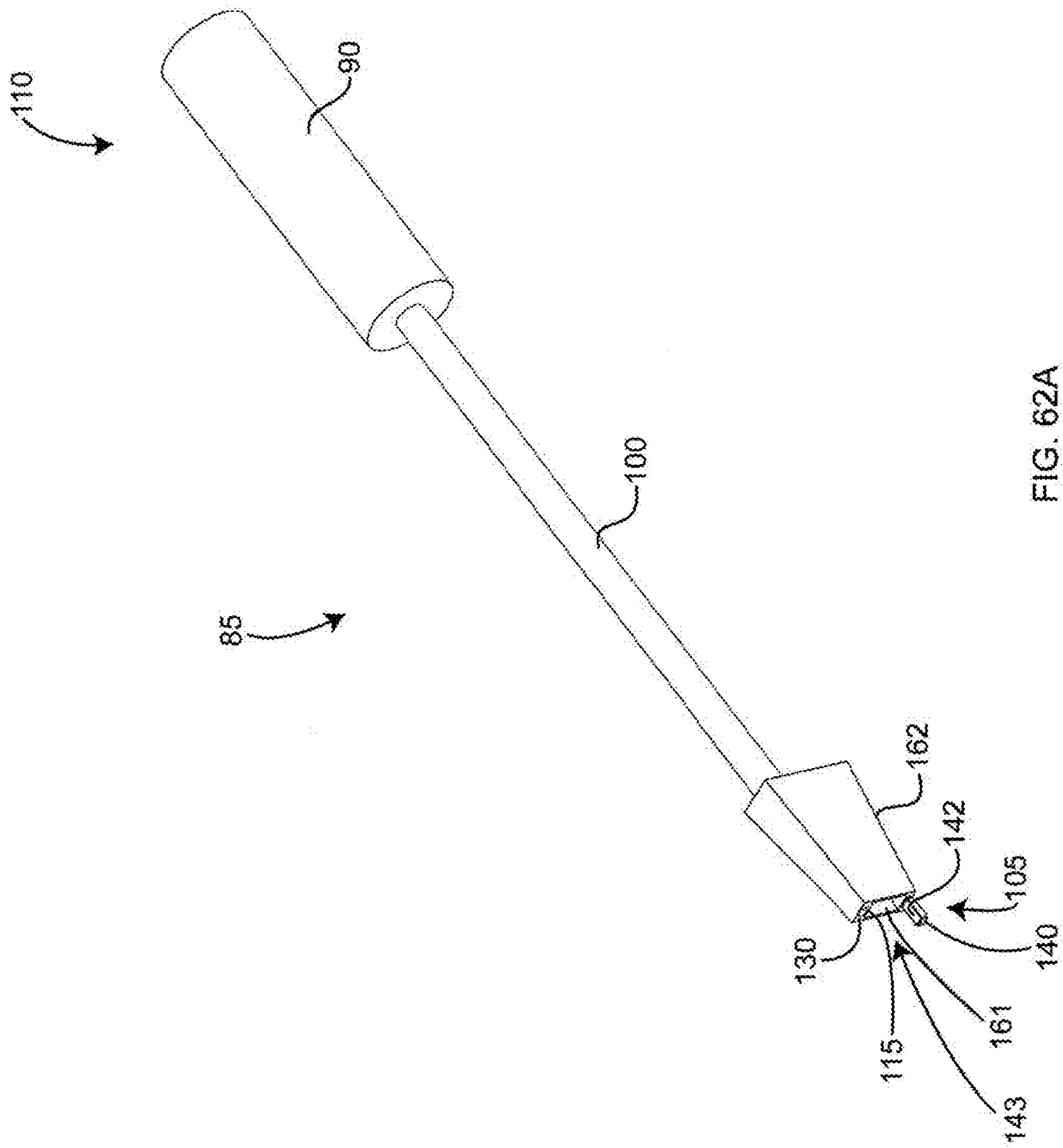

FIG. 62A

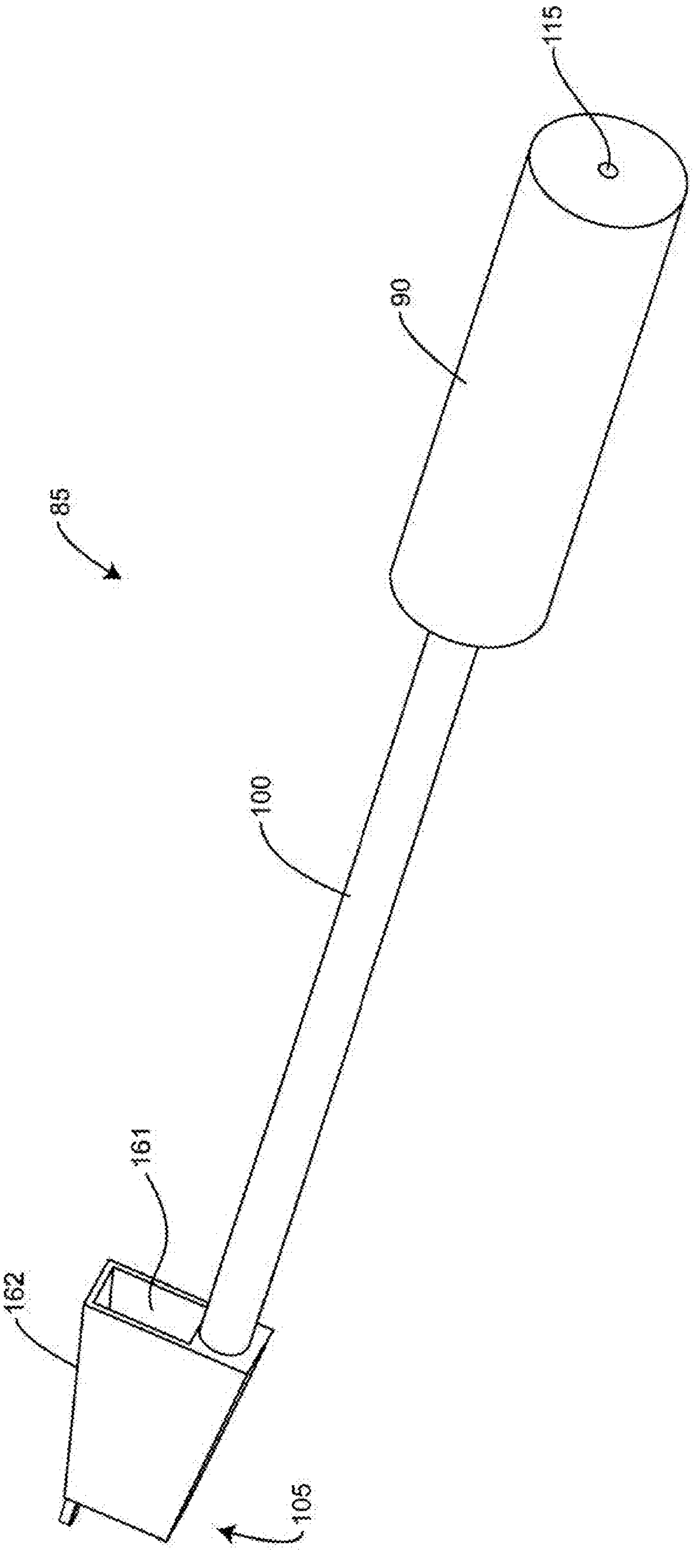

FIG. 62B

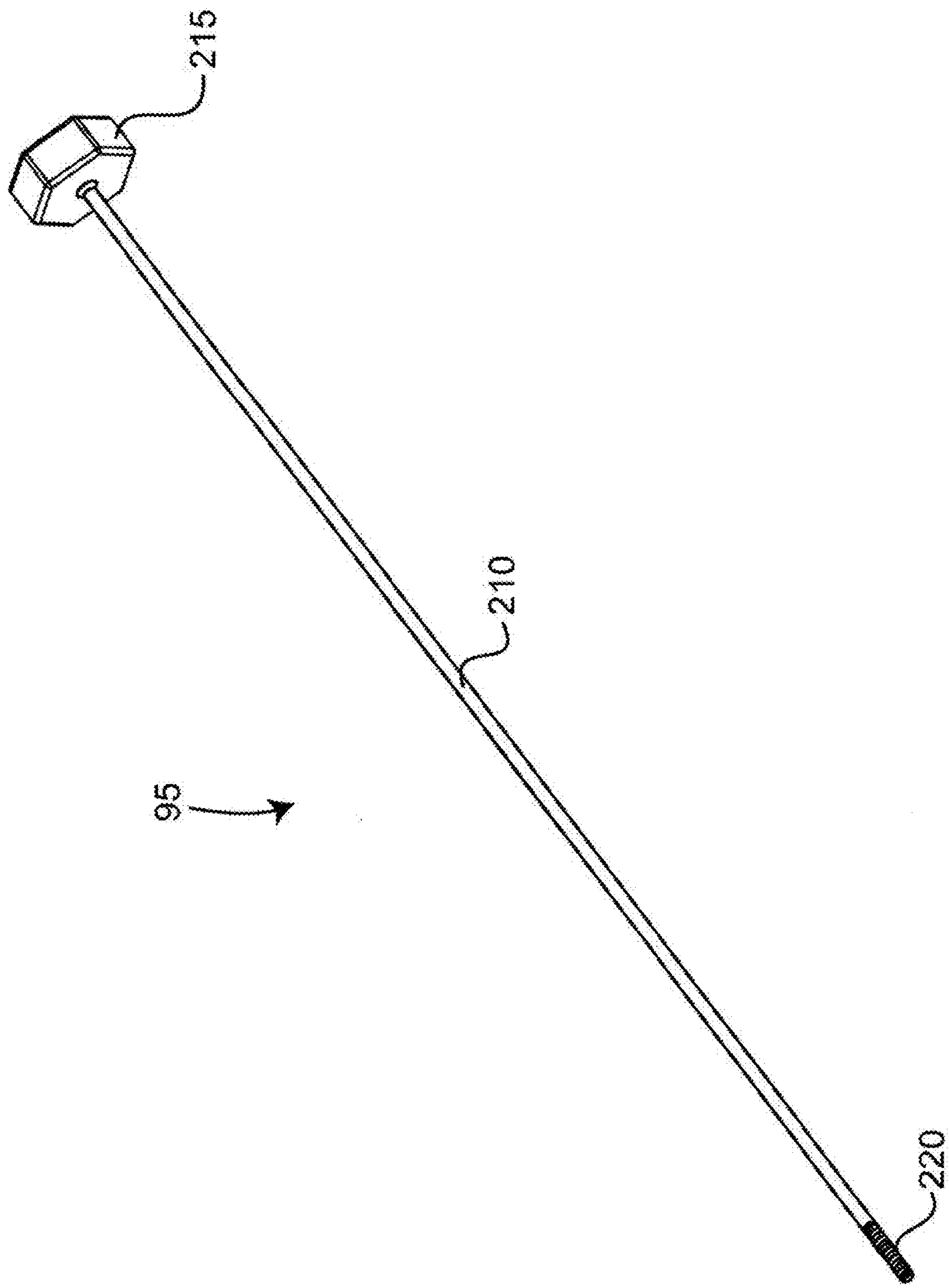

FIG. 63

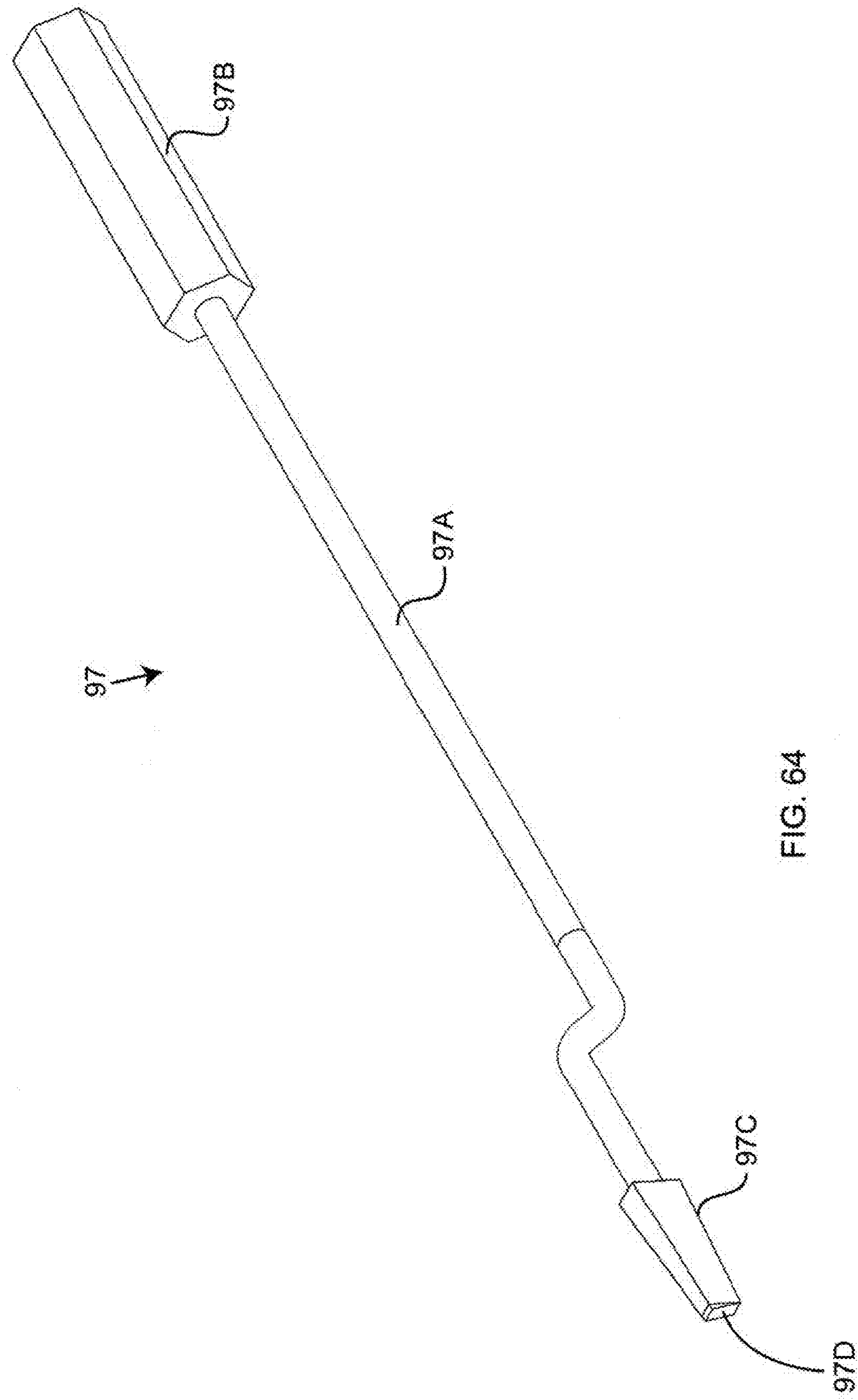

FIG. 64

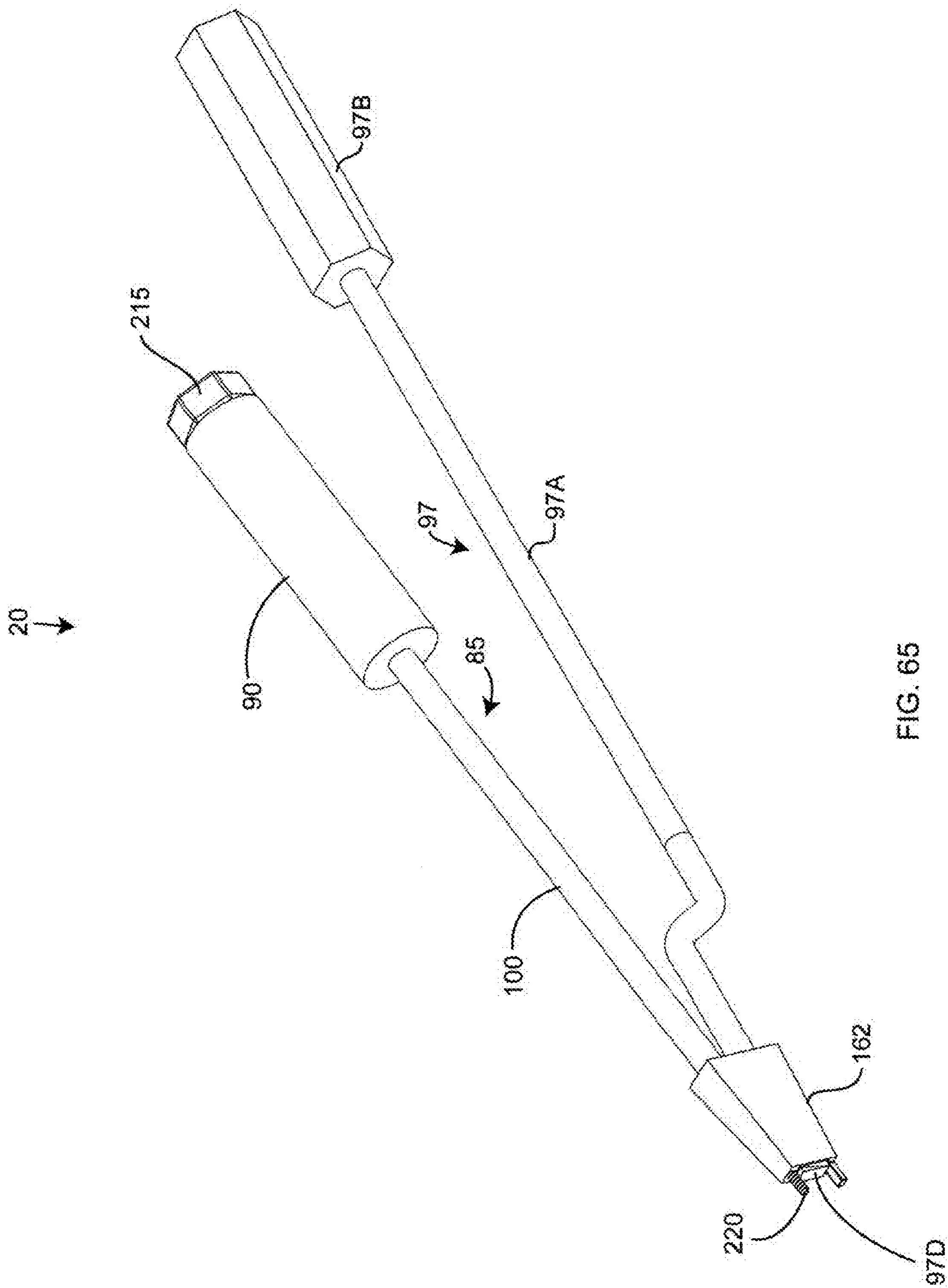

FIG. 65

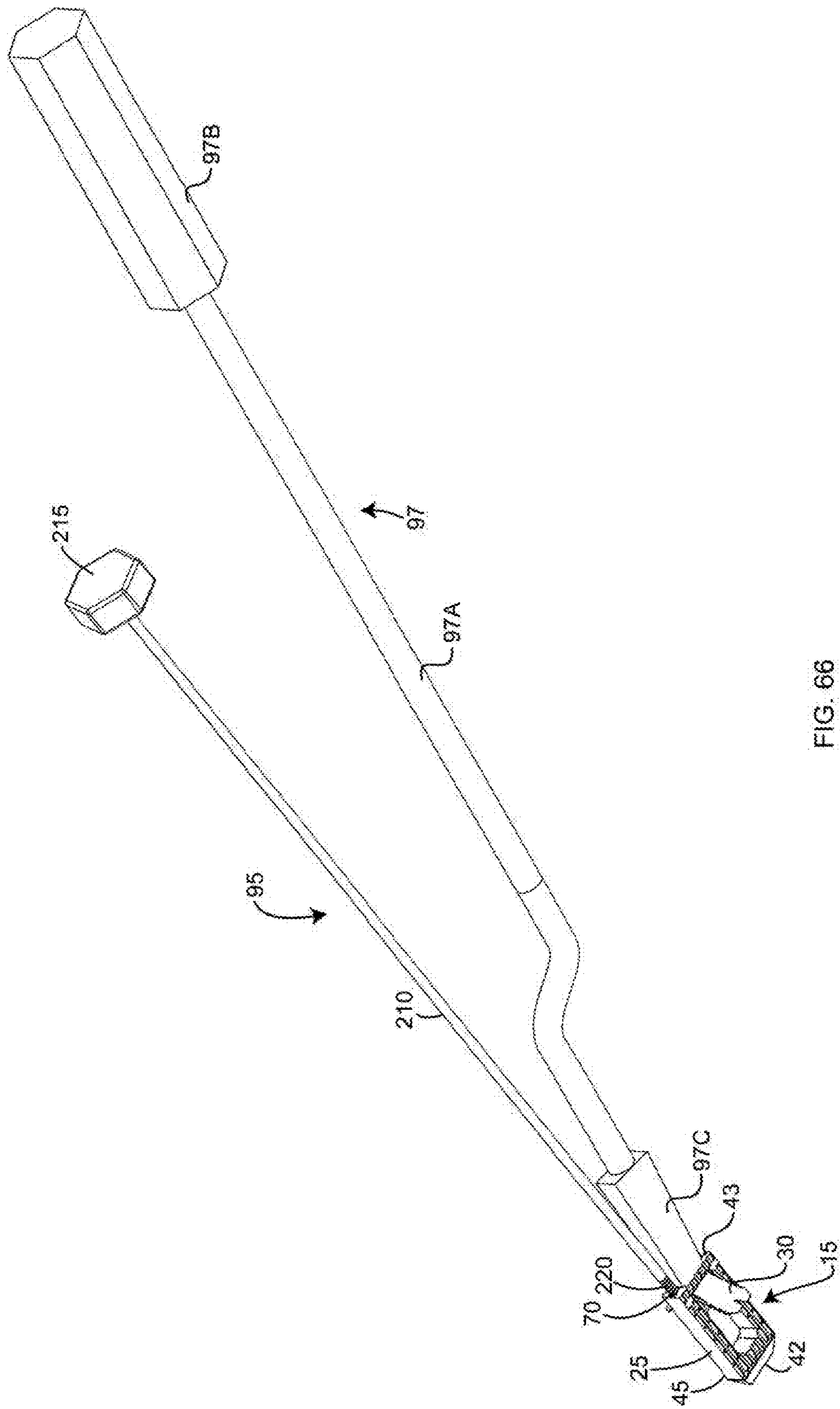

FIG. 66

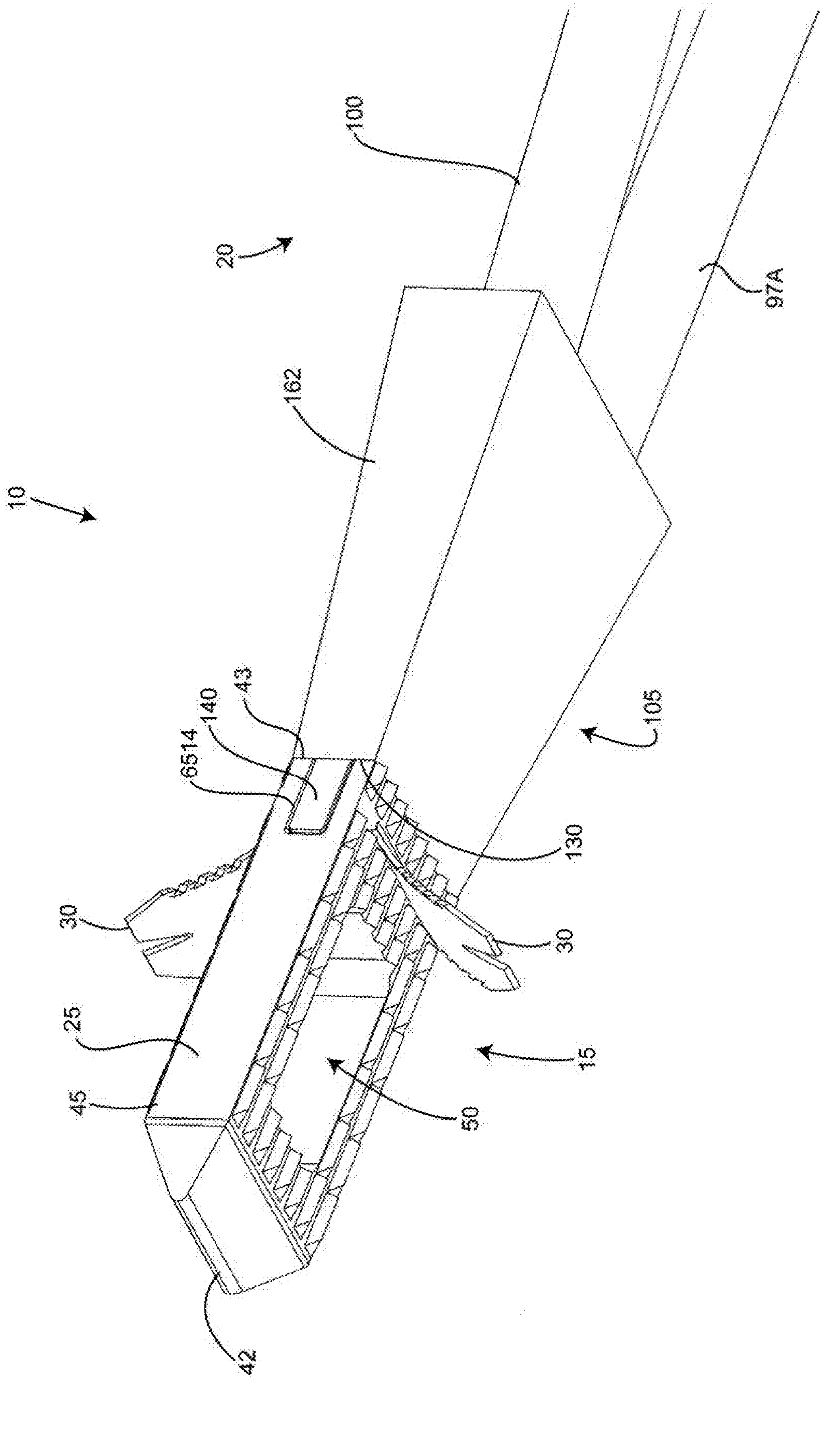

FIG. 67

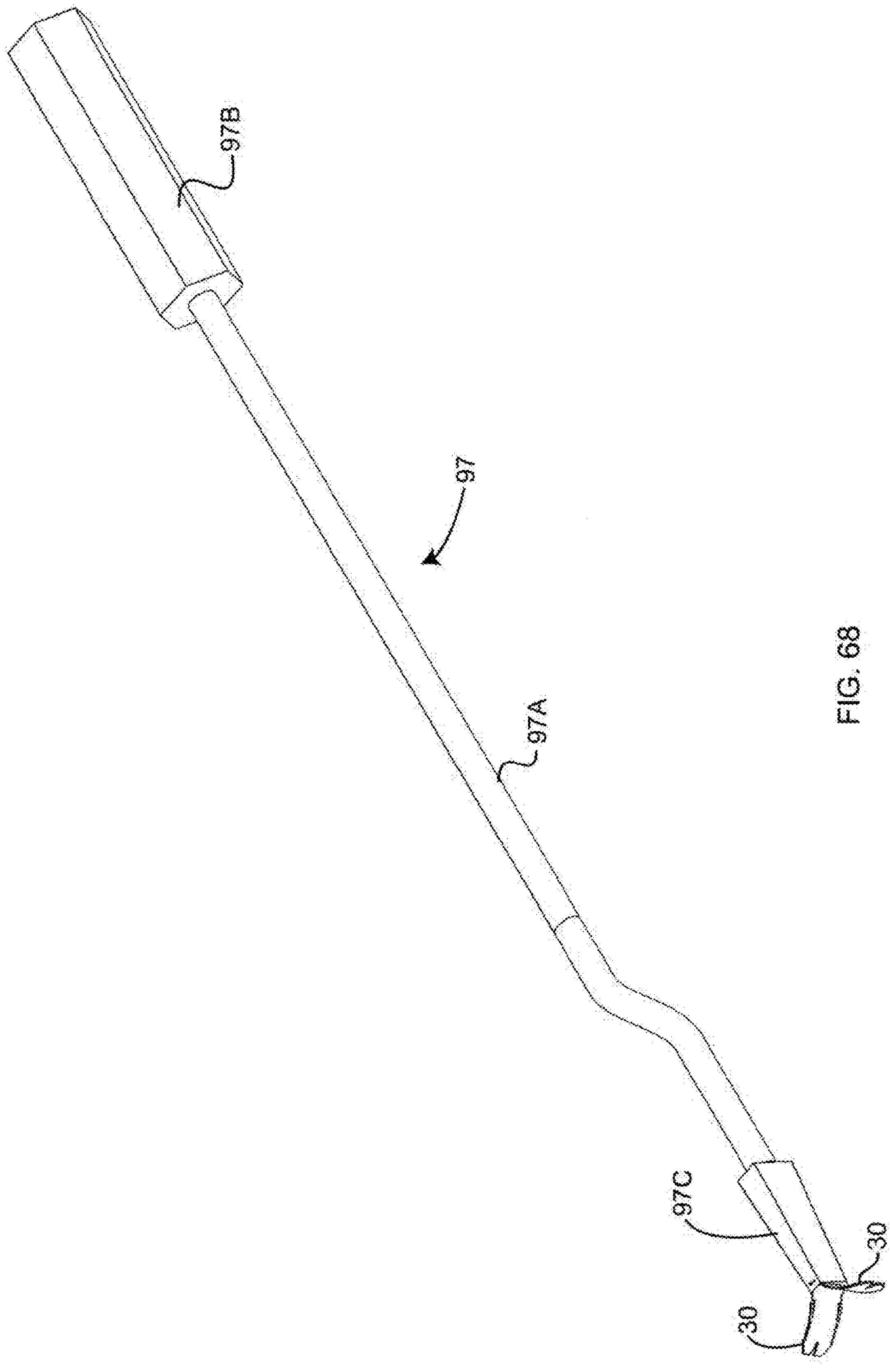

FIG. 68

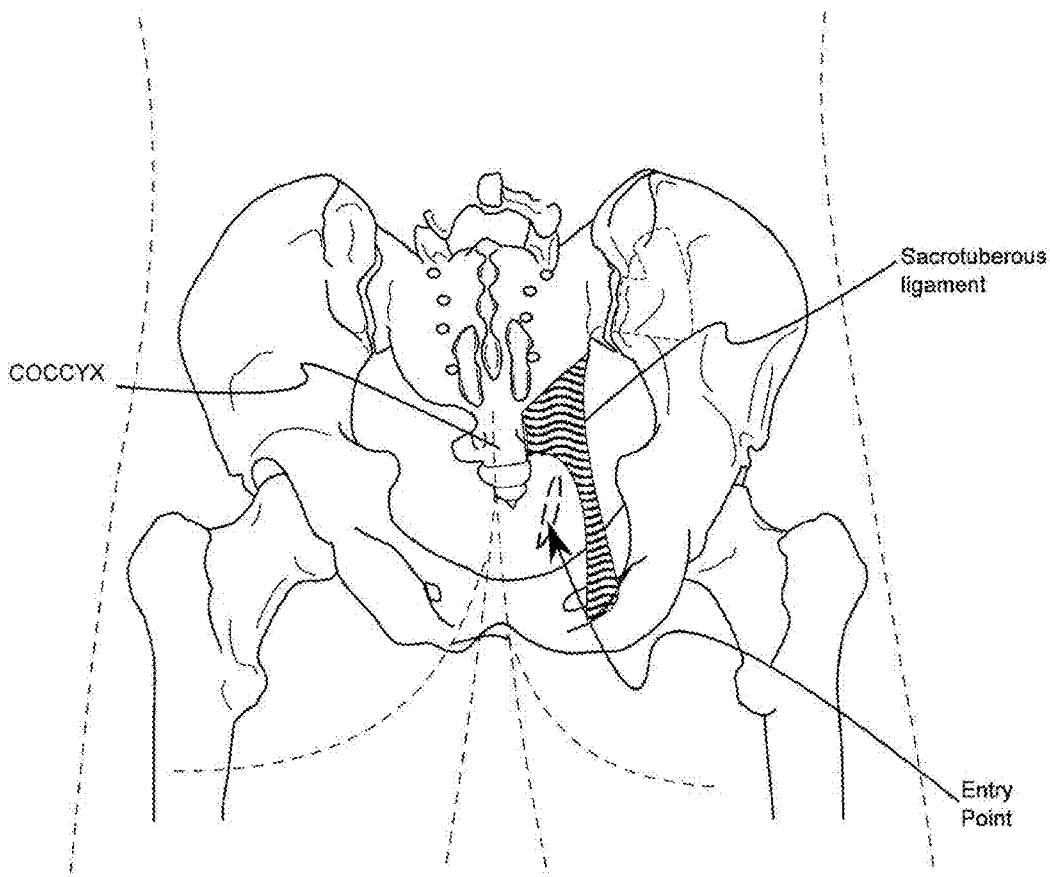

FIG. 69

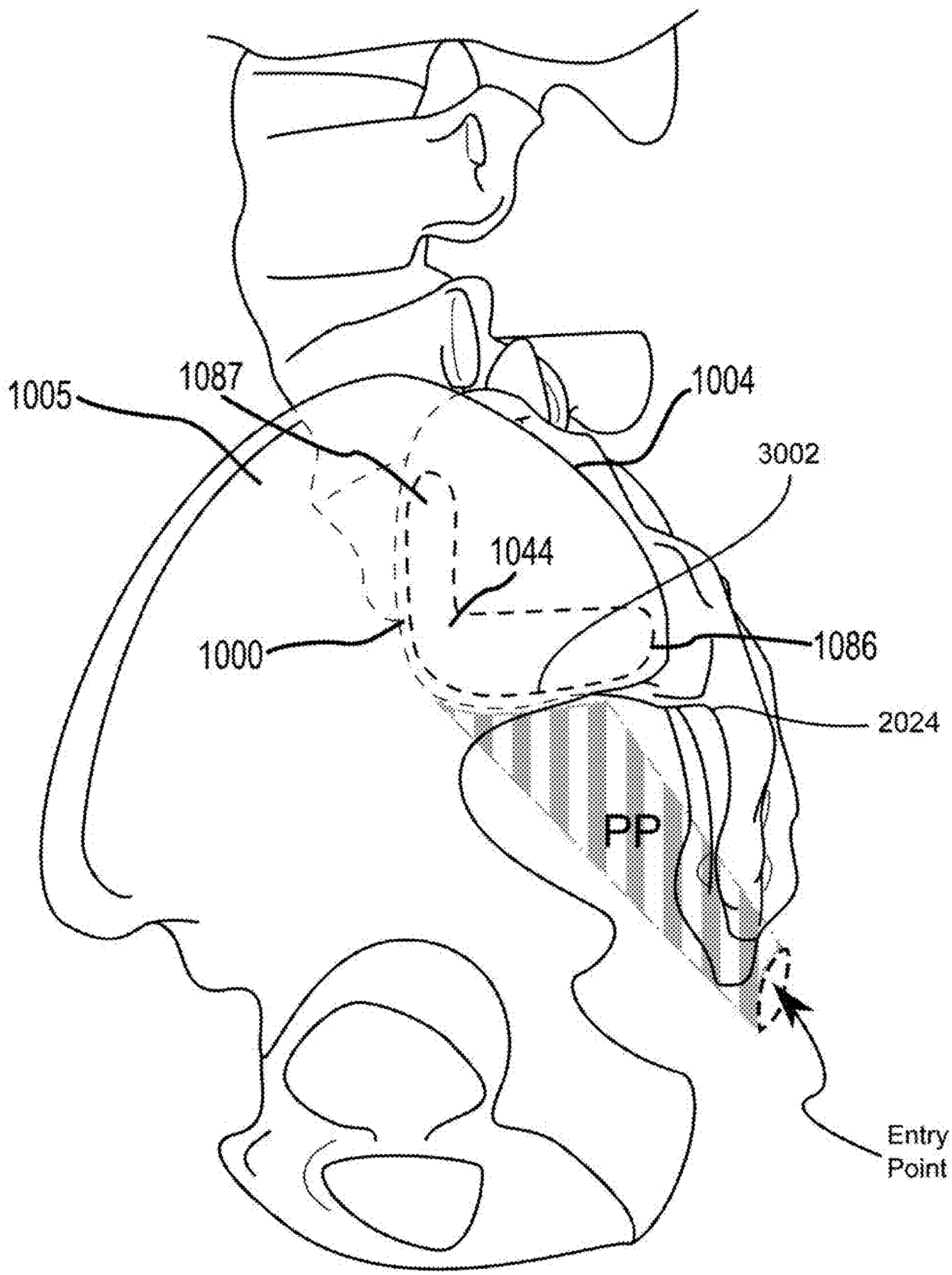

FIG. 70

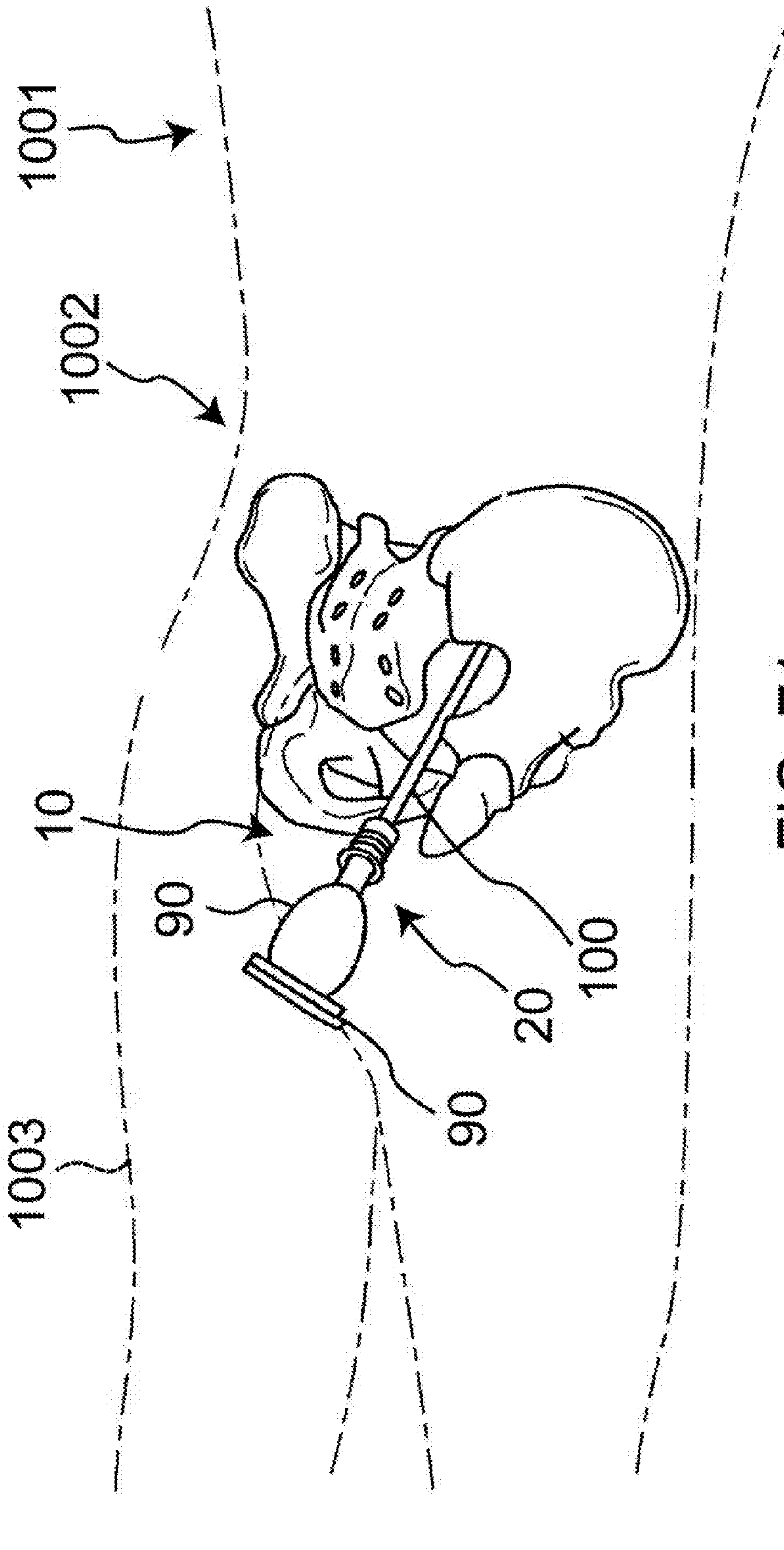

FIG. 71

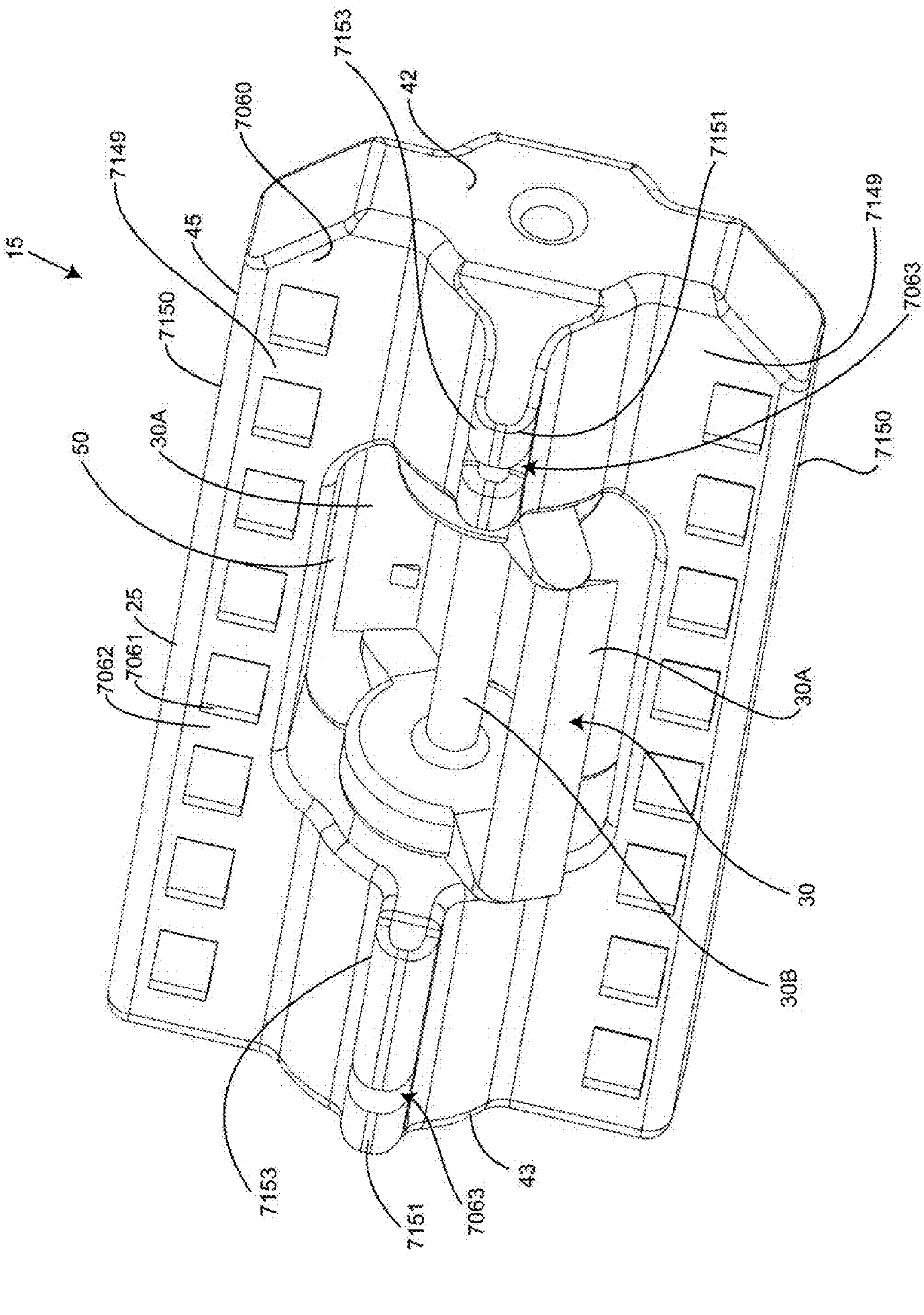
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FIG. 72

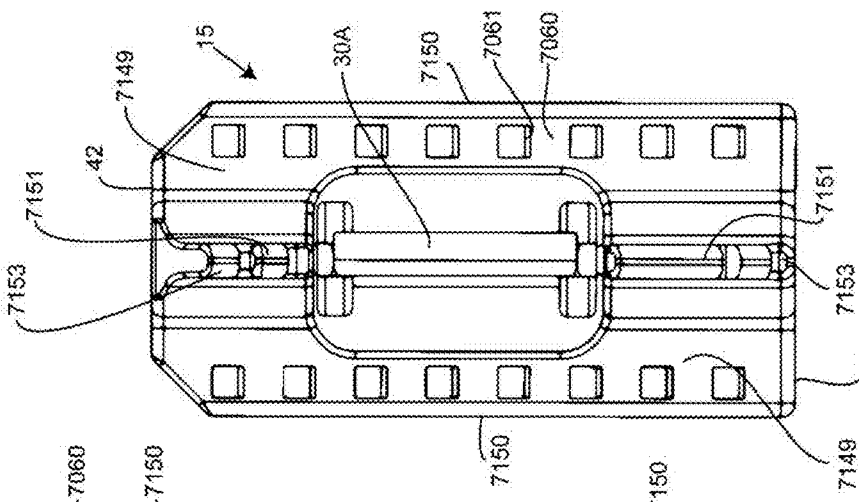

FIG. 74

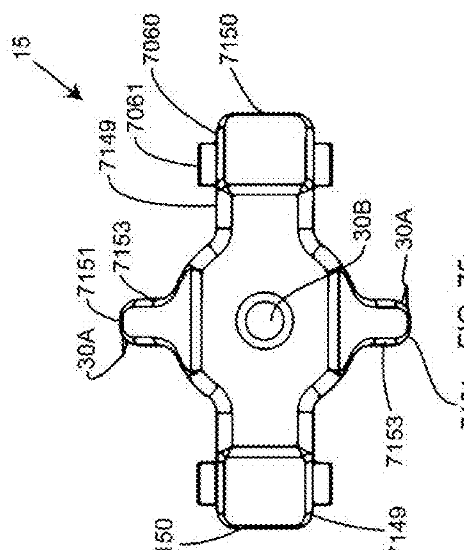

FIG. 75

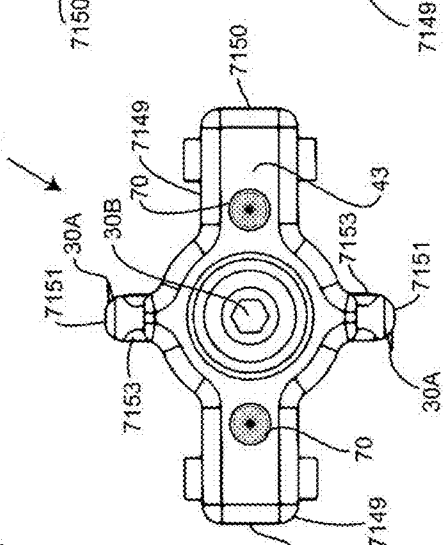

FIG. 76

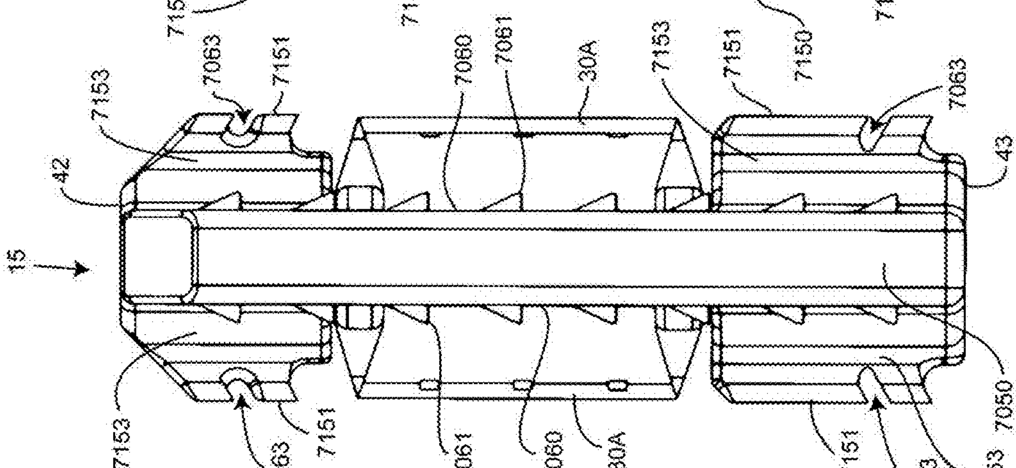

FIG. 73

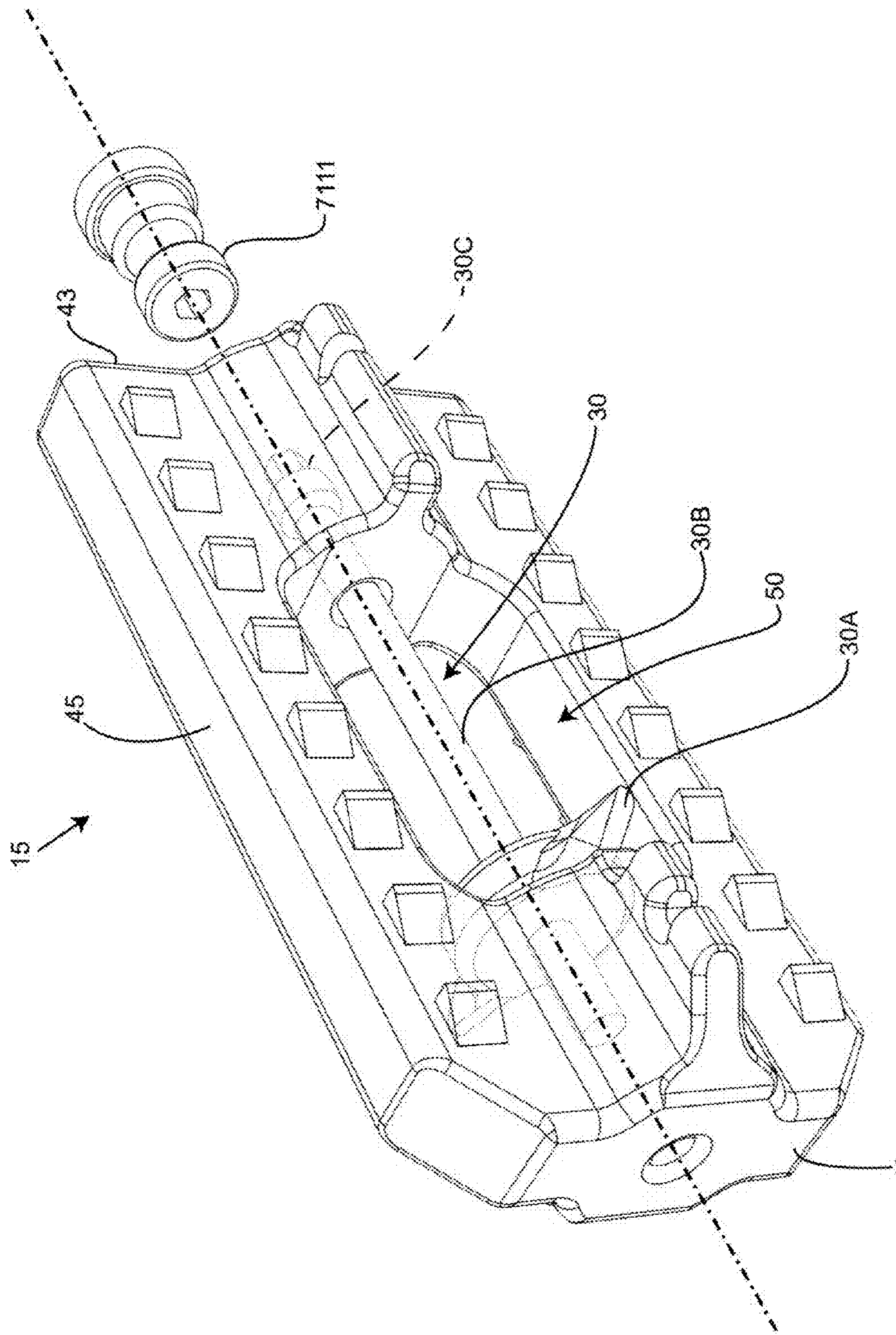

FIG. 77

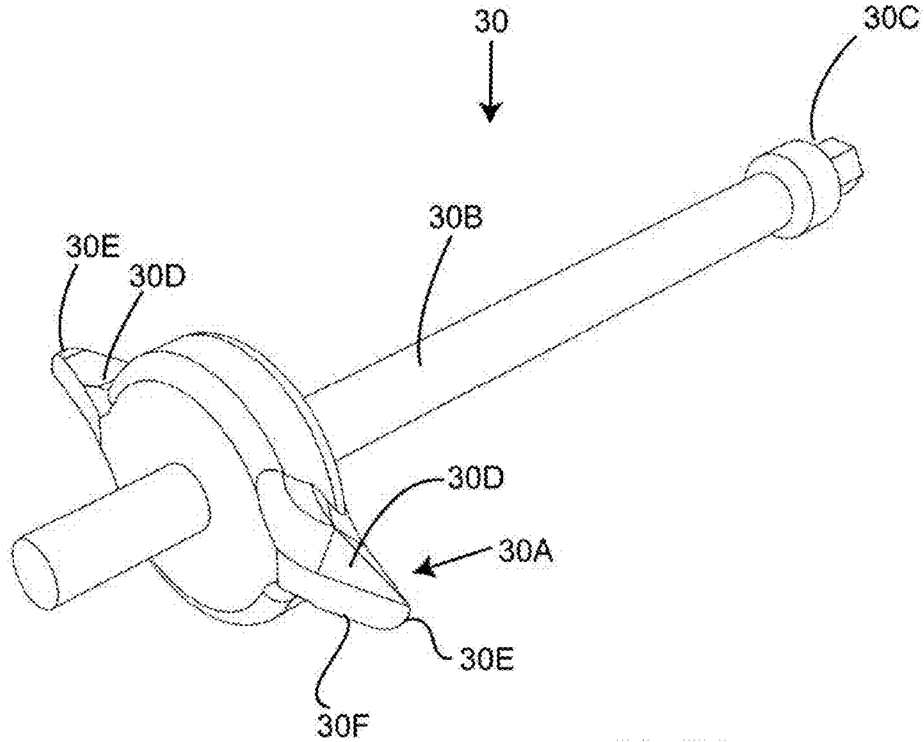
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FIG. 79

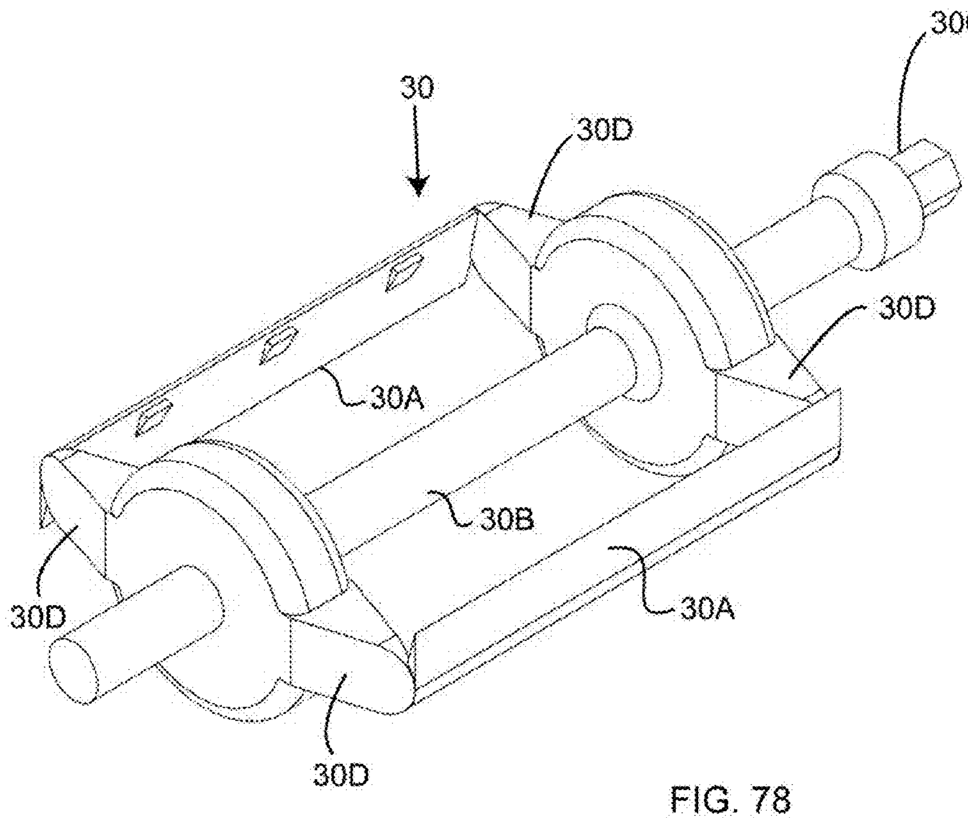
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FIG. 78

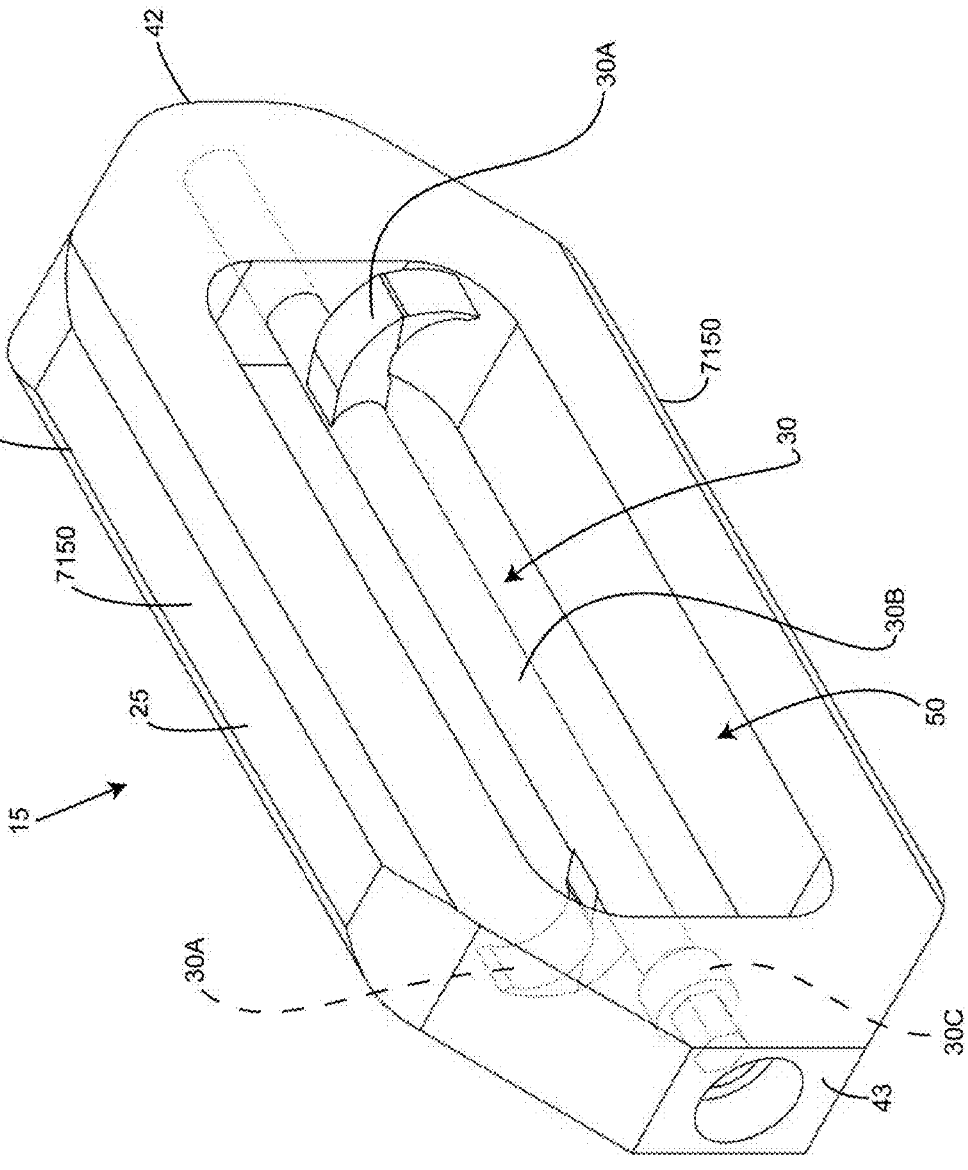

FIG. 80

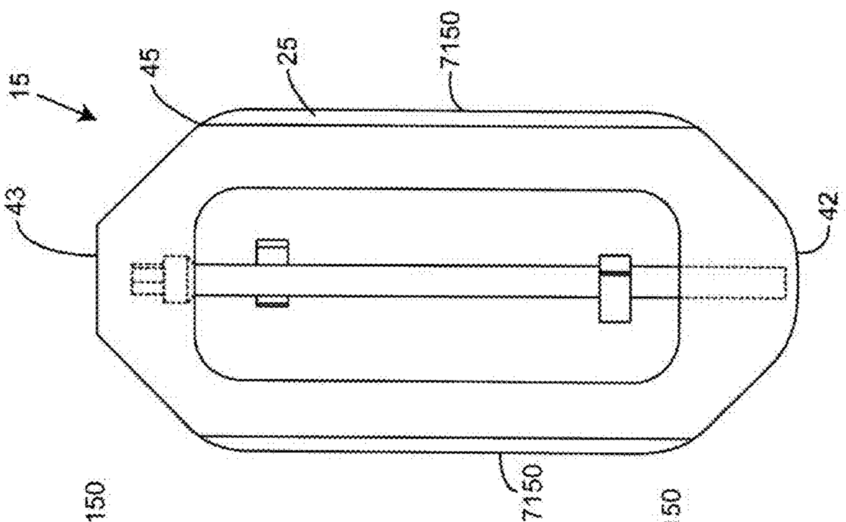

FIG. 82

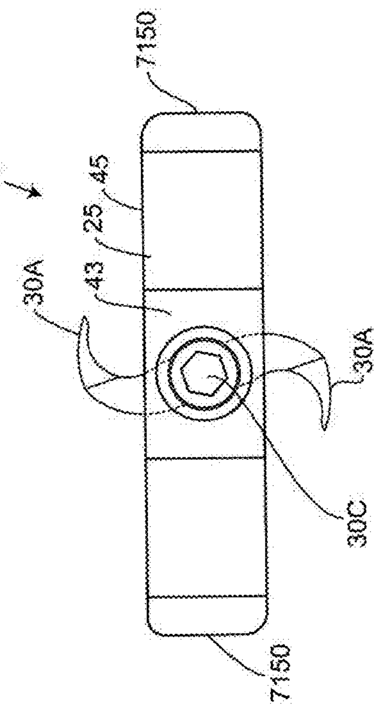

FIG. 84

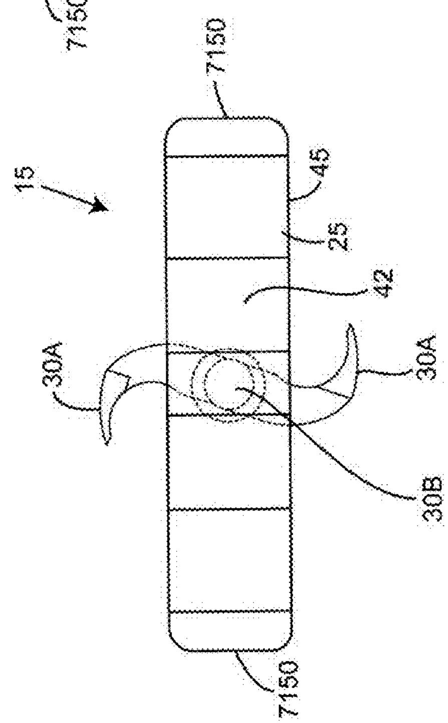

FIG. 83

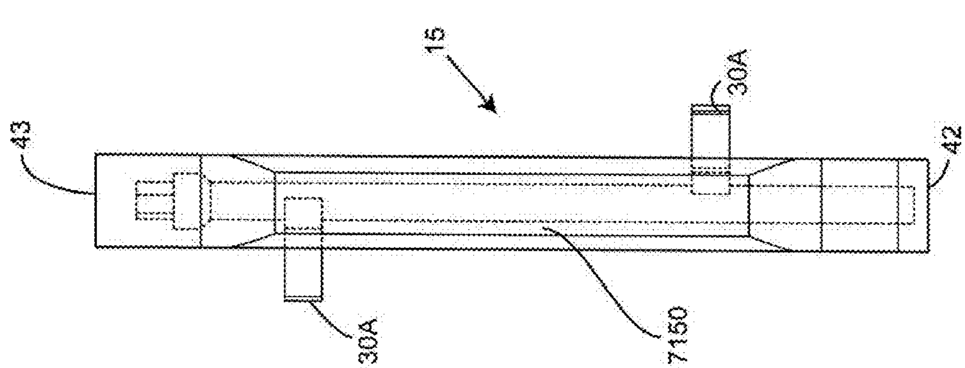

FIG. 81

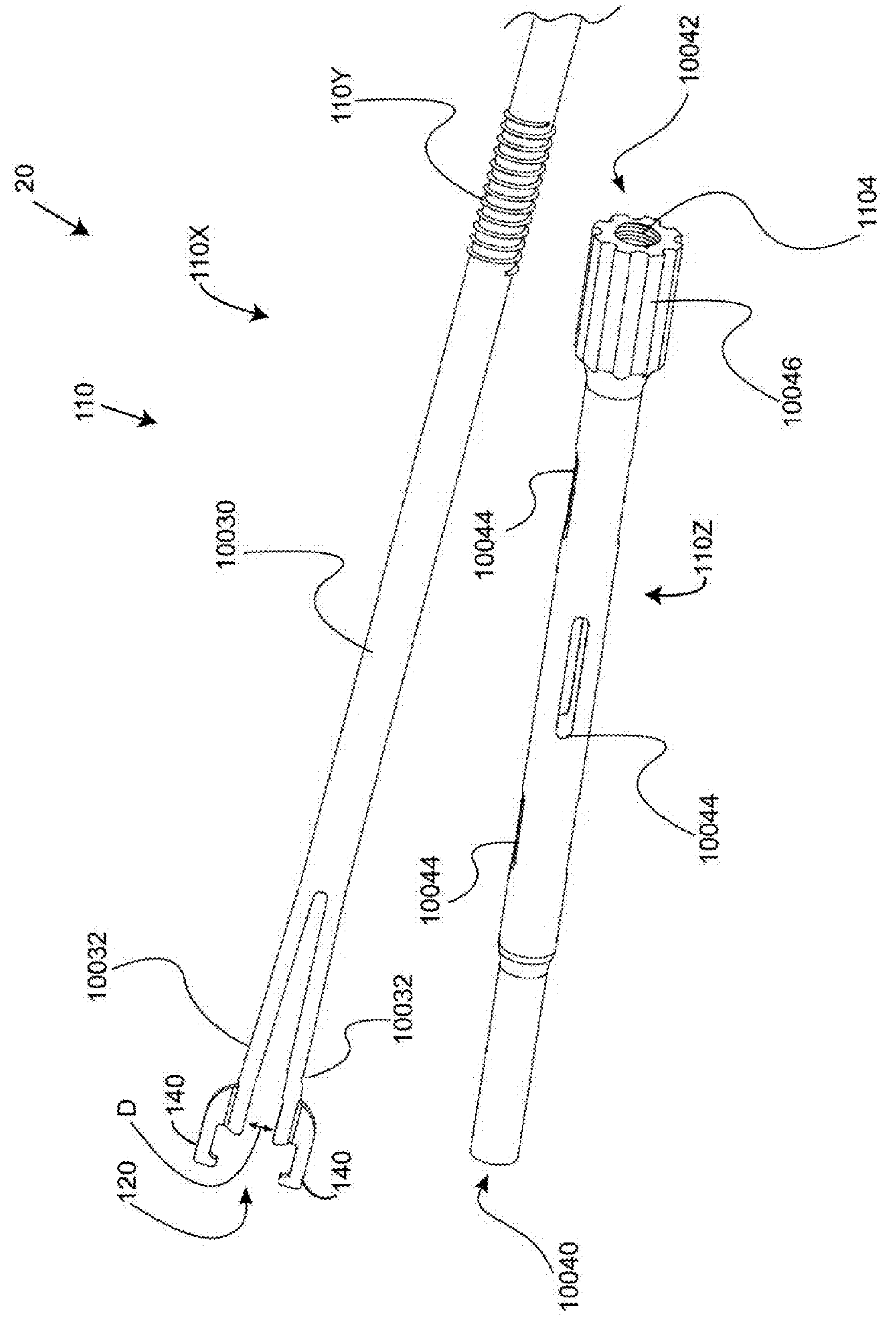
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FIG. 85

METHODS OF FUSING A SACROILIAC JOINT

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a divisional application of U.S. application Ser. No. 13/945,053 filed Jul. 18, 2013, which application claims priority to U.S. Provisional Patent Application 61/674,130, which was filed Jul. 20, 2012.

Application Ser. No. 13/945,053 is a continuation-in-part application of U.S. patent application Ser. No. 13/475,695, filed May 18, 2012, now U.S. Pat. No. 9,381,045, which application is a continuation-in-part application of U.S. patent application Ser. No. 13/236,411, filed Sep. 19, 2011, now U.S. Pat. No. 9,017,407, which application is a continuation-in-part of U.S. patent application Ser. No. 12/998,712 ("the '712 application"), which was filed May 23, 2011, now U.S. Pat. No. 8,979,928. The '712 application is the National Stage of International Patent Cooperation Treaty Patent Application PCT/US2011/000070 (the "PCT application"), which was filed Jan. 13, 2011. The PCT application claims the benefit of U.S. Provisional Patent Application 61/335,947, which was filed Jan. 13, 2010.

All of the aforementioned applications are hereby incorporated by reference in their entireties into the present application.

FIELD OF THE INVENTION

Aspects of the present invention relate to medical apparatus and methods. More specifically, the present invention relates to devices and methods for fusing a sacroiliac joint.

BACKGROUND OF THE INVENTION

The sacroiliac joint is the joint between the sacrum and the ilium of the pelvis, which are joined by ligaments. In humans, the sacrum supports the spine and is supported in turn by an ilium on each side. The sacroiliac joint is a synovial joint with articular cartilage and irregular elevations and depressions that produce interlocking of the two bones.

Pain associated with the sacroiliac joint can be caused by traumatic fracture dislocation of the pelvis, degenerative arthritis, sacroiliitis an inflammation or degenerative condition of the sacroiliac joint, osteitis condensans ilii, or other degenerative conditions of the sacroiliac joint. Currently, sacroiliac joint fusion is most commonly advocated as a surgical treatment for these conditions. Fusion of the sacroiliac joint can be accomplished by several different conventional methods encompassing an anterior approach, a posterior approach, and a lateral approach with or without percutaneous screw or other type implant fixation. However, while each of these methods has been utilized for fixation and fusion of the sacroiliac joint over the past several decades, substantial problems with respect to the fixation and fusion of the sacroiliac joint remain unresolved.

A significant problem with certain conventional methods for fixation and fusion of the sacroiliac joint including the anterior approach, posterior approach, or lateral approach may be that the surgeon has to make a substantial incision in the skin and tissues for direct access to the sacroiliac joint involved. These invasive approaches allow the sacroiliac joint to be seen and touched directly by the surgeon. Often referred to as an "open surgery", these procedures have the attendant disadvantages of requiring general anesthesia and

can involve increased operative time, hospitalization, pain, and recovery time due to the extensive soft tissue damage resulting from the open surgery.

A danger to open surgery using the anterior approach can be damage to the L5 nerve root, which lies approximately two centimeters medial to the sacroiliac joint or damage to the major blood vessels. Additionally, these procedures typically involve fixation of the sacroiliac joint (immobilization of the articular surfaces of the sacroiliac joint in relation to one another) by placement of one or more screws or one or more trans-sacroiliac implants (as shown by the non-limiting example of FIG. **1**) or by placement of implants into the S1 pedicle and iliac bone.

Use of trans-sacroiliac and S1 pedicle-iliac bone implants can also involve the risk of damage to the lumbosacral neurovascular elements. Damage to the lumbosacral neurovascular elements as well as delayed union or non-union of the sacroiliac joint by use of these procedures may require revision surgery to remove all or a portion of the implants or repeat surgery as to these complications.

Another significant problem with conventional procedures utilizing minimally invasive small opening procedures can be that the procedures are technically difficult, requiring biplanar fluoroscopy of the articular surfaces of the sacroiliac joint and extensive surgical training and experience. Despite the level of surgical training and experience, there is a substantial incidence of damage to the lumbosacral neurovascular elements. Additionally, sacral anomalies can further lead to mal-placement of implants leading to damage of surrounding structures. Additionally, these procedures are often performed without fusion of the sacroiliac joint, which does not remove the degenerative joint surface and thereby does not address the degenerative condition of the sacroiliac joint, which may lead to continued or recurrent sacroiliac joint pain.

Another significant problem with conventional procedures can be the utilization of multiple trans-sacroiliac elongate implants, which do not include a threaded surface. This approach requires the creation of trans-sacroiliac bores in the pelvis and nearby sacral foramen, which can be of relatively large dimension and which are subsequently broached with instruments, which can result in bone being impacted into the pelvis and neuroforamen.

The creation of the trans-sacroiliac bores and subsequent broaching of the bores requires a guide pin, which may be inadvertently advanced into the pelvis or sacral foramen, resulting in damage to other structures. Additionally, producing the trans-sacroiliac bores, broaching, or placement of the elongate implants may result in damage to the lumbosacral neurovascular elements, as above discussed. Additionally, there may be no actual fusion of the articular portion of the sacroiliac joint, which may result in continued or recurrent pain requiring additional surgery.

Another substantial problem with conventional procedures can be that placement of posterior extra-articular distracting fusion implants and bone grafts may be inadequate with respect to removal of the articular surface or preparation of cortical bone, the implant structure and fixation of the sacroiliac joint. The conventional procedures may not remove sufficient amounts of the articular surfaces or cortical surfaces of the sacroiliac joint to relieve pain in the sacroiliac joint. The conventional implant structures may have insufficient or avoid engagement with the articular surfaces or cortical bone of the sacroiliac joint for adequate fixation or fusion. The failure to sufficiently stabilize and fuse the sacroiliac joint with the conventional implant structures and methods may result in a failure to relieve the condition of sacroiliac joint being treated. Additionally, conventional methods of driving apart a sacrum and ilium may lead to mal-alignment of the sacroiliac joint and increased pain.

The inventive sacroiliac fusion system described herein addresses the problems associated with conventional methods and apparatuses used in fixation and fusion of the sacroiliac joint.

BRIEF SUMMARY OF THE INVENTION

One implementation of the present disclosure may take the form of a sacroiliac joint fusion system including a joint implant and a delivery tool. The joint implant includes at least one integral anchor configured to move relative to a body of the implant when being brought into anchoring engagement with bone defining a sacroiliac joint space in which the body of the implant is located. In one embodiment, the at least one anchor extends distally and laterally relative to a body of the implant when being brought into anchoring engagement with the bone. In another embodiment, the at least one anchor rotates relative to the body of the implant when being brought into anchoring engagement with the bone. The delivery tool is configured to support the implant off of a distal portion of the tool. The delivery tool is further configured to cause the displacement of the at least one anchor relative to the implant body so as to cause the at least one anchor to be brought into anchoring engagement with the bone.

While multiple embodiments are disclosed, still other embodiments of the present disclosure will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the disclosure. As will be realized, the invention is capable of modifications in various aspects, all without departing from the spirit and scope of the present disclosure. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an anterior view of the pelvic region and a conventional method and device for stabilizing the sacroiliac joint.

FIG. **2**A is an isometric view of a first embodiment of a system for fusing a sacroiliac joint.

FIG. **2**B is the same view as FIG. **2**A, except the delivery tool and implant assembly are decoupled from each other.

FIG. **3** is the same view as FIG. **2**A, except the system is exploded to better illustrate its components.

FIGS. **4**A-**4**C are, respectively, proximal isometric, proximal end elevation and side elevation views of the implant assembly, which has a body that approximates or generally mimics a sacroiliac joint.

FIGS. **5** and **6** are distal end isometric views of the implant of the implant assembly of FIGS. **4**A-**4**C.

FIGS. **7** and **8** are proximal end isometric views of the implant of the implant assembly of FIGS. **4**A-**4**C.

FIGS. **9** and **10** are opposite lateral side plan views of the implant of the implant assembly of FIGS. **4**A-**4**C.

FIGS. **11** and **12** are, respectively, proximal and distal end elevations of the implant of the assembly of FIGS. **4**A-**4**C.

FIGS. **13** and **14** are opposite edge side elevations of the implant of the assembly of FIGS. **4**A-**4**C.

FIG. **15** is a longitudinal cross section of the implant as taken along section lines **15**-**15** in FIG. **11**.

FIGS. **16**A-**16**B are, respectively, distal isometric and proximal isometric views of an implant assembly similar to that of FIGS. **4**A-**15**, except having a rectangular body.

FIG. **16**C is a lateral side plan view of the rectangular implant assembly.

FIG. **16**D is an edge side elevation of the rectangular implant assembly.

FIGS. **16**E and **16**F are, respectively, proximal and distal end elevations of the rectangular implant assembly.

FIGS. **16**H and **16**G are enlarged isometric views of proximal ends of bores at proximal ends of any of the implant bodies disclosed herein as employing a screw type anchor arrangement.

FIG. **16**I is a distal end isometric view of an implant having a body that approximates or generally mimics a sacroiliac joint and includes a pair of keels extending from opposite lateral side surfaces.

FIGS. **17**A and **17**B are, respectively, distal and proximal isometric views of the shaft assembly of the delivery tool of FIGS. **2**A-**3**.

FIG. **17**C is an enlarged isometric view of the delivery tool distal end and implant assembly all shown exploded.

FIG. **18** is a distal isometric view of the implant retainer of the delivery tool of FIGS. **2**A-**3**.

FIG. **19** is a distal isometric view of the delivery tool.

FIG. **20** is an isometric view of the implant assembly coupled to the implant retainer with the rest of the delivery tool hidden for clarity purposes.

FIG. **21** is an isometric view of the delivery tool and anchors with the implant hidden for clarity purposes.

FIGS. **22** and **23** are, respectively, distal and proximal isometric views of the implant assembly supported off of the delivery tool distal end.

FIG. **24** is a cross section through an anchor arm, anchor and implant bore when the implant assembly is supported off of the delivery tool distal end.

FIG. **25** is an inferior-posterior view of a patient wherein the delivery tool has penetrated the soft tissue to deliver the implant system into the sacroiliac joint in the hip region of the patient.

FIG. **26** is the same view as FIG. **25**, except the soft tissue has been hidden to reveal only the patient's skeletal structure and the delivery tool delivering the implant system into the sacroiliac joint.

FIG. **27** is the same view as FIG. **26**, except substantially enlarged to show the detail of the hip region of the patient.

FIG. **28** is the same view as FIG. **27**, except still further enlarged and with the ilium hidden to more clearly shown the implantation of the implant system in the sacroiliac joint space.

FIG. **29** is a lateral view of a patient wherein the delivery tool has penetrated the soft tissue to deliver the implant system into the sacroiliac joint in the hip region of the patient.

FIG. **30** is the same view as FIG. **29**, except the soft tissue has been hidden to reveal only the patient's skeletal structure and the delivery tool delivering the implant system into the sacroiliac joint.

FIG. **31** is the same view as FIG. **30**, except substantially enlarged to show the detail of the hip region of the patient.

FIG. **32** is the same view as FIG. **31**, except with the ilium hidden to more clearly shown the implantation of the implant system in the sacroiliac joint space.

FIG. **33** is a superior-anterior-lateral view of a patient wherein the delivery tool has penetrated the soft tissue to deliver the implant system into the sacroiliac joint in the hip region of the patient.

FIG. **34** is the same view as FIG. **33**, except the soft tissue has been hidden to reveal only the patient's skeletal structure and the delivery tool delivering the implant system into the sacroiliac joint.

FIG. **35** is the same view as FIG. **34**, except substantially enlarged to show the detail of the hip region of the patient.

FIG. **36** is a superior-posterior-lateral view of a patient wherein the delivery tool has penetrated the soft tissue to deliver the implant system into the sacroiliac joint in the hip region of the patient.

FIG. **37** is an enlarged view of the patient's hip region as viewed from the same perspective as FIG. **36**, the soft tissue having been hidden to reveal only the patient's skeletal structure and the delivery tool delivering the implant system into the sacroiliac joint.

FIG. **38** is the same view as FIG. **37**, except still further enlarged and with the ilium hidden to more clearly shown the implantation of the implant system in the sacroiliac joint space.

FIG. **39**A is a right lateral side view of a hip region of a patient lying prone, wherein the soft tissue surrounding the skeletal structure of the patient is shown in dashed lines.

FIG. **39**B is an enlarged view of the hip region of FIG. **39**A.

FIG. **40**A is a lateral-posterior view of the hip region of the patient of FIG. **39**A, wherein the patient is lying prone and the soft tissue surrounding the skeletal structure of the patient is shown in dashed lines.

FIG. **40**B is an enlarged view of the hip region of FIG. **40**A.

FIG. **41**A is a posterior view of the hip region of the patient of FIG. **39**A, wherein the patient is lying prone and the soft tissue surrounding the skeletal structure of the patient is shown in dashed lines.

FIG. **41**B is an enlarged view of the hip region of FIG. **41**A.

FIGS. **42**A-**42**M are each a step in the methodology and illustrated as the same transverse cross section taken along a plane extending medial-lateral and anterior posterior along section line **41**-**41** in FIG. **41**B.

FIG. **42**N is a similar view to FIG. **42**L, except the delivery tool in FIG. **42**N includes an anchor arm extending off of the delivery tool to position an anchor transversely in relation to the implant assembly.

FIG. **43**A is a posterior-lateral view of the hip region of the patient, illustrating the placement of a cannula alignment jig.

FIGS. **43**B-**43**C are different isometric views of the cannula alignment jig.

FIG. **44**A is a posterior-lateral view of the hip region of the patient, illustrating the placement of a drill jig.

FIG. **44**B is an isometric view of the drill jig.

FIG. **45**A is a lateral view of the hip region of the patient, illustrating the implant implanted in the caudal region of the sacroiliac joint space.

FIG. **45**B is an anterior view of the hip region of the patient, illustrating the implant implanted in the caudal region of the sacroiliac joint space.

FIG. **45**C is an enlarged view of the implant taken along the plane of the sacroiliac joint.

FIG. **45**D is a transverse cross section of the implant and joint plane taken along section line **45**D-**45**D of FIG. **45**C.

FIG. **46** is generally the same enlarged view as FIG. **39**B, except illustrating the delivery tool being used to deliver the implant to the sacroiliac joint space.

FIG. **47** is the same view as FIG. **46**, except the implant has now been fully inserted into the prepared space in the sacroiliac joint.

FIG. **48** is generally the same view as FIG. **46**, except the ilium is removed to show the sacroiliac joint space boundary defined along the sacrum and the implant positioned for implantation within the joint space.

FIGS. **49**A and **49**B are, respectively, posterior and posterior-lateral views of the implantation area and the implant assembly implanted there.

FIG. **50** is a plan view of a medical kit containing the components of the system, namely, the delivery tool, multiple implants of different sizes, and multiple anchor members of different sizes, wherein the system components are sealed within one or more sterile packages and provided with instructions for using the system.

FIG. **51** is the same transverse cross sectional view of the patient's hip as shown in FIG. **42**M, except showing the implant having structure attached thereto that will allow the implant to serve as an attachment point for structural components of a spinal support system configured to support across the patient's hip structure and/or to support along the patient's spinal column.

FIG. **52** is a posterior view of the patient's sacrum and ilia, wherein structural components of a spinal support system extend medial-lateral across the patient's hip structure and superiorly to support along the patient's spinal column.

FIG. **53** is the same view as FIG. **52**, except having a different spanning member structure.

FIG. **54** is a schematic depiction of a system for fusing a joint, wherein the joint implant includes an electrode in electrical communication with a nerve sensing system.

FIG. **55**A is an isometric view of a second embodiment of a system for fusing a sacroiliac joint.

FIG. **55**B is the same view as FIG. **55**A, except the delivery tool and implant assembly are decoupled from each other.

FIG. **56** is the same view as FIG. **55**A, except the system is exploded to better illustrate its components.

FIGS. **57**A-**57**F are, respectively, distal isometric, proximal end elevation, first side elevation, second side elevation opposite the first side elevation, plan and distal end elevation views of the implant assembly, which has a body that is generally rectangular.

FIG. **58** is a distal end isometric view of the implant of the implant assembly of FIGS. **57**A-**57**F.

FIG. **59** is a lateral side plan view of the implant of the implant assembly of FIGS. **57**A-**57**F.

FIG. **60** is a proximal end elevation of the implant of the assembly of FIGS. **57**A-**57**F.

FIG. **61** is a longitudinal cross section of the implant as taken along section lines **61**-**61** in FIG. **60**.

FIGS. **62**A and **62**B are, respectively, distal and proximal isometric views of the shaft assembly of the delivery tool of FIGS. **55**A-**56**.

FIG. **63** is a distal isometric view of the implant retainer of the delivery tool of FIGS. **55**A-**56**.

FIG. **64** is a distal isometric view of the impactor of the delivery tool of FIGS. **55**A-**56**.

FIG. **65** is a distal isometric view of the delivery tool.

FIG. **66** is a distal isometric view of the implant assembly coupled to the implant retainer, the impactor positioned as if having driven the anchor blades fully distal in the implant slots, and the rest of the delivery tool hidden for clarity purposes.

FIG. **67** is an enlarged isometric view of a distal end of the system of FIGS. **55**A-**56**.

FIG. **68** is a distal isometric view of the impactor abutting against the proximal ends of the blade anchors, the rest of the implant assembly and delivery tool being hidden for clarity purposes.

FIGS. **69** and **70** are, respectively, posterior and lateral views of a patient hip region illustrating a surgical approach employing an entry point near the coccyx and the sacrotuberous ligament.

FIG. **71** is a posterior-lateral view of the patient hip region illustrating the delivery tool extending along the surgical approach of FIGS. **69** and **70**.

FIG. **72** is an isometric view of an implant employing a rotatable or pivotable integral anchor.

FIGS. **73** and **74** are side elevation views of the implant of FIG. **72**.

FIGS. **75** and **76** are, respectively, distal and proximal end views of the implant of FIG. **72**.

FIG. **77** is an isometric view of an implant similar to that of FIG. **72**, except employing a different anchor configuration.

FIGS. **78** and **79** are isometric views of the anchors employed in the implants of FIGS. **72** and **77**, respectively.

FIG. **80** is an isometric view of an implant employing a rotatable or pivotable integral anchor.

FIGS. **81** and **82** are, respectively, side elevation and plan views of the implant of FIG. **80**.

FIGS. **83** and **84** are, respectively, distal and proximal end views of the implant of FIG. **80**.

FIG. **85** is an isometric view of an implant delivery tool for use with the implants of FIGS. **72**-**84**.

DETAILED DESCRIPTION

Implementations of the present disclosure involve a system **10** for fusing a sacroiliac joint. The system **10** includes a delivery tool **20** and an implant assembly **15** for delivery to a sacroiliac joint via the delivery tool **20**. The implant assembly **15**, which includes an implant **25** and one or more anchors **30**, is configured to fuse a sacroiliac joint once implanted at the joint. The anchors **30** are integrally supported on the implant **25** and configured to laterally project from sides of the implant. By acting on the anchors **30** or a portion of the implant at a proximal end **43** of the implant **25** (e.g., by rotational or longitudinally displacing forces actuated by a component of the delivery tool **20** or by a separate tool), the anchors may be caused to deploy from the sides of the implant so as to penetrate into bone material defining the joint space in which the implant **25** is implanted. The tool **20** is configured to support the implant **25** from a distal end **35** of the delivery tool **20** for delivery of the implant into the joint space and further configured to facilitate the deployment of the anchors from the sides of the implant. Thus, the system **10** is configured such that the implant **25** can be quickly, accurately and reliably delivered to, and anchored in, a sacroiliac joint.

To begin a detailed discussion of a first embodiment of the system **10**, reference is made to FIGS. **2**A-**3**. FIG. **2**A is an isometric view of the system **10**. FIG. **2**B is the same view as FIG. **2**A, except an implant assembly **15** of the system **10** is separated from a delivery tool **20** of the system **10**. FIG. **3** is the same view as FIG. **2**A, except the system **10** is shown exploded to better illustrate the components of the system **10**.

As can be understood from FIGS. **2**A and **2**B, the system **10** includes a delivery tool **20** and an implant assembly **15** for implanting at the sacroiliac joint via the delivery tool **20**, the implant assembly **15** being for fusing the sacroiliac joint. As indicated in FIG. **3**, the implant assembly **15** includes an implant **25** and anchor elements **30** (e.g., bone screws, nails or other elongated bodies). As discussed below in greater detail, during the implantation of the implant assembly **15** at the sacroiliac joint, the implant **25** and anchor element **30** are supported by a distal end **35** of the delivery tool **20**, as illustrated in FIG. **2**A. In one embodiment, the distal end **35** may be fixed or non-removable from the rest of the delivery tool **20**. In other embodiments, the distal end **35** of the delivery tool **20** may be removable so as to allow interchanging of different sized or shaped distal ends **35** to allow matching to particular implant embodiments without requiring the use of a different delivery tool **20**. The delivery tool **20** is used to deliver the implant **25** into the sacroiliac joint space. The delivery tool **20** is then used to cause the anchor elements **30** to deploy or otherwise extend from the sides of the implant **25** and into the bone of the ilium and sacrum defining the sacroiliac joint. The delivery tool **20** is then decoupled from the implanted implant assembly **15**, as can be understood from FIG. **2**B.

To begin a detailed discussion of components of an embodiment of the implant assembly **15**, reference is made to FIGS. **4**A-**4**C, which are, respectively, proximal isometric, proximal end elevation, and side elevation views of the implant assembly **15**. As shown in FIGS. **4**A-**4**C, the implant assembly **15** includes an implant **25** and anchor elements **30**. The anchor elements **30** may be in the form of an elongated body such as, for example, a nail, rod, pin, threaded screw, etc. The anchor elements **30** are configured to be received in bores **40** defined through the implant **25**. The bores **40** extend through the implant **25** distally and laterally from a proximal end **43** of the implant **25** and are sized such that the anchor elements **30** can at least project both laterally and distally from the sides of the implant **25** as illustrated in FIGS. **4**A-**4**C.

For a detailed discussion of the implant **25**, reference is made to FIGS. **5**-**15**. FIGS. **5**-**8** are various isometric views of the implant **25**. FIGS. **9** and **12** are opposite plan views of the implant **25**, and FIGS. **11**-**14** are various elevation views of the implant. FIG. **15** is an isometric longitudinal cross section of the implant **25** as taken along section lines **15**-**15** in FIG. **11**.

As shown in FIGS. **5**-**15**, in one embodiment, the implant **25** includes a distal or leading end **42**, a proximal or trailing end **43**, a longitudinally extending body **45**, bores **40** extending distally and laterally through the body from the proximal end **43**, a center bore **70**, a distal opening **50**, and a proximal opening **55**. In one embodiment, the implant **25** is configured to have a shape that generally mimics and even substantially fills a sacroiliac joint space. For example, as can be understood from a comparison of the plan views of the implant **25** as illustrated in FIGS. **9** and **10** to the shape of the sacroiliac joint articular region **1044** depicted in FIGS. **45**A and **48** discussed below, the implant has an overall exterior shape that generally mimics the sacroiliac joint articular region **1044**. The anatomic implant **25** can be provided from the manufacturer in the configuration generally as shown in the FIGS. **5**-**15**.

As illustrated in FIGS. **7** and **8**, the implant **25** includes a proximal end **43** for being removably coupled to the extreme distal end **35** of the delivery tool **20**. Specifically, in one embodiment, the implant proximal end **43** includes a center bore **70** that extends distally through the implant from the proximal end **43**. The center bore **70** may be a blind hole in that it only has a single opening, which is at the proximal end

43. Alternatively, as best understood from FIG. **15**, the center bore **70** may be configured as a hole that communicates between the implant proximal end **43** and implant proximal opening **55**. The center bore **70** may be threaded or otherwise configured so as to allow mechanical engagement with a distal end **220** of a retainer member **95** of the delivery tool **20**, the retainer member **95** being used to secure the implant **25** off of the distal end **35** of the delivery tool **20**, as described in detail below. Additionally, the center bore **70** may extend distally across void **55** and continue distally further into body **45**. Accordingly, e.g., a bone graft can be placed in void **55** where the graft may have a bore similar to and in alignment with center bore **70** to allow retainer member **95** to pass there through, thereby retaining the graft in place during implantation of implant **25**. Subsequently, e.g., bone marrow aspirate may be injected via center bore **70** into the bone graft material, which if substantially solid may have passages cut into it which communicate between the external surfaces of the graft and the graft's bore. In one embodiment, the center attachment bore **70** has a diameter of between approximately 2 mm and approximately 10 mm, with one embodiment having a diameter of approximately 5 mm.

As shown in FIGS. **9** and **10**, the implant **25** includes a long portion **7100** and a short portion **7101** perpendicularly oriented to the long portion. The long portion transitions smoothly into the short portion via a small radius **7102** and a large radius **7103** opposite the small radius. The large radius and small radius form an elbow region **7104** of the implant. The large radius forms a heal region **7105** of the implant, and opposite the heal region is a blunt toe region **7106** forming a right angle with a base region **7107** that is generally parallel to the proximal end **43**. These regions **7105-7107** form the distal end **42** of the implant **25**.

As can be understood from FIGS. **9** and **10**, the long portion **7100** has a length D**1** of between approximately 25 mm and approximately 45 mm, and the short portion **7101** has a length D**2** of between approximately 20 mm and approximately 40 mm. The small curve **7102** has a radius of between approximately 2.5 mm and approximately 16 mm, with one embodiment having a radius of approximately 8 mm, and the large curve **7103** has a radius of between approximately 8 mm and approximately 20 mm, with one embodiment having a radius of approximately 15 mm. The implant body **45** has an overall width D**3** of between approximately 10 mm and approximately 20 mm and an overall length D**4** of between approximately 35 mm and approximately 60 mm. The toe projects from the immediate lateral side edge **7150** of the implant body **45** by a distance D**5** of between approximately 8 mm and approximately 20 mm, with one embodiment having a distance D**5** of approximately 15 mm.

The implant **25** can be configured such that the body **45** of the implant is a generally continuous solid surface with the exception of the bores **40**, **70** extending through portions of the body **45**. However, as indicated in FIGS. **5-10** and **15**, the body **45** of the implant **25** may have one or more openings or voids defined in the body **45**. For example, an opening or void **50** may be defined in a distal region of the implant body **45**, and another opening or void **55** may be defined in a proximal region of the implant body **45**. The voids **50**, **55** may be packed with bone growth material prior to the implant **25** being delivered into the sacroiliac joint space.

As indicated in FIGS. **5-15**, the implant body **45** includes side edge surfaces **7150** that extend between the proximal end **43** and the distal end **42**. These side edge surfaces **7150** and the similar side edge surfaces associated with the small curve **7102**, the large curve **7104**, the toe **7106**, the distal end **42** and proximal end **43** combine to define side edge surface boundary **7110** (indicated in FIG. **15**) that extends unbroken and unitary through all of the above-mentioned regions of the implant, thereby forming an outer boundary that may at least somewhat resemble the sacroiliac joint space and more fully occupy the joint space than more linearly shaped rectangle and cylindrical implant embodiments.

As illustrated in FIGS. **5-15**, in one embodiment, the implant body **45** includes generally planar lateral side surfaces **7060**. In some embodiments, the lateral side surfaces **7060** may be generally spaced apart by a distance or body thickness that is generally continuous over the entirety of the surfaces **7060**. However, as can be understood from FIGS. **13** and **14**, in some embodiments, the distance or body thickness may taper from a greater thickness D**4** in the long portion **7100** and a lesser thickness D**5** in the short portion **7101**. In one embodiment, the greater thickness D**6** may be between approximately 3 mm and approximately 10 mm, and the lesser thickness D**7** may be between approximately 3 mm and approximately 6 mm.

In one embodiment, the planar lateral side surfaces **7060** may be substantially smooth. However, in other embodiments, as indicated in FIGS. **9-14**, the planar lateral side surfaces **7060** may have multiple parallel ridges **7061** that extend longitudinally along the long portion **7100** and may be serrated with notches **7062** oriented so as to prevent proximal migration of the implant **25** once implanted in the sacroiliac joint. The anti-migration features **7062** are generally evenly distributed along the planar surfaces **7060**. While the anti-migration features **7062** are depicted as being notches **7062** defined in the longitudinally extending ribs or ridges **7061**, in other embodiments the anti-migration features **7062** may be in the form of other types of surface texturing or protrusions in the form of cylinders, trapezoids, squares, rectangles, etc. Further, although the anti-migration features **7062** are depicted in the form of unidirectional serrated notches **7062** in ridges **7061** on the planar lateral side surfaces **7060** the implant **25**, the invention is not so limited and, as to particular embodiments, can be configured to have said features **7062** arranged in multiple directions, unidirectional, or a combination of multiple direction on some surfaces of the implant and unidirectional on other surfaces of the implant. Accordingly, the features **7062** can be so arranged on the various surfaces of the implant so as to prevent undesired migration in particular directions due to the forces present at the sacroiliac joint **1000**.

As indicated in FIGS. **7** and **8**, longitudinally extending rectangular notches **6514** may be defined in the planar lateral side surfaces **7060**. As described below, such notches **6514** may interact with members **140** forming part of the delivery tool distal end **35** so as to help retain the implant **25** on the distal end **35** and to prevent the implant from rotating relative to the distal end **35** when the retaining rod threaded distal end **220** is being threaded into or out of the center bore **70**.

As can be understood from FIGS. **4**A and **5-10**, in one embodiment, the bores **40** extend distally and laterally from a proximal end **43** of the implant **25** to begin day lighting distally in the proximal void **55** and eventually exit the implant body **45** laterally as grooves or portions of bores defined in the planar lateral side surface **7060**. Since the bores **40** are oriented so as to extend distally and laterally from the proximal end **43** and, further, since the anchors **30** have sufficient length, the anchors **30** project both laterally and distally from the planar lateral side surfaces **7060** of the implant **25**, as illustrated in FIGS. **4**A-**4**C.

In summary, as can be understood from FIGS. **5-15**, in one embodiment, a sacroiliac joint fusion implant **25** includes a proximal end **43**, a distal end **42** generally opposite the proximal end, and side edge surfaces **7150** extending between the proximal and distal ends and defining a long portion of the implant **7100** and a short portion **7101** of the implant. The long portion is longer than the short portion and the two portions extend in directions generally perpendicular to each other. The proximal end terminates proximally in a generally blunt end and the distal end terminates distally in a generally blunt end **7106** facing in a direction generally perpendicular of the direction faced by the generally blunt end of the proximal end. The generally blunt end of the proximal end is configured to releasably couple to an implant delivery system. An offset distance between the side edge surfaces **7150** is substantially greater than a thickness of the implant as defined by an offset distance between the planar lateral side surfaces **7060**. One side edge surface **7150** transitions between the long and short portions **7100**, **7101** via a first curved portion **7103** and the another side edge surface **7150** transitions between the long and short portions via a second curved portion **7102** having a radius smaller than the first curved portion. The cumulative exterior side edge border surface **7110** defines a shape resembling a shape of an adult human sacroiliac joint as viewed in a direction perpendicular a plane of the sacroiliac joint. For example, the cumulative exterior side edge border surface **7110** defines a shape resembling a boot for a human foot.

In one embodiment, the implant **25** may be machined, molded, formed, or otherwise manufactured from stainless steel, titanium, ceramic, polymer, composite, bone or other biocompatible materials. The anchor member **30** may be machined, molded, formed or otherwise manufactured from similar biocompatible materials.

In some embodiments, the implant **25** may be substantially as described above with respect to FIGS. **4-15**, except the implant **25** may have an overall shape that is something other than shaped to mimic the sacroiliac joint. For example, as shown in FIGS. **16**A-**16**F, which are various isometric, plan, and elevational views of an alternative embodiment of an implant assembly **15** that may be employed with the delivery tool **20** of FIGS. **2**A-**3**, the implant **25** may have a rectangular shape. Other than the overall shape of the implant **25** of the implant assembly **15** of FIGS. **16**A-**16**F being different than the overall shape of the implant **25** of the implant assembly **15** of FIGS. **4**A-**4**C and the implant **25** of FIGS. **16**A-**16**F having only a single void **50** as opposed to two voids **50**, **55**, all other features of the implant assemblies **15** are essentially the same for both implant assemblies **15**. While the implant **25** are shown herein to have a joint-shaped configuration and a rectangular shape, in other embodiments the implant **25** may have other shapes such as cylindrical, trapezoidal, triangular, etc. and still be useable with the delivery tool **20** of FIGS. **2**A-**3** and have anchors oriented and deployable as described above with respect to FIGS. **4**A-**16**F.

As illustrated in FIGS. **16**H and **16**G, which are enlarged isometric views of proximal ends of bores **40** at proximal ends **43** of any of the implant bodies **25** disclosed herein as employing a screw type anchor **30**, the bores **40** may be configured to have a retainer arrangement that acts against the anchors **30** when in the bores **40** to prevent the anchors **30** from backing out of the bores **40**.

As indicated in FIG. **16**H, in one embodiment, the proximal end of a bore **40** may have a disk-shaped seat **310** having a center hole **315** that forms the remainder of the extent of the bore **40**. The disk-shaped seat **310** has a plurality of arcuate members **320** distributed along an inner circumferential boundary **325** of a rim **330** of the disk-shaped seat **310**. There may be five or more or less arcuate members **320** distributed generally evenly about the inner circumferential surface **325** of the rim **330**.

In one embodiment, each arcuate member **320** has ends **332** that intersect the inner circumferential surface **325** of the rim **330**, with a center point **335** of the arcuate member **320** that is offset or spaced apart from inner circumferential surface **325** of the rim **330**. Thus, in one embodiment, the arcuate members **320** may be deflectable so as to allow the head of the anchor member **30** to pass between the center points **335** of the members **330** as the head of the anchor member **30** is seated in the seat **310**. As a result, the arcuate members **320** can act against the head of the anchor member **30** to prevent the anchor member from working its way out of the bore **40** and opening **315** of the implant **25**, thereby serving as an anchor member locking mechanism.

Other anchor member locking mechanisms may be employed. For example, as illustrated in FIG. **16**H, the bore **40** includes a cantilevered abutment arm **335** defined proximal end **43** of the implant body **25** via a series of parallel arcuate slots **340**. In one embodiment, a face **345** of the abutment arm **335** is deflectable and biased radially inward of the inner circumferential surface **350** of the bore **40** such that when the anchor member **30** is extended through the bore **40**, the face **345** abuts against the anchor member to prevent the anchor member from working its way out of the bore **40** of the implant **25**, thereby serving as an anchor member locking mechanism.

In other embodiments of the implant, other anchor member locking mechanisms may be employed including, for example, set screws supported off of the implant body to engage the anchor **30** when received in a bore **40**.

The particular embodiments of FIGS. **4**A-**16**F depict implant assemblies **15** having an implant **25** with a generally planar body **45** such that the width and length of the body **45** are substantially greater than the thickness of the body **45** and the planar body **45** is generally free of any substantial features of the body extending away from the planar lateral side surfaces **7060**. However, in other embodiments, the implant body **45** of the present disclosure may have the anchoring arrangement illustrated in FIGS. **4**A-**16**F and further be configured to have a shape and/or radially extending wings as described with respect to any of the many implant body embodiments described in U.S. patent application Ser. No. 13/475,695, which was filed May 18, 2012 and is hereby incorporated by reference in its entirety. For example, as seen in FIG. **16**I, which is a distal end isometric view of the implant **25**, the body **45** is similar to the implant **25** of FIGS. **5-15**, except the body **45** includes a pair of keels, fins, planar members, or wing members **56** extending generally perpendicularly outward from the planar lateral side surfaces **7060**. The body **45** may include voids **50**, **55** as in other embodiments of the implant **25**. As seen in the figure, the keels **56** may extend along a longitudinal axis of the body **45** of the implant and may extend from opposite planar lateral side surfaces **7060** such that the keels **56** are generally coplanar with each other. For example, the keels **56** opposite each other generally exist in the same plane. More specifically, planar faces of a first keel **56** are generally coplanar with the planar faces of a second keel **56** opposite the first keel **56**. As seen in the figure, the keels **56** are generally positioned centrally on the respective planar lateral side surfaces **7060** so as to be generally equidistant between a top and bottom side edge surface **7150**. A width of the keels **56** may be smaller than a width of the body **45** of the implant **25** between the opposite planar lateral side surfaces **7060**.

The particular embodiments of FIGS. **4A-16F** depict implant assemblies **15** having an implant **25** with a generally planar body **45** such that the width and length of the body **45** are substantially greater than the thickness of the body **45** and the planar body **45** is generally free of any substantial features of the body extending away from the planar lateral side surfaces **7060**. However, in other embodiments, the implant body **45** of the present disclosure may have the anchoring arrangement illustrated in FIGS. **4A-16F** and further be configured to have a shape and/or radially extending wings as described with respect to any of the many implant body embodiments described in U.S. patent application Ser. No. 13/475,695, which was filed May 18, 2012 and is hereby incorporated by reference in its entirety.

Alternatively, the implant may be configured as disclosed in U.S. Provisional Patent Application 61/520,956 which is entitled "Sacroiliac Joint Implant System," which was filed Jun. 17, 2011 and the corresponding Patent Cooperation Treaty patent application PCT/US12/42823.

To begin a detailed discussion of components of an embodiment of the delivery tool **20**, reference is again made to FIGS. **2A-3**. As shown in FIG. **2A**, the delivery tool **20** includes a distal end **35** and a proximal end **80**. The distal end **35** supports the components **25**, **30** of the implant assembly **15**, and the proximal end **80** is configured to be grasped and manipulated to facilitate the implantation of the implant assembly **15** in the sacroiliac joint.

As illustrated in FIG. **3**, the delivery tool **20** further includes a shaft assembly **85**, a handle **90**, an implant retainer **95**. As shown in FIGS. **17A** and **17B**, which are, respectively, distal and proximal isometric views of the shaft assembly **85**, the shaft assembly **85** includes the handle, **90**, a tubular elongated body **100**, a distal implant engagement end **105**, and anchor guides **160**. The handle **90** is coupled on a proximal end **110** of the tubular elongated body **100**. The tubular elongated body **100** includes a lumen **115** through which the implant retainer **95** extends, as described below. The anchor guides **160** are tubular structures mounted on opposite sides of the distal implant engagement end **105**. The anchor guides **160** may have other shapes that are complementary with the shape of anchors **30** having shapes. For example, anchor guides **160** may have a rectangular in cross section in order to correctly align an anchor which is rectangular in cross section with an implant bore **40** which is also rectangular in cross section.

As shown in FIG. **17C**, which is an enlarged isometric view of the delivery tool distal end **35** and implant assembly **15** all shown exploded, the distal implant engagement end **105** includes a distal face **130** that is located between the distal openings of the lumens **132** of the anchor guides **160** and offset distally extending members **140**. The members **140** have opposed planar faces **142** that are each configured to be matingly received by the respective notches **6514** of the implant **25** when the proximal end **43** of the implant **25** is received in an implant receiving space **143** defined by the distal face **130** and opposed planar faces **142**.

As illustrated in FIG. **18**, which is a distal isometric view of the implant retainer **95**, the implant retainer **95** includes a longitudinal cylindrical member **210**, a handle **215** on a proximal end of the longitudinal cylindrical member **210**, and an implant engagement feature **220** on a distal end the longitudinal cylindrical member **210**. As can be understood from FIG. **19**, which is a distal isometric view of the delivery tool **20**, the member **210** of the implant retainer **95** extends through the lumen **115** of the body **100**, the engagement feature **220** distally extending from the lumen **115** when a distal face of the retainer handle **215** is abutting against a proximal face of the shaft assembly handle **90**.

As can be understood from FIG. **20**, which is an isometric view of the implant assembly **15** coupled to the implant retainer **95** with the rest of the delivery tool **20** hidden for clarity purposes, in one embodiment, the implant engagement feature **220** is in the form of a threaded shaft for engaging complementary threads in the center bore **70**, thereby securing the implant proximal face **43** against the distal face **130** of the distal implant engagement end **105**, the members **140** being received in the notches **6514**, as can be understood from FIG. **2A**.

As illustrated in FIG. **21**, which is a distal isometric view of the delivery tool **20** with the anchors **30** loaded in the anchor guides **160** of the delivery tool **20**, the anchor guides **160** are oriented such that the longitudinal axes of the anchor guide lumens **132** extend both distally and laterally. Thus, anchors **30** loaded in the anchor guide lumens **132** are oriented so as to be guided along a trajectory that is both distal and laterally outward relative to a longitudinal axis of the tubular member **100**.

FIGS. **22** and **23** are, respectively, distal and proximal isometric views of the implant assembly **15** supported off of the delivery tool distal end **35**. FIG. **24** is a cross section through an anchor arm **160**, anchor **30** and implant bore **40** when the implant assembly **15** is supported off of the delivery tool distal end **35**. As can be understood from FIGS. **22-24**, when the implant **25** is coupled to the delivery tool distal end **35**, the longitudinal axes of the anchor guide lumens **132** and the respective bores **40** are coaxially aligned such that the trajectory of an anchor **30** positioned in an anchor guide lumen **132** extends through the respective bore **40**. Thus, as indicated in FIG. **24**, the anchor **40** automatically tracks into the respective bore **40** upon a wrench or other tool being applied to the distal or head end **144** of the anchor screw **30** via the proximal anchor lumen opening **146**, as can be understood from FIG. **23**.

For a general overview of a method of implanting the above-described implant system **15** in a caudal region **1086** of the sacroiliac joint articular region **1044** of a patient **1001** via the above-described delivery tool **20** through a caudal access, reference is now made to FIGS. **25-38**. FIGS. **25**, **29**, **33** and **36** are, respectively, inferior-posterior, lateral, superior-anterior-lateral, and superior-posterior-lateral views of the patient **1001**. As shown in FIGS. **25**, **29**, **33** and **36**, the delivery tool **20** penetrates the soft tissue **1003** of the patient **1001** to extend into the patient's hip region **1002** via a tissue penetration in a superior region of one of the patient's buttocks. In doing so, the delivery tool **20** can be seen to be oriented such that a longitudinal axis of the shaft **100** of the delivery tool **20** has a generally anterior trajectory.

FIG. **26** is the same view as FIG. **25**, except the soft tissue **1003** has been hidden to reveal only the patient's skeletal structure **1006**, and FIG. **27** is the same view as FIG. **26**, except substantially enlarged to show the detail of the hip region **1002** of the patient. As illustrated in FIGS. **26** and **27**, the position and orientation of the implant system **15** deployed in the sacroiliac joint **1000** can be understood with respect to common anatomical features of the sacrum **1004** and ilium **1005**, such anatomical features including the posterior superior iliac spine **2004**, posterior inferior iliac spine **2006**, greater sciatic notch **2008**, ischial spine **2010**, and tubercle of iliac crest **2012**. Other anatomical features shown include the posterior inferior access region **2016** of the sacroiliac joint articular region, the superior end **2018** on the sacroiliac joint line, the posterior inferior overhang **2020** of the posterior superior iliac spine, the inferior end **2022** on the sacroiliac joint line that is at approximately the superior beginning of the greater sciatic notch, and the lateral anterior curved boundary **2024** of the sacrum **1004**.

Additional understanding regarding the position and orientation of the implant system **15** deployed in the sacroiliac joint **1000** can be gained from a review of FIGS. **30** and **34**, which are, respectively, the same views as FIGS. **29** and **33**, except the soft tissue **1003** has been hidden to reveal only the patient's skeletal structure **1006**. Still further understanding can be obtained from FIGS. **31** and **35**, which are the same respective views as FIGS. **30** and **34**, except substantially enlarged to show the detail of the hip region **1002** of the patient. FIG. **37** is a substantially enlarged view showing the detail of the hip region of the patient, except correlating to the view of the patient depicted in FIG. **36**.

FIGS. **26** and **27** make it possible to understand the position and orientation of the delivery tool elements when the delivery tool distal end **35** is coupled to the proximal end of the implant **25** when the implant is positioned in the sacroiliac joint **1000**. For example, the position and location of delivery tool elements such as the handle **90**, shaft **100**, implant retainer handle **215** and anchor guide **160** can be understood from FIGS. **26** and **27**. FIGS. **30**, **31**, **34**, **35** and **37** also provide understanding regarding the position and orientation of the delivery tool elements when the delivery tool distal end **35** is coupled to the proximal end of the implant **25** when the implant is positioned in the sacroiliac joint **1000**.

FIGS. **28**, **32** and **38** are the same respective views as FIGS. **27**, **31** and **37**, except still further enlarged and with the ilium hidden to more clearly shown the implantation of the implant system **15** in the sacroiliac joint **1000**. The distal and lateral projection of the lateral anchor **30** from the implant **25** is clearly indicated in each of FIGS. **28**, **32** and **38**. The coupling of the proximal end of the implant **25** to the distal end of the delivery tool guide portion **160** can also be clearly seen in FIGS. **28**, **32** and **38**.

To begin a more detailed discussion regarding the step-by-step methodology associated with employing the above-described delivery tool **20** in implanting the above-described implant **25** in the sacroiliac joint **1000** of a patient **1001**, reference is first made to FIGS. **39**A-**41**B to identify the bone landmarks adjacent, and defining, the sacroiliac joint **1000**. FIG. **39**A is a right lateral side view of a hip region **1002** of a patient **1001** lying prone, wherein the soft tissue **1003** surrounding the skeletal structure **1006** of the patient **1001** is shown in dashed lines. FIG. **39**B is an enlarged view of the hip region **1002** of FIG. **39**A. As illustrated in FIGS. **39**A and **39**B, a lateral view of the patient's hip region **1002** reveals certain features of the ilium **1005**, including the anterior superior iliac spine **2000**, the iliac crest **2002**, the posterior superior iliac spine **2004**, the posterior inferior iliac spine **2006**, the greater sciatic notch **2008** extending from the posterior inferior iliac spine **2006** to the ischial spine **2010**, and the tubercle of iliac crest **2012**. The sacroiliac joint articular region **1044** is shown in dashed lines. A posterior inferior access region **2016** of the sacroiliac joint articular region **1044** has a superior end **2018** on the sacroiliac joint line **2019** that is between approximately 0 mm and approximately 40 mm inferior the posterior inferior overhang **2020** of the posterior superior iliac spine **2004**. The posterior inferior access region **2016** of the sacroiliac joint articular region **1044** has an inferior end **2022** on the sacroiliac joint line that is at approximately the intersection of the posterior inferior iliac spine **2006** with the lateral anterior curved boundary **2024** of the sacrum **1004**. In other words, the posterior inferior access region **2016** of the sacroiliac joint articular region **1044** has an inferior end **2022** on the sacroiliac joint line that is at approximately the superior beginning of the greater sciatic notch **2008**.

FIG. **40**A is a lateral-posterior view of the hip region **1002** of the patient **1001** of FIG. **39**A, wherein the patient **1001** is lying prone and the soft tissue **1003** surrounding the skeletal structure **1006** of the patient **1001** is shown in dashed lines. FIG. **40**B is an enlarged view of the hip region **1002** of FIG. **40**A. As shown in FIGS. **40**A and **40**B, a lateral-posterior view of the patient's hip region **1002** reveals the same features of the sacrum **1004** and ilium **1005** as discussed above with respect to FIGS. **39**A and **396**B, except from another vantage point. The vantage point provided via FIGS. **40**A and **40**B provides further understanding regarding the posterior inferior access region **2016** of the sacroiliac joint articular region **1044** and superior end **2018** and inferior end **2022** of the posterior inferior access region **2016** relative to nearby anatomical features, such as, for example, the posterior inferior overhang **2020** of the posterior superior iliac spine **2004**, the intersection of the posterior inferior iliac spine **2006** with the lateral anterior curved boundary **2024** of the sacrum **1004**, and the superior beginning of the greater sciatic notch **2008**.

FIG. **41**A is a posterior view of the hip region **1002** of the patient **1001** of FIG. **39**A, wherein the patient **1001** is lying prone and the soft tissue **1003** surrounding the skeletal structure **1006** of the patient **1001** is shown in dashed lines. FIG. **41**B is an enlarged view of the hip region **1002** of FIG. **41**A. As shown in FIGS. **41**A and **41**B, a posterior view of the patient's hip region **1002** reveals the same features of the sacrum **1004** and ilium **1005** as discussed above with respect to FIGS. **39**A and **39**B, except from yet another vantage point. The vantage point provided via FIGS. **41**A and **41**B provides yet further understanding regarding the posterior inferior access region **2016** of the sacroiliac joint articular region **1044** and superior end **2018** and inferior end **2022** of the posterior inferior access region **2016** relative to nearby anatomical features, such as, for example, the posterior inferior overhang **2020** of the posterior superior iliac spine **2004**, the intersection of the posterior inferior iliac spine **2006** with the lateral anterior curved boundary **2024** of the sacrum **1004**, and the superior beginning of the greater sciatic notch **2008**.

Now that the relevant anatomical landmarks have been identified with respect to FIGS. **39**A-**41**B, the methodology associated with employing any of the above-described delivery tools **20** in implanting any of the above-described implants **25** in the sacroiliac joint **1000** of a patient **1001** can be discussed. In doing so, reference will be made to FIGS. **42**A-**42**M, which are each a step in the methodology and illustrated as the same transverse cross section taken in along a plane extending medial-lateral and anterior posterior along section line **42**-**42** in FIG. **41**B. In this cross section, articular surfaces **1016** are covered by a thick layer of articular cartilage with a joint space existing between them, the FIGS. **42**A-**42**M are simplified for illustrative purposes and do not show these features to scale. Now referring primarily to FIG. **42**A, an embodiment of the method can include the step of placing a patient under sedation prone on a translucent operating table (or other suitable surface). The sacroiliac joint **1000** can be locally anesthetized to allow for injecting a radiographic contrast **1046** (as a non-limiting example, Isoview **300** radiographic contrast) under fluoroscopic guidance into the inferior aspect of the sacroiliac joint **1000** to outline the articular surfaces **1016** of the sacroiliac joint **1000**) defined between the sacrum **1004** and ilium **1005**, the sacroiliac joint **1000** having an interarticular region **1044**. Injection of the radiographic contrast **1046** within the sacroiliac joint **1000** can be accomplished utilizing a tubular member **1047**)(such as a syringe needle) having first tubular member end **1048** which can be advanced between the articulating surfaces **1016** of the sacroiliac joint **1000** and having a second tubular member end **1049** which removably couples to a hub **1050**. The hub **1050** can be configured to removably couple to a syringe barrel **1051** (or other device to contain and deliver an amount of radiographic contrast **1046**). In the example of a syringe barrel **1051**, the syringe barrel **1051** can have an internal volume capable of receiving an amount of the radiographic contrast **1046** sufficient for outlining the articular surfaces **1016** of the sacroiliac joint **1000**, for example, under lateral fluoroscopy. A plunger **1052** can be slidingly received within the barrel **1051** to deliver the radiographic contrast **1046** through the tubular member **1047** into the sacroiliac joint **1000**. The tubular member **1047** can have a gauge in the range of about 16 gauge and about 20 gauge and can further be incrementally marked on the external surface to allow determination of the depth at which the first needle end **1048** has advanced within the sacroiliac joint **1000**. As the first needle end **1048** advances into the sacroiliac joint **1000** the radiographic dye **1046** can be delivered from within the syringe barrel **1051** into the sacroiliac joint **1000** to allow visualization of the sacroiliac joint **1000** and location of the tubular needle **1047** within the sacroiliac joint **1000**.

Now referring primarily to FIG. **42**B, once the first tubular member end **1048** has been sufficiently advanced into the sacroiliac joint **1000** and the articular surfaces **1016** of the sacroiliac joint **1000** have been sufficiently visualized, the hub **1050** can be removed from the tubular member **1047** leaving the tubular member **1047** fixed within the sacroiliac joint **1000** as an initial guide for tools subsequently used to locate or place the sacroiliac joint implant **25** non-transversely between the articulating surfaces **1016** of the sacroiliac joint **1000** (e.g., locate the implant **25** non-transversely to the joint plane **1030** generally defined by the articulating surfaces **1016** of the interarticular region **1044** of the sacroiliac joint **1000**) or in removal of a portion of the sacroiliac joint **1000** within the region defined by the articular surfaces **1016** to generate an implant receiving space **1029** (see FIG. **42**H). Alternately, one or more guide pins **1013** can be inserted along substantially the same path of the tubular member **1047** for fixed engagement within the sacroiliac joint **1000** and used in subsequent steps as a guide(s).

Now referring primarily to FIG. **42**C, a small incision **1053** can be made in the skin at the posterior superior (or as to certain embodiments inferior) aspect of the sacroiliac joint **1000**, extending proximal and distal to the tubular member **1047** along the line of the sacroiliac joint **1000** to provide a passage to access the interarticular space between the articulating surfaces **1016** (see FIG. **42**B) of the sacroiliac joint **1000**. More specifically, as can be understood from FIGS. **39**A-**41**B, in one embodiment, the small incision **1053** can be made along the joint line **2019** of the sacroiliac joint **1000** in the tissue covering the posterior inferior access region **2016** of the sacroiliac joint articular region **1044**. A cannulated probe **1054** can be slidingly engaged with the tubular member **1047** (or guide pin **1013**) extending outwardly from the sacroiliac joint **1000** (while the sacroiliac joint may be shown in the figures as being substantially linear for illustrative purposes, it is to be understood that the normal irregular features of the sacroiliac joint have not been removed). The cannulated probe **1054** can have a probe body **1054** of generally cylindrical shape terminating in a spatulate tip **1055** at the end advanced into the sacroiliac joint **1000**. A removable cannulated probe handle **1056** couples to the opposed end of the probe body **1054**. The spatulate tip **1055** can be guided along the tubular needle **1047** or guide wire **1013** into the posterior portion of the sacroiliac joint **1000** and advanced to the anterior portion of the sacroiliac joint **1000** under lateral fluoroscopic visualization. The cannulated probe handle **1056** can then be removed providing the generally cylindrical probe body **1054** extending outwardly from the sacroiliac joint **1000** through the incision **1053** made in the skin.

Alternatively, probe **1054** can be used to guide, advance or place a needle, guide wire or other instrument up to, near, or into the joint.

Additionally, in particular embodiments, probe handle **1056** or the opposed end of the probe body **1054**, or both, can be configured to have an interference fit or a luer lock hub to communicate with a syringe barrel **1051** in order to advance contrast, in situ curable biocompatible materials, stem cells, or etc. through the cannulated probe **1054** or cannulated probe handle **1056**.

Now referring primarily to FIG. **42**D, a passage from the incision **1053** (see FIG. **42**C) to the sacroiliac joint **1000** can be generated by inserting a cannula **1057** into the incision. A soft tissue dilator **1058** having a blunt end **1059** can be advanced over the probe body **1054**, or a plurality of soft tissue dilators of increasing size, until the blunt end **1059** of the soft tissue dilator **1058** and the corresponding cannula end contact the posterior aspect of the sacroiliac joint **1000**. More specifically, as can be understood from FIGS. **39**A-**41**B, in one embodiment, the ends of the dilator **1058** and cannula **1057** contact the joint line **2019** of the sacroiliac joint **1000** at the posterior inferior access region **2016** of the sacroiliac joint articular region **1044**. The soft tissue dilator **1058** can be removed from within the cannula **1057**. The external surface of the cannula **1057** can be sufficiently engaged with the surrounding tissue to avoid having the tissue locate with in the hollow inside of the cannula **1057**. A non-limiting embodiment of the cannula **1057** provides a tubular body having substantially parallel opposed side walls which terminate in a radius at both ends (lozenge shape) into which a plurality of different jigs can be inserted. Alternatively, as a non-limiting example, according to particular embodiments, cannula **1057** and corresponding dilators **1058** and alignment jigs **1060** can be configured to have tubular bodies with an elliptical or circular cross section.

In some embodiments, the cannula **1057** may be additionally configured to have within or near its walls a light source such as, for example, a fiber optic or a LED light source to assist in visualization of the working area. Also, in some embodiments, irrigation and suction tubing may communicate with the inside passage of cannula **1057**.

Now referring primarily to FIGS. **43**A-**43**C, a cannula alignment jig **1060** can be advanced over the probe body **1054** (or guide pins **1013**) and received within the cannula **1057**. Substantially, identical cross hairs **1063**, **1064** can be disposed on the upper jig surface **1065** and the lower jig surface **1066**. Alignment of the cross hairs **1063**, **1064** under x-ray with the sacroiliac joint **1000** can confirm that the cannula **1057** has proper orientation in relation to the paired articular surfaces **1016** of the sacroiliac joint **1000**. The cannula **1057** properly oriented with the paired articular surfaces **1016** can then be disposed in fixed relation to the sacroiliac joint by placement of fasteners through the cannula **1057** into the sacrum **1004** or the ilium **1005**. A handle extending from a part of the cannula may be configured to allow fixturing to an operating table.

Now referring to FIGS. **44**A and **44**B, a first drill jig **1067** can be advanced over the probe body **1054** (or guide pins **1013**) and received within the cannula **1057**. The probe body **1054** (or guide pins **1013**) extending outwardly from the sacroiliac joint **1000** passes through a drill guide hole **1068** of the first drill jig **1067** (or a plurality of guide pins **1013** can extend through a corresponding plurality of guide pin holes **1069**). The drill guide hole **1068** can take the form of a circular hole as shown in the Figures, a slot, or other configuration to restrict the movement of the drill bit **1062** (see FIG. **42**E) within the drill jig **1060** and provide a guide for a drill bit **1062** in relation to the sacroiliac joint **1000**. Guide pin holes **1069** can receive guide pins which can be positioned between the articular surfaces **1016** of the sacroiliac joint **1000** to demarcate the zone of desired treatment or safe working zones while using, for example, lateral fluoroscopy. As a non-limiting example, a first guide pin **1013** can be advanced through a first guide pin hole **1069**, or alternatively a guide pin **1013** is first inserted into the sacroiliac joint **1000** and subsequently a guide jig **1067** is advanced over the guide pin **1013**, the first guide pin **1013** can enter near inferior end **2022** of the posterior inferior access region **2016** of the sacroiliac joint articular region **1044** via the sacroiliac joint line **2019** to border a portion of the greater sciatic notch **2008** thereby allowing a medical person, computer guided surgical system, or other observer to more easily highlight under x-ray a border which should not be crossed during the procedure due to the presence of nerve and other structures. Additionally, as a non-limiting example, first guide pin **1013** can configured as an electrode, insulated from the operator and the patient's soft tissues, and may be connected to a monitor to signal to an operator or surgeon when implant **25**, configured with a stimulating electrode (NM), as discussed below, comes into contact with first guide pin. Similarly, a second guide pin **1013** can be placed in another guide pin hole **1069** to demarcate a second limit to a desired zone of treatment, or safe working zone. For example, a second guide pin **1013** can enter near the superior end **2018** of the posterior inferior access region **2016** of the sacroiliac joint articular region **1044** via the sacroiliac joint line **2019** to be positioned to border an area of the sacroiliac joint **1000** such as a transition zone between the extra-articular **3007** (see FIG. **48**) and the interarticular region **1044** which, for example, has been highlighted by contrast material as above described.

Now referring to FIG. **42**E, a cannulated drill bit **1070** can be advanced over the probe body **1054** and within a drill guide hole **1068** (see FIGS. **44**A and **44**B) of the first drill jig **1067**. The cannulated drill bit **1070** under fluoroscopic guidance can be advanced into the interarticular region **1044** between the articulating surfaces **1016** of the sacroiliac joint **1000** to produce a first bore **1071** (shown in broken line) to a determined depth. As to certain embodiments of the method, an amount of articular cartilage or other tissues from between the articular surfaces **1016** of the sacroiliac joint **1000** can be removed sufficient to allow embodiments of the sacroiliac joint implant **25** to be implanted in replacement of the removed articular cartilage or tissue. Because the method removes the degenerative articular cartilage or tissue between the articular surfaces **1016** of the sacroiliac joint **1000**, the articular surfaces **1016** of the sacroiliac joint **1000** can remain intact or substantially intact allowing the sacroiliac joint implant **25** to be non-transversely located between the articular surfaces **1016** of the sacroiliac joint **1000**. Understandably, other instruments can be utilized separately or in combination with a cannulated drill bit **1062** for the removal of articular cartilage or tissue between articular surfaces **1016** such as: endoscopy tools, box chisels, side cutting router bits, burs, flexible burs and bits, hole saws, curettes, lasers (such as C02, Neodymium/Y AG (yttrium-aluminum-garnet), argon, and ruby), electrosurgical equipment employing electromagnetic energy (the cutting or heating electrode can be a fine micro-needle, a lancet, a knife, a wire or band loop, a snare, an energized scalpel, or the like) where, e.g., the energy transmitted can be either monopolar or bipolar and operate with high frequency currents, for example, in the range of about 300 kHz and about 1000 kHz whether as pure sinusoidal current waveform where the "crest factor" can be constant at about 1.4 for every sinus waveform, and a voltage peak of approximately 300 V to enable a "pure" cutting effect with the smallest possible coagulation effect or as amplitude modulated current waveforms where the crest factor varies between 1.5 and 8, with decreasing crest factors providing less of a coagulation effect. Electrosurgical waveforms may be set to promote two types of tissue effects, namely coagulation (temperature rises within cells, which then dehydrate and shrink) or cut (heating of cellular water occurs so rapidly that cells burst). The proportion of cells coagulated to those cut can be varied, resulting in a "blended" or "mixed" effect. Additionally, a fully rectified current, or a partially rectified current, or a fulguration current where a greater amount or lateral heat is produced can be employed to find the articular surfaces of the joint and aid in advancing a probe or guide wire into a position in between the articulating surfaces. These currents can effectively degrade the cartilage and allow advance into the joint without grossly penetrating much beyond the cartilage.

Now referring to FIG. **42**F, as to certain embodiments of the invention, the first drill jig **1067** can be removed from within the cannula **1057** and a second drill jig **1072** can be advanced over the probe body **1054** and received within the cannula **1057**; however, the invention is not limited to any particular number of drill jigs and as to certain embodiments of the method the first drill jig **1067** can include all the required drill guide hole(s) **1068** (or slots or other configurations of the drill guide) and as to other embodiments of the method a plurality of drill jigs can be utilized in serial order to provide all the drill guide holes **1068**. As to the particular embodiment of the invention shown by the Figures, the first drill jig **1067** can provide one or more additional drill guide holes **1068** which guide in relation to the first bore **1071** a second or more cannulated drills **1062** of the same or different configuration to be inserted within and advanced into the sacroiliac joint **1000** to produce a second bore **1073** (generally shown in broken line as **1071/1073**) or a plurality of bores within the sacroiliac joint **1000** spaced apart in predetermined pattern to allow removal of sufficient articular cartilage **1016** or other tissue from the interarticular space of sacroiliac joint **1000** for placement of embodiments of the sacroiliac joint implant **25** within the region defined by and between the paired articular surfaces **1016** of the sacroiliac joint **1000**. As to certain methods of the invention, the first drill jig **1067** or the second drill jig **1072** or a plurality of drill jigs can be utilized in serial order to remove a portion of the sacroiliac joint **1000** for generation of an implant receiving space **1029** (see, for example, FIG. **42**H). As these embodiments of the method, articular cartilage or other tissues and sufficient subchondral bone can be removed from between the articular surfaces **1016** of the sacroiliac joint **1000** sufficient to allow placement of certain embodiments of the sacroiliac joint implant **25** and one or more radial member receiving channels **1074** can be cut into at least one of the articular surfaces **1016** of said sacroiliac joint **1000** sufficient to receive other embodiments of the sacroiliac implant **25**. The one or more radial member receiving channels **1074** can be cut a depth into the subchondral, cortical bone or cancellous bone of the sacrum **1004** or ilium **1005**.

Now referring primarily to FIG. **42**G, in a subsequent step, the last in the serial presentation of drill jigs **1067**, **1072** can be removed from within the cannula **1057** and a broach jig **1075** can be advanced over the probe body **1054** to locate within the cannula **1057**. The broach jig **1075** can include a broach guide hole **1076** which receives a first broach end **1077** of a cannulated broach **1078** advanced over the probe body **1054**. The first broach end **1077** can have a configuration which can be advanced into the sacroiliac joint **1000**. As to certain embodiments of the method, the first broach end **1077** can be adapted to remove an amount of articular cartilage and other tissue from between the articular surfaces **1016** within the articular region **1044** of the sacroiliac joint **1000** for non-transverse placement of a sacroiliac joint implant **25** having an elongate body **45**, or having an elongate body **45** and other features (e.g., members radially extending from the body **45**) between the articular surfaces **1016** of the sacroiliac joint **1000**. As to other embodiments of the method, the cannulated broach **1078** can remove a sufficient portion of the sacroiliac joint **1000** to generate an implant receiving space **1029** to receive embodiments of the sacroiliac joint implant **25** having an elongate body **45** or an elongate body **45** and one or more radial members adapted for non-transverse placement between the articular surfaces **1016** or adapted to extend into the bone of the sacrum **1004** or the ilium **1005**.

As a non-limiting example, FIG. **42**G shows a broach **1078** configured to remove a portion of the sacroiliac joint **1000** to produce an implant receiving space **1029** (shown in FIG. **42**H) to receive embodiments of the sacroiliac joint implant **25** having an elongate body **45** that extends between the articular surfaces **1016** of the sacroiliac joint **1000** and one or more anchors **30** that extend from the implant body **45** into the adjacent sacrum **1004** and ilium **1005**.

Now referring primarily to FIGS. **45**A-**45**D, the implant receiving space **1029** and the sacroiliac joint implant **25** can be configured having related dimension relations such that placement of the sacroiliac joint implant **25** within the implant receiving space **1029** disposes the sacrum **1004** and the ilium **1005** in substantially immobilized relation and substantially avoids alteration of the positional relation of the sacrum **1004** and the ilium **1005** from the normal condition, or avoids driving together or driving apart the sacrum **1004** from the ilium **1005** outside of or substantially outside of the normal positional relation. An intention in selecting configurations of the sacroiliac joint implant **25** and the implant receiving space **1029** being immobilization of the sacrum **1004** in relation to the ilium **1005** while maintaining the sacroiliac joint **1000** in substantially normal or substantially normal positional relation, or returning the sacroiliac joint **1000** to a substantially normal positional relation to correct a degenerative condition of the sacroiliac joint **1000**.

As a non-limiting example, configurations of an implant receiving space **1029** allow embodiments of the sacroiliac joint implant **25** to be placed non-transversely between the caudal portion **1086** of the articular surfaces **1016** of the sacroiliac joint **1000**. In one embodiment of the sacroiliac joint implant **25**, the implant body **45** is located within a correspondingly configured implant receiving space **1029** to engage at least a portion of the bone of the ilium **1005** or sacrum **1004**. In some embodiments, members may radially extend from the implant body **45** to extend into a portion of the bone **1073** of the sacrum **1004** and the ilium **1005**. As to those embodiments of the sacroiliac joint implant **25** which having such radial members, the implant receiving space **1029** can further include one or more radial member receiving channels, which correspondingly allow the radial members to extend into the bone **1073** of the sacrum **1004** or the ilium **1005** (whether subchondral, cortical, cancellous, or the like), or impact of the sacroiliac joint implant **25** into the implant receiving space **1029** without the radial member receiving channels can forcibly urge such radial members into the bone **1073** of the sacrum **1004** and the ilium **1005**. While not depicted in the accompanying figures of the present application, such radial members and radial member receiving channels are discussed in detail in U.S. patent application Ser. No. 12/998,712 (which is incorporated herein in its entirety) and can be readily employed with any of the implant embodiments disclosed herein.

As indicated in FIGS. **45**B-**45**D, anchor members **30** (such as threaded members) can be inserted through the bores **40** in the implant **25** and into the sacrum **1004** and ilium **1005** to fix the location of the fixation fusion implant **25** within the implant receiving space **1029**.

While the preceding discussion is given in the context of the implant **25** being implanted non-transversely in the caudal portion **1086** of the sacroiliac joint **1000**, in other embodiments, the implant **25** may be implanted in other locations within the sacroiliac joint. For example, as disclosed in U.S. patent application Ser. No. 12/998,712, which is incorporated herein by reference, in some embodiments, the implant **25** may be implanted non-transversely in the cranial portion **1087** (see FIG. **45**A) of the sacroiliac joint **1000** by the similar procedures or steps as above described with the incision and generation of the passage to the superior articular portion of the sacroiliac joint **1000**. The implant may also be implanted in the sacroiliac joint in such a manner so as to extend between the cranial and caudal portions, as also disclosed in U.S. patent application Ser. No. 12/998,712.

To begin a discussion of employing the delivery tool **20** to implant the implant **25** in the sacroiliac joint **1000** once the implant receiving space **1029** has been created, reference is made to FIGS. **42**I, and **46**. FIG. **46** is generally the same enlarged view as FIG. **39**B. As shown in FIGS. FIGS. **42**I and **46**, once the implant receiving space **1029** has been created as discussed above with respect to FIGS. **42**A-**42**H, the implant **25** can be supported off of the distal end **35** of the delivery tool **20** and positioned such that the distal end **42** of the implant **25** begins to enter the sacroiliac joint articular region **1044** via the posterior inferior access region **2016**, which is described in detail above with respect to FIGS. **39**A-**41**B. As can be understood from FIG. **46**, in entering the sacroiliac joint space, the implant **25** is oriented such that its body **45** is oriented generally parallel to, and aligned with, the sacroiliac joint line **2019**. In other words, the body **45** is generally located within the joint plane **1030** such that its faces **7060** are generally parallel to the joint plane **1030** and its side edge faces **7150** project in a directions that extends along the joint plane **1030** (see, e.g., FIGS. **45**C and **45**D). The longitudinal axis of the shaft **100** of the delivery tool **20** has a generally anterior trajectory that is located within the joint plane **1030**. Alternatively, according to particular embodiments, as a non-limiting example, the longitudinal axis of the shaft **100** of the delivery tool **20** can have a trajectory which can be defined as being generally lateral or, in particular embodiments, generally posterior. In some embodiments, when the implant **25** is being delivered into the joint space, the shaft **100** can be said to be at least one of generally superior or cephald the sciatic notch.

FIG. **47** is the same view as FIG. **46**, except the implant **25** has now been fully inserted into the prepared space **1029** in the sacroiliac joint **1000**. As illustrated in FIGS. **42**J and **47**, the implant **25** is fully received in the prepared sacroiliac space **1029** such that the body **45** is oriented generally parallel to, and aligned with, the sacroiliac joint line **1030** such that its faces **7060** are generally parallel to the joint plane **1030** and its side edge faces **7150** project in a directions that extends along the joint plane **1030** (see, e.g., FIGS. **45**C and **45**D). As can be understood from FIG. **42**J, the longitudinal axis of the implant **25** and the longitudinal axis of the shaft **100** of the delivery tool **20** may be coaxially aligned with each other and generally located in the sacroiliac joint plane **1030**.

FIG. **48** is generally the same view as FIG. **46**, except the ilium **1005** is removed to show the sacroiliac joint space boundary **3000** defined along the sacrum **1004** and outlining the sacroiliac joint articular region **1044**, the implant **25** positioned for implantation within the sacroiliac joint articular region **1044**. As shown in FIG. **48**, the sacroiliac joint space boundary includes an inferior boundary segment **3002**, an anterior boundary segment **3004**, a superior boundary segment **3006**, and a posterior boundary segment **3008**. The inferior boundary segment **3002** is immediately adjacent, and extends along, the sciatic notch **2024**.

The inferior boundary segment **3002** and anterior boundary segment **3004** intersect to form an anterior-inferior corner **3010**. The anterior boundary segment **3004** and superior boundary segment **3006** intersect to form an anterior-superior corner **3012**. The superior boundary segment **3006** and posterior boundary segment **3008** intersect to form a superior-posterior corner **3014**. The posterior boundary segment **3008** and posterior inferior access region **2016** intersect to form a superior-posterior corner **3016** of the posterior inferior access region **2016**. The inferior boundary segment **3002** and posterior inferior access region **2016** intersect to form an inferior-posterior corner **3018** of the posterior inferior access region **2016**.

The inferior boundary segment **3002** extends between corners **3010** and **3018**. The anterior boundary segment **3004** extends between corners **3010** and **3012**. The superior boundary segment **3006** extends between corners **3012** and **3014** and provides an access into the cranial portion **1087** of the sacroiliac joint. The posterior boundary segment **3008** extends between corners **3014** and **3016**. The posterior inferior access region **2016** extends between corners **3016** and **3018** and provides an access into the caudal region **1086** of the sacroiliac joint. The posterior boundary segment **3008** separates articular region **1044** and extra-articular region **3007**, which includes the sacral fossa on the sacrum **1004** and the corresponding iliac tuberosity on the ilium **1005** and defined by the extra-articular region boundary **3009**.

As shown in FIG. **48**, the implant **25** is inserted via the distal end **35** of the shaft **100** of the delivery tool **20** into the caudal region **1086** of the sacroiliac joint articular region **1044**. As shown via the implant **25** and shaft **100** shown in solid lines, in one embodiment, the implant **25** enters the posterior inferior access region **2016**, and is further advanced into the caudal region **1086** of the sacroiliac joint articular region **1044**, in an orientation such that the shaft **100** and side edge faces **7150** of the implant body **45** face in a direction that extends along the joint plane **1030** (see, for example, FIGS. **42**I-**42**J and FIGS. **45**C and **45**D) and the longitudinally extending side edge face **7150** of the implant body **45** next to the inferior boundary segment **3002** is generally parallel to, and immediately adjacent to, the inferior boundary segment **3002**. Thus, the distal end **42** of the implant is heading generally perpendicular to, and towards, the anterior boundary segment **3004**.

As shown in FIG. **48** via the implant **25** and delivery tool shaft **100** shown in dashed lines, in one embodiment, the implant **25** enters the posterior inferior access region **2016**, and is further advanced into the caudal region **1086** of the sacroiliac joint articular region **1044**, in an orientation such that the delivery tool shaft **100** and side edge faces **7150** of the implant body **45** face in a direction that extends along the joint plane **1030** (see, for example, FIGS. **42**I-**42**J and FIGS. **45**C and **45**D) and the longitudinally extending side edge face **7150** of the implant body **45** next to the inferior boundary segment **3002** is somewhere between being generally parallel to the inferior boundary segment **3002** (as illustrated by the solid-lined implant **25** in FIG. **48**) or forming an angle AJ with the inferior boundary segment **3002** of up to approximately 50 degrees. Thus, the distal end **42** of the implant shown in dashed lines can be said to head anywhere from generally perpendicular to, and towards, the anterior boundary segment **3004** to heading generally towards the superior-anterior corner **3012**, or points in between.

In one embodiment, the implant **25** may be first directed into the joint space as illustrated by the solid-lined implant **25** in FIG. **48** after which the implant **25** is rotated within the joint space to be positioned somewhere between, and including, angled position depicted by the dashed-lined implant **25**. In other embodiments, the implant **25** may be first directed into the joint space as illustrated by the dashed-lined implant **25** in FIG. **48** after which the implant **25** is rotated within the joint space to be positioned somewhere between, and including, the parallel position depicted by the solid-lined implant **25**.

As can be understood from FIGS. **4**A-**15**, **45** and **48** where the implant **25** has a body **45** that is configured to have a shape that generally mimics and even substantially fills a sacroiliac joint space, depending on the needs of the patient and the treatment plan devised by the physician, generally the entirety of both the long portion **7100** and short portion **7101** of the implant body **45** may reside substantially in the caudal portion **1086** of the sacroiliac joint space (as indicated in FIG. **48**). Alternatively, the long portion **7100** of the implant body **45** may reside in the caudal portion **1086** of the sacroiliac joint space and the short portion **7101** may extend into the cranial portion **1087** of the sacroiliac joint space (as indicated in FIG. **45**), the small radius **7102** and large radius of the implant body **45** being generally located at the generally right-angled intersection between the cranial portion **1087** and the caudal portion **1086** of the sacroiliac joint.

As can be understood from FIG. **42**K, with the delivery tool **20** still coupled to the implant and the implant **25** located within the sacroiliac joint space as shown in FIG. **45**A-**45**D or **48**, the anchor members **30** are positioned in the guide lumens **132** of the delivery tool distal end **35** (see FIGS. **17**C and **21**) in preparation for driving the anchors **30** through the respective bores **40** of the implant body **45**.

As can be understood from FIGS. **22**-**24** and **45**B-**45**D, a distal end of a driving tool (e.g., screw driver) is engaged in turn with a proximal end of the anchor member **30** (e.g., screw) residing in the respective guide lumen **132** to drive the anchor **30** through the implant bores **40** and into the adjacent bone of the sacrum and ilium as reflected in FIG. **42**L. Specifically, the driving tool is used to drive (e.g., a screw) each anchor **30** through its respective guide lumen **132** and into the respective implant anchor bore **40** aligned with the respective guide lumen **132** such that the distal region of the anchor **30** extends both distally and laterally from the respective side face **7060** of the implant body **45** into the respective bone (i.e., ilium and sacrum) bordering the sacroiliac joint space as depicted in FIG. **42**L.

Prior to anchor member implantation, guide lumen **132** may be further configured with a needle guide sleeve to allow for guided advancement of a needle into the bone of a sacrum or ilium for aspiration of bone marrow which may be used in subsequent steps during the course of the procedure or for administration into the patient at a later date after the procedure has been completed (e.g., the aspirate may be manipulated and stem cells isolated and cultured for administration into the patient to treat a medical condition).

As shown in FIG. **42**M, once the implant assembly formed of the implant **25** and anchor members **30** is secured at the implantation site such that the implant **25** is located in the prepared space **1029** of the sacroiliac joint space and the anchor members **30** extend from the implant body bores **45** into the bone of the ilium **1005** and sacrum **1004**, the distal end **35** of the delivery tool **20** can be decoupled from the implant proximal end **43**, e.g., by unthreading the retainer distal end **220** from the implant threaded bore **70** (see FIG. **20**). The incision through which the delivery tool distal end **35** entered the patient can then be closed.

The anchor members **30** prevent migration of the implant **25** within the joint space. The anchor members **30** also can draw the ilium and sacrum together about the implant **25**, increasing the sturdiness of the fixation of the implant in the joint space. The anchor members extending through the implant bores and into the bone of both the sacrum and ilium allow the anchor members **30** to be used to drawn the articular surfaces **1016** of the sacroiliac joint **1000** against the external surfaces of the sacroiliac joint implant **25**. With the implant implanted in the sacroiliac joint, the body will cause the joint surfaces to fuse together about the implant **25**.

As shown in FIG. **42**N, another embodiment of the delivery tool **20** may include an implant arm **21** and an anchor arm **23** adapted to guide the delivery of an anchor **27** into the sacrum **1004**, ilium **1005**, or both the sacrum **1004** and ilium **1005** in transverse relation to the sacroiliac joint and the implant **25**. The implant arm **21** may include a distal region and a proximal region and may releasably couple with or be fixedly attached to the delivery tool **20**. The anchor arm **23** may extend from and be supported off of the implant arm **21**. The anchor arm **23** may include an extension member **29** and an anchor guide **31**, which may be a sleeve, collar, or other guide mechanism configured to guide an anchor **27** or anchor delivery tool (not shown) coupled with an anchor **27** along a trajectory **33** that is transverse (i.e., across) to a longitudinal axis of the implant **25**. As seen in the figure, the anchor arm **23** may be fixed and non-adjustable relative to the implant arm **21** and the delivery tool **20** such that the anchor **27** will be delivered in a pre-determined angular orientation relative to the implant **25** when the implant **25** is coupled with the distal end of the delivery tool **20** and when the anchor **27** is guided along the trajectory **33** via the anchor arm **23**.

As can be understood from FIGS. **49**A and **49**B, which are, respectively, posterior and posterior-lateral views the implantation area and the implant assembly implanted there, proximal end **43** of the implant **25** can be seen positioned in the posterior inferior access region **2016**, the implant being implanted in the caudal area of the sacroiliac joint space. The anchor member **30** can be understood to have been driven into the implant bore **40** transversely to the joint plane **1030** via a route in the ilium **1005** that avoids contact with vascular and neurological structures, thereby avoiding potentially life threatening injury to such structures. The ability to blindly, yet safely, drive the anchor members **30** into the respective implant bores **40** and adjacent bones while the implant **25** is hidden in the joint space is made possible by the cooperating configurations of the implant **25** and the delivery tool **20**. Specifically, the guide lumens **132** of the delivery tool distal end **35** being axially aligned with the respective implant bores **40** when the proximal end **43** of the implant **25** is supported off of the distal end **35** of the delivery tool **20** makes it possible to safely drive the anchor members **30** through the implant bores **40** and into the ilium **1005** and sacrum **1004** when the implant is hidden in the joint space on account of being delivered to the joint space via the delivery tool **20**.

While the delivery tool **20** may be employed to deliver the implant **25** to the caudal portion **1086** of the sacroiliac joint space via the caudal approach discussed above with respect to FIGS. **42**A-**49**B, in other embodiments the other approaches and implant locations may be employed. For example, the implant **25** may be implanted in cranial portion **1087** of the sacroiliac joint space via a cranial approach as discussed in U.S. patent application Ser. No. 13/475,695 ("the '695 application"), which is incorporated herein by reference in its entirety. Alternatively, as described in the '695 application, the implant **25** may be implanted in the extra-articular space, as opposed to the sacroiliac joint articular region **1044**, the extra-articular space being accessed via the extra-articular recess access region.

In some embodiments, the system **10** may be provided in the form of a kit **4999**. Such a kit **4999** is shown in FIG. **50**. The kit **4999** may include the system **10** enclosed in a sterile main package **5000**. For example, the delivery tool **20**, the implant **25** and anchor members **30** may be sealed within the sterile main package **5000**. The delivery tool **20** may be any of the tool embodiments disclosed herein and may include all of its components. Also, the implant **25** may be any of the implant embodiments disclosed herein.

As illustrated in FIG. **113**, in some embodiments, the kit **4999** may include multiple sizes of the implant **25** and/or multiple sizes of the anchor members **30**. The multiple implants **25** may be contained in a sterile individual package **5002** within the sterile main package **5000**, and the multiple anchor members **30** may be contained in another sterile individual package **5004** within the sterile main package **5000**. By providing the multiple sizes of implants **25** and anchor members **30**, the implants and anchor members can be used as trials during certain steps of the procedure to determine appropriate implant sizes and to allow a physician, who is presented with the kit **4999** containing the delivery system **20** and multiple sizes and configurations of the implant and anchor members, to evaluate particular embodiments of an implant and anchor member as described herein that would be best suited to a particular patient, application or implant receiving space. The kit **4999** may also or alternatively contain multiple implants **25** with different angles of bores **40** to provide various desirable trajectories for anchor members **30** and multiple delivery systems **20** with as-manufactured angular relations corresponding to the different angles of the bores. The kit **4999** may also include color coded, numeric or other indicators corresponding between delivery systems **20** and the corresponding implants **25**.

In some embodiments, the kit **4999** may include instructions **5006** that lay out the steps of using the system **10**. The instructions **5006** may be contained within one of the sterile packages such as, for example, the sterile main package **5000**. Alternatively, the instructions **5006** may be adhered or otherwise attached to an exterior surface of one of the sterile packages such as, for example, the sterile main package **5000**. Alternatively, the instructions **5006** may be simply provided separately such as, for example, via simply shipped loose with the rest of the kit **4999**, emailed, available for download at a manufacturer website, or provided via a manufacture offered training seminar program.

In some embodiments, the kit **4999** may have any one or more of the tool **20**, implants **25** and anchor members **30** contained in individual sterile packages that are not held within a sterile main package. Alternatively, the tool **20**, implants **25** and anchor members **30** may be contained in a single common package or in any combination of packages and combination of tool, implants and anchor members.

As can be understood from FIG. **51**, which is the same transverse cross sectional view of the patient's hip as shown in FIG. **42**M, once the implant **25** and anchors **30** are secured at the sacroiliac joint **1000** in the manner depicted in FIG. **42**M, the implant **25** can be used as an attachment point for structural components of a spinal support system configured to support across the patient's hip structure and/or to support along the patient's spinal column. To serve as an attachment point for structural components of a spinal support system, a coupling element **2087** is connected to the proximal end **2011** of the sacroiliac joint implant **25**. As a non-limiting example, the coupling element **2087** can be disposed in fixed relation to the proximal end **2011** of the sacroiliac joint implant **25** by threaded engagement of a fastener portion **2088**; however, the invention is not so limited and the fastener portion **2088** can be connected to the first end **2011** of the sacroiliac joint implant **25** by any method such as welding, spin welding, adhesive, or the like. The coupling element **2087** can further provide a coupling portion **2089** configured to join with a numerous and wide variety of cross sectional geometries of spanning members **2090**. As a non-limiting example, the coupling portion **2089** can be configured as cylindrical cup **2091** pivotally coupled to the fastener portion **2088**. A spiral thread can be coupled to the internal surface of the cylindrical cup **2091** to rotationally receive a spirally threaded body **2092**. The side wall **2093** of the cylindrical cup **2091** can include a pass through element **2094** in which part of a spanning member **2090** can be received. The part of the spanning member **2090** received within the pass through element **2094** can be placed in fixed relation to the cylindrical cup **2091** by rotational engagement of the spirally threaded body **2092**.

FIG. **52** is a posterior view of the patient's sacrum **1004** and iliums **1005**, wherein structural components of a spinal support system extend medial-lateral across the patient's hip structure and superiorly to support along the patient's spinal column. As shown in FIG. **52**, in one embodiment, each of a pair of sacroiliac joints **1000** can receive an embodiment of the sacroiliac joint implants **25**, disclosed herein, each having a coupling element **2087** coupled to the first end **2011**. Each of the coupling elements **2087** can receive the opposed ends **2095** of a spanning member **2090**. Additionally, the spanning member **2090** in fixed relation to the sacroiliac joint implants **25** can be connected to a plurality of additional spanning members **2096** which can as a non-limiting example be placed in positional relation to the vertebral column **2097** to allow support of additional implants which can be anchored between vertebrae.

FIG. **53** is the same view as FIG. **52**, except having a different spanning member structure. As illustrated in FIG. **53**, a first coupling element **2087** can be joined to the first end **2011** of an embodiment of a sacroiliac joint implant **25** as disclose herein and the fastener portion **2088** of a second coupling element **2087** can be disposed directly into the bone of the sacrum **1004** or the ilium **1005**, or both. The opposed ends **2095** of a spanning element **2090** in the form of a flat plate can provide apertures **2096** through which the fastener portion **2088** of the coupling element **2087** can pass. The corresponding parts of the external surface of the coupling portion **2089** and the spanning member **2090** can be engaged to fix the location of the spanning member **2090** allowing for coupling of the lumbar spine to the stabilized pelvis by a plurality of fixation elements to further increase stability. As an example, fastener **2088** can be a pedicle screw and may be implanted in the S1 pedicle and angled generally anteriorly and generally parallel to the S1 endplate. Alternatively or additionally, fastener **2088** can be a S2AI screw and may be implanted in the sacrum, across the sacroiliac joint, and terminate in or through the ilium.

In one embodiment, the implant **25** and spanning element **2090** of FIG. **52** are a multi-piece arrangement as illustrated in FIG. **52** and assembled during the surgery. In another embodiment, the implant **25** and spanning element **2090** of FIG. **52** are in the form of an integral, unitary construction that is provided to the physician by a manufacturer in such an integral, unitary construction with the spanning element **2090** simply being an extension of a proximal region of the implant **25**.

Similarly, in one embodiment, the implant **25** and spanning element **2090** of FIG. **53** are a multi-piece arrangement as illustrated in FIG. **53** and assembled during the surgery. In another embodiment, the implant **25** and spanning element **2090** of FIG. **53** are in the form of an integral, unitary construction that is provided to the physician by a manufacturer in such an integral, unitary construction with the spanning element **2090** simply being an extension of a proximal region of the implant **25**.

In one embodiment, as schematically depicted in FIG. **54**, the implant **25** may be configured to include a stimulating electrode (NM) connected to an internal controllable power source or external controllable power source. For example, the external controllable power sources may be either in the delivery system instrumentation **20** itself or a separate controller unit located in the operating suite and electrically coupled to the implant supported electrode NM via electrical conductors extending through the implant body and the shaft **100** of the delivery system **20** to electrically couple to the separate controller unit via a cable extending proximally from the delivery system **20** to the separate controller. With the exception of the electrode (NM) itself, the entirety of the rest of the implant surfaces may be electrically insulated so as to prevent current shunting into surrounding tissues or the operator.

In one embodiment, the stimulating electrode (NM) during navigation can have an amperage of about 8 milliamps (mA) or, nearing final placement, an amperage of about 1-4 mA and, in certain cases, up to 5 mA. The electrode (NM) may be attached to or at least partially imbedded in implant **25** (either permanently or retrievable/removable after implantation) (or according to particular embodiments, located within, near or on the anchor **30**, probe **1054**, on or within a trial, broach, drill or other tools of system **10**) to reduce the risk to the patient of iatrogenic damage to the nervous system by using intraoperative neurophysiological monitoring, for example electromyography (EMG), which is able to alert the surgeon or technician reliably and in real-time of implant **25** advancing beyond, for example, inferior boundary segment **3002** or beyond anterior-inferior corner **3010**.

As illustrated in FIG. **54**, which is a schematic depiction of a joint implantation system **10** configured for nerve stimulating and sensing, in one embodiment, the system **10** includes a joint implant **25**, a delivery tool **20**, a nerve stimulating system **10003**, a pre-amplifier unit **10004**, an amplifier unit **10005**, a computer **10006**, and an electrical conductor pathway **10001**. The joint implant **25** includes an electrode NM and a body **45** including a distal end **42** and a proximal end **43** opposite the distal end. The electrode NM is supported on the implant **25**. The delivery tool **20** includes an implant arm **110** with a distal end **35** configured to releasably couple to the proximal end **43** of the body **45** of the joint implant **25**. The nerve stimulating system **10003** is configured to stimulate electrode NM in order to sense nerve contact made with the electrode NM or when NM is approaching and near a nerve. The electrical conductor pathway **10001** extends from the electrode NM along the implant **25** and implant arm **110** to the nerve stimulating system **10003**. The electrical conductor pathway **10001** places the electrode NM and nerve stimulating system **10003** in electrical communication.

A sensing (or recording) electrode **10011** can be placed in, for example, a quadriceps femoris, tibialis anterior, gastrocnemius, or abductor hallucis muscle and may be coupled to an electrical conductor pathway **10007** that extends to the pre-amplifier **10004**. A reference electrode **10010** can also be placed in, for example, a quadriceps femoris, tibialis anterior, gastrocnemius, or abductor hallucis muscle, but in a location between the area subject to stimulation from the stimulating electrode (NM) and the sensing (or recording) electrode **10011**; and may be coupled to an electrical conductor pathway **10012** that extends to the nerve stimulating system **10003**. An additional needle **10009** can be placed in proximity to the aforementioned needles (i.e., electrodes **10010**, **10011**) within a muscle (or when the electrode is in the form of a patch it may be applied to the skin of the patient) and may be coupled to an electrical conductor pathway **10008** that extends to the pre-amplifier **10004** and a ground.

The pre-amplifier **10004** may be connected to the amplifier **10005** that itself may be connected to the computer unit **10006**. The computer unit **10006** may process or interpret the signal from the amplifier **10005** and display or otherwise alert (e.g., auditory signals with varying amplitude or frequency) or convey to an observer or operator in an operating suite or to a monitoring physician in a remote location (e.g., by employing computer software and processing and networking hardware) the state of the various electrical connections and pathways (e.g., connected versus disconnected) and electrical activity caused by the stimulating electrode NM.

In one embodiment, the proximal end **43** of the implant **25** and the distal end **35** of the implant arm include a cooperatively mating electrical connection **10000** that form a segment of the electrical conductor pathway **10001**. An example of such a cooperatively mating electrical connection includes a male-female pin contact assembly **10000**. The proximal end **80** of the delivery tool **20** and a distal end of an electrical conductor segment of the pathway **10001** between the sensing system **10003** and the proximal end **80** include a cooperatively mating electrical connection **10002** that form a segment of the electrical conductor pathway **10001**. The electrical conductor pathway **10001** may be in the form of one or more multi-filar cables, one or more solid core wires, etc. The electrode NM is at or near the distal end **42** of the implant **25** and the rest of the implant (or only an area directly surrounding the electrode NM) has an electrically insulative coating or is formed of an electrically nonconductive material.

To begin a detailed discussion of a second embodiment of the system **10**, reference is made to FIGS. **55A**-**56**. FIG. **55A** is an isometric view of the system **10**. FIG. **55B** is the same view as FIG. **55A**, except an implant assembly **15** of the system **10** is separated from a delivery tool **20** of the system **10**. FIG. **56** is the same view as FIG. **55A**, except the system **10** is shown exploded to better illustrate the components of the system **10**.

As can be understood from FIGS. **55A** and **55B**, the system **10** includes a delivery tool **20** and an implant assembly **15** for implanting at the sacroiliac joint via the delivery tool **20**, the implant assembly **15** being for fusing the sacroiliac joint. As indicated in FIG. **56**, the implant assembly **15** includes an implant **25** and anchor elements **30** (e.g., self-locking blades or other elongated bodies slidably extendable from the implant body). As discussed below in greater detail, during the implantation of the implant assembly **15** at the sacroiliac joint, the implant **25** and anchor element **30** are supported by a distal end **35** of the delivery tool **20**, as illustrated in FIG. **55A**. In one embodiment, the distal end **35** may be fixed or non-removable from the rest of the delivery tool **20**. In other embodiments, the distal end **35** of the delivery tool **20** may be removable so as to allow interchanging of different sized or shaped distal ends **35** to allow matching to particular implant embodiments without requiring the use of a different delivery tool **20**. The delivery tool **20** is used to deliver the implant **25** into the sacroiliac joint space. The delivery tool **20** is then used to cause the anchor elements **30** to deploy or otherwise extend from the sides of the implant **25** and into the bone of the ilium and sacrum defining the sacroiliac joint. The delivery tool **20** is then decoupled from the implanted implant assembly **15**, as can be understood from FIG. **55B**.

To begin a detailed discussion of components of an embodiment of the implant assembly **15**, reference is made to FIGS. **57A**-**57F**, which are various isometric, end elevation, side elevation, and plan views of the implant assembly **15**. As shown in FIGS. **57A**-**57F**, the implant assembly **15** includes an implant **25** and anchor elements **30**. In one embodiment, the anchor elements **30** may be in the form of an self-locking blades **30** or other elongated bodies slidably extendable from the implant body.

As indicated in FIGS. **57A**-**57F**, the anchor elements **30** are configured to be received in bores **40** defined through the implant **25**. The bores **40** extend through the implant **25** distally and laterally from a proximal end **43** of the implant **25** and are sized such that the anchor elements **30** can at least project both laterally and distally from the sides of the implant **25** as illustrated in FIGS. **57A**-**57F**. In one embodiment, the anchor elements **30** may be generally blade-like members **30** that are substantially wider and longer than thick. Where the anchor elements **30** are blade-like, the bores **40** may then be slots **40** that are shaped to match the blade-like anchor elements **30** received therein. Each blade-like member **30** may have a slight curvature along its length that matches the slight curvature of the slot **40** in which the blade-like member **30** is received, as can be understood from FIG. **61**, which is a longitudinal cross section of the implant **25** as taken along section line **61-61** in FIG. **60**.

As can be understood from FIGS. **57**A-**57**F, the blade-like anchor members **30** may have a distal or leading edge **30**A with a notch **30**B defined therein. Serrations or other anti-migration features **30**C may be defined in the side edges **30**D of the members **30**. Locking tabs **30**E may extend from the side edges **30**D of each member **30** to bias outwardly once free of the confines of the slot **40** after the member **30** has been sufficiently distally displaced out of the slot **40**. By biasing outwardly to have an overall width that is greater than the width of the corresponding slot **40**, the locking tabs **30**E prevent the proximal migration of the member **30** within the slot **40**. By applying a distal acting force on the blunt proximal end **30**F of a member **30**, the member **30** may be caused to slide distally within its slot **40** to cause the distal end **30**A of the member **30** to project distally and laterally from the implant body **45**, such projection being capable of anchoring the implant assembly **15** into bone defining the sacroiliac joint space.

For a detailed discussion of the implant **25** of the implant assembly **15** discussed above with respect to FIGS. **57**A-**57**F, reference is made to FIGS. **58-61**. FIG. **58** is an isometric view of the implant **25**. FIGS. **59** and **60** are, respectively, plan and proximal end elevation views of the implant **25**. FIG. **61** is an isometric longitudinal cross section of the implant **25** as taken along section lines **61-61** in FIG. **60**.

As shown in FIGS. **58-61**, in one embodiment, the implant **25** includes a distal or leading end **42**, a proximal or trailing end **43**, a longitudinally extending body **45**, slots **40** extending distally and laterally through the body from the proximal end **43**, an attachment bore **70**, and an opening **50**. In one embodiment, as reflected in FIGS. **58-61**, the implant body **45** has a generally rectangular box shape. However, in other embodiments similar to that discussed above with respect to FIGS. **5-15**, the implant body **45** may be configured to have a shape that generally mimics and even substantially fills a sacroiliac joint space.

As illustrated in FIG. **60**, the implant **25** includes a proximal end **43** for being removably coupled to the extreme distal end **35** of the delivery tool **20**. Specifically, in one embodiment, the implant proximal end **43** includes an attachment bore **70** that extends distally through the implant from the proximal end **43**. The attachment bore **70** may be a blind hole in that it only has a single opening, which is at the proximal end **43**. Alternatively, the attachment bore **70** may be configured as a hole that communicates between the implant proximal end **43** and implant opening **50**. The attachment bore **70** may be threaded or otherwise configured so as to allow mechanical engagement with a distal end **220** of a retainer member **95** of the delivery tool **20**, the retainer member **95** being used to secure the implant **25** off of the distal end **35** of the delivery tool **20**, as described in detail below. In one embodiment, the attachment bore **70** has a diameter of between approximately 2 mm and approximately 10 mm, with one embodiment having a diameter of approximately 5 mm.

In one embodiment, the implant **25** can be configured such that the body **45** of the implant is a generally continuous solid surface with the exception of the slots **40** and bore **70** extending through portions of the body **45**. However, as illustrated in FIGS. **58** and **60**, in other embodiments, the body **45** of the implant **25** may have one or more openings or voids defined in the body **45**. For example, an opening or void **50** may be defined in the implant body **45**. The void **50** may be packed with bone growth material prior to the implant **25** being delivered into the sacroiliac joint space.

As indicated in FIGS. **58-60**, the implant body **45** includes side edge surfaces **7150** that extend between the proximal end **43** and the distal end **42**. These side edge surfaces **7150** and the similar side edge surfaces associated with the distal end **42** and proximal end **43** combine to define side edge surface boundary that extends unbroken and unitary through all of the above-mentioned regions of the implant, thereby forming an outer boundary that may at least somewhat resemble a rectangle. In other embodiments, the outer boundary formed by the side edge surfaces may resemble other shapes including, for example, a circle, an oval or etc. In one embodiment, the outer boundary formed by the side edge surfaces may even resemble the sacroiliac joint space as discussed above with respect to FIGS. **5-15**, thereby allowing the implant **25** to more fully occupy the joint space than more linearly shaped rectangle and cylindrical implant embodiments.

As illustrated in FIGS. **58-61**, in one embodiment, the implant body **45** includes generally planar lateral side surfaces **7060**. In some embodiments, the lateral side surfaces **7060** may be generally spaced apart by a distance or body thickness that is generally continuous over the entirety of the surfaces **7060**. However, in some embodiments, the distance or body thickness may taper from a greater thickness in some regions of the body to a lesser thickness in other regions of the body.

In one embodiment, the planar lateral side surfaces **7060** may be substantially smooth. However, in other embodiments, as indicated in FIGS. **58-61**, the planar lateral side surfaces **7060** may have multiple parallel ridges **7061** that extend longitudinally along the long portion **7100** and may be serrated with notches **7062** oriented so as to prevent proximal migration of the implant **25** once implanted in the sacroiliac joint. The anti-migration features **7062** are generally evenly distributed along the planar surfaces **7060**. While the anti-migration features **7062** are depicted as being notches **7062** defined in the longitudinally extending ribs or ridges **7061**, in other embodiments the anti-migration features **7062** may be in the form of other types of surface texturing or protrusions in the form of cylinders, trapezoids, squares, rectangles, etc. Further, although the anti-migration features **7062** are depicted in the form of unidirectional serrated notches **7062** in ridges **7061** on the planar lateral side surfaces **7060** the implant **25**, the invention is not so limited and, as to particular embodiments, can be configured to have said features **7062** arranged in multiple directions, unidirectional, or a combination of multiple direction on some surfaces of the implant and unidirectional on other surfaces of the implant. Accordingly, the features **7062** can be so arranged on the various surfaces of the implant so as to prevent undesired migration in particular directions due to the forces present at the sacroiliac joint **1000**.

As indicated in FIGS. **58** and **60**, a longitudinally extending rectangular notch **6514** may be defined in a side edge surface **7150**. As described below, such a notch **6514** may interact with a member **140** forming part of the delivery tool distal end **35** so as to help retain the implant **25** on the distal end **35** and to prevent the implant from rotating relative to the distal end **35** when the retaining rod threaded distal end **220** is being threaded into or out of the attachment bore **70**.

As can be understood from FIGS. **58-61**, in one embodiment, the slots **40** extend distally and laterally from a proximal end **43** of the implant **25** to daylight distally in the planar lateral side surfaces **7060**, thereby exiting the implant body **45** laterally as slots **40** defined in the planar lateral side surface **7060**. Since the slots **40** are oriented so as to extend distally and laterally from the proximal end **43** and, further, since the blade-like anchors **30** have sufficient length, the anchors **30** project both laterally and distally from the planar lateral side surfaces **7060** of the implant **25**, as illustrated in FIGS. **57**A-**57**F.

In one embodiment, the implant **25** may be machined, molded, formed, or otherwise manufactured from stainless steel, titanium, ceramic, polymer, composite, bone or other biocompatible materials. The anchor member **30** may be machined, molded, formed or otherwise manufactured from similar biocompatible materials.

As to particular embodiments as shown in FIGS. **57**A-**61**, and in other embodiments as disclosed throughout, the implants described herein can be configured to be used as trials during certain steps of the procedure to determine appropriate implant sizes and to allow a physician, who is presented with a kit containing the delivery system **20** and multiple sizes and configurations of the implant **15**, to evaluate particular embodiments of an implant as described herein that would be best suited to a particular patient, application or implant receiving space.

The particular embodiments of FIGS. **57**A-**61** depict implant assemblies **15** having an implant **25** with a generally planar body **45** such that the width and length of the body **45** are substantially greater than the thickness of the body **45** and the planar body **45** is generally free of any substantial features of the body extending away from the planar lateral side surfaces **7060**. However, in other embodiments, the implant body **45** of the present disclosure may have the anchoring arrangement illustrated in FIGS. **57**A-**61** and further be configured to have a shape and/or radially extending wings as described with respect to any of the many implant body embodiments described in U.S. patent application Ser. No. 13/475,695, which was filed May 18, 2012 and is hereby incorporated by reference in its entirety.

To begin a detailed discussion of components of an embodiment of the delivery tool **20**, reference is again made to FIGS. **55**A-**56**. As shown in FIG. **55**A, the delivery tool **20** includes a distal end **35** and a proximal end **80**. The distal end **35** supports the components **25**, **30** of the implant assembly **15**, and the proximal end **80** is configured to be grasped and manipulated to facilitate the implantation of the implant assembly **15** in the sacroiliac joint.

As illustrated in FIG. **56**, the delivery tool **20** further includes a shaft assembly **85**, a handle **90**, an implant retainer **95**, and an impactor **97**. As shown in FIGS. **62**A and **62**B, which are, respectively, distal and proximal isometric views of the shaft assembly **85**, the shaft assembly **85** includes the handle **90**, a tubular elongated body **100**, a distal implant engagement end **105**, and an impactor guide **161**. The handle **90** is coupled on a proximal end **110** of the tubular elongated body **100**. The tubular elongated body **100** includes a lumen **115** through which the implant retainer **95** extends, as described below. The impactor guide **161** is a rectangular opening longitudinally extending through a guide head **162** of the distal implant engagement end **105**.

As illustrated in FIG. **63**, which is a distal isometric view of the implant retainer **95**, the implant retainer **95** includes a longitudinal cylindrical member **210**, a handle **215** on a proximal end of the longitudinal cylindrical member **210**, and an implant engagement feature **220** on a distal end the longitudinal cylindrical member **210**. As can be understood from FIG. **65**, which is a distal isometric view of the delivery tool **20**, the member **210** of the implant retainer **95** extends through the lumen **115** of the body **100**, the engagement feature **220** distally extending from the lumen **115** when a distal face of the retainer handle **215** is abutting against a proximal face of the shaft assembly handle **90**.

As illustrated in FIG. **64**, which is a distal isometric view of the impactor **97**, the impactor **97** includes a shaft **97**A, a handle **97**B on a proximal end of the shaft **97**A, and an impactor head **97**C on a distal end of the shaft **97**A. The impactor head **97**C includes planar lateral sides that taper slightly as the planar lateral sides extend distally to a blunt distal end **97**D of the impactor head **97**C. As can be understood from FIGS. **62**A-**62**B, the impactor guide **161** is in the form of a tapered rectangular hole **161** that generally matches the shape of the impactor head **97**C. Thus, the impactor guide hole **161** includes planar lateral sides that taper slightly as the planar lateral sides extend distally to the distal daylight opening of the hole **161** in the guide head **162**. As can be understood from FIG. **65**, the interaction of the tapered configurations of the impactor head **97**C and the impactor guide hole **161** allow the impactor head **97**C to displace distal-proximal within impactor guide hole **161**, but limits the maximum distal displacement of the impactor head **97**C within the impactor guide hole **161** such that the blunt distal end **97**D can protrude from the distal end of the guide head **162** only a small distance.

As shown in FIG. **62**A, the distal implant engagement end **105** includes a distal face **130** that surrounds the distal opening of the anchor guide hole **161** and from which a distally extending member **140** distally projects. The member **140** has a planar face **142** that is configured to be matingly received by the notch **6514** of the implant **25** when the proximal end **43** of the implant **25** is received in an implant receiving space **143** (shown in FIG. **56**) defined by the distal face **130** and planar face **142** (shown in FIG. **62**A). The implant **25** so coupled to the distal implant engagement end **105** of the delivery tool **20** is illustrated in FIG. **67**, which is an enlarged distal isometric view of the system **10**.

As can be understood from FIG. **66**, which is an isometric view of the implant assembly **15** coupled to the implant retainer **95**, the impactor **97** positioned as having fully distally driven the anchors **30**, and the rest of the delivery tool **20** hidden for clarity purposes, in one embodiment, the implant engagement feature **220** is in the form of a threaded shaft for engaging complementary threads in the attachment bore **70**, thereby securing the implant proximal face **43** against the distal face **130** of the distal implant engagement end **105**, the member **140** being received in the notch **6514**, as can be understood from FIGS. **55**A and **67**. The blunt distal end **97**D of the impactor head **97**C is abutting against the implant proximal face **43** after having been displaced sufficiently distal so as to impact the blades proximal ends **30**F to drive the anchor blades **30** fully distal in their respective slots **40** such that the blade tabs **30**E have exited the distal openings of the respective slots **40** and biased wide to prevent the proximal migration of the anchor blades **30** within the slots **40**.

As illustrated in FIG. **68**, which is a distal isometric view of the impactor **97** abutting against the proximal ends of the anchors **30**, the rest of the delivery tool and implant being hidden for clarity purposes, the blunt distal end **97**D can be brought into impacting contact with the proximal ends **30**F of the blade anchors **30**. As can be understood from FIGS. **65**-**66**, the threaded distal end **220** of the retainer **95** is threadably received in the attachment bore **70** of the implant **25** to retain the implant **25** in the implant receiving area **143** (see FIG. **56**) of the tool attachment end **105**. Also, the impactor head **97**C is guided in its distal-proximal displacement against the anchor proximal ends **30**F by the guide head hole **161**.

Prior to being distally driven through the slots **40** by the impactor **97**, the implant **25** may be secured to the distal end of the tool **10** via the mechanical interaction of the retainer distal end **220** in the implant attachment hole **70**. The blades **30** may be staged in the slots **40** by inserting just the blade distal ends **30**A in the proximal openings of the slots **40** when the implant is supported off of the distal end of the delivery tool **10**. With the blades so positioned and the implant so supported, the implant can be delivered into the sacroiliac joint via the delivery tool, and once the implant is positioned within the sacroiliac joint as desired, the impactor **97** can then be used to drive the blades **30** from being substantially in the guide hole **161** and only partially in the slots **40** to being fully out of the guide hole **161** and into the implant slots **40** such that the distal ends **30**A of the blades **30** distally and laterally project from the lateral faces of **7060** of the implant **25** a substantial distance.

It should be noted that the delivery methods described above with respect to FIGS. **25-53** are readily adaptable to the implant system **15** and delivery tool **20** discussed with respect to FIGS. **55**A-**68**, the main difference being that the anchor blades **30** of the implant **25** of FIGS. **57**A-**57**F are impacted through the implant **25** and into the adjacent sacrum and ilium bone, as opposed to being screwed through the implant **25** and into the adjacent bone as is the case with the screw anchors **30** of the implant **25** of FIGS. **4**A-**4**C.

The systems **10** disclosed herein may be further configured, as disclosed in U.S. patent application Ser. No. 13/475,695, which was filed May 18, 2012 and is incorporated herein in its entirety, to allow placement of an anchor **30** near the implant or through a part of the implant **25** from a generally medial or, in some embodiments, a lateral approach as guided by the delivery tool.

To begin a detailed discussion of another method of accessing a sacroiliac joint space to treat a musculoskeletal condition, reference is made to FIGS. **69-71**. To begin and as can be understood from FIGS. **69** and **70**, a stab incision is made in the patient's skin to create an entry point near the coccyx and the sacrotuberous ligament. A cannulated blunt dissecting tool for deflecting soft tissue away from the sacrum may be advanced through the entry point and advanced while following the sacrum up to a sacroiliac joint inferior boundary **3002** which is immediately adjacent, and extends along, the sciatic notch **2024**. A guide wire may then be placed through the cannulation in the dissecting tool and advanced into the sacroiliac joint. Optionally, after the dissecting tool has been removed an inflatable bowel retractor may be advanced over the guide wire and, once in place, inflated to provide a protected passageway for access to a sacroiliac joint. A working cannula may then be advanced over the guide wire to further protect the soft tissues from subsequent use of tools during the remainder of the procedure. The guide wire may then be removed or alternatively left in place to be used to guide an implant delivery tool up to the sacroiliac joint. Regardless, as can be understood from FIG. **71**, any of the tools **20** disclosed herein can be used along the surgical pathway depicted in FIGS. **69** and **70** to deliver corresponding implants **15** into the sacroiliac joint space.

To begin a discussion regarding an embodiment of an implant **15** including an integral rotating anchor arrangement, reference is made to FIGS. **72-76**, which are various isometric, side, and end views of such an implant **15**. As shown in FIGS. **72-76**, the implant **25** includes a distal or leading end **42**, a proximal or trailing end **43**, a longitudinally extending body **45**, bores **70** for coupling the implant to a delivery tool, a center opening **50**, and an anchor **30** pivotably supported in the center opening **50**. In one embodiment, the implant **25** is configured to have a shape that generally mimics and even substantially fills a sacroiliac joint space. However, as indicated in FIGS. **72-76**, in one embodiment, the implant **50** is generally rectangular in shape and includes large opposed radial members **7149** terminating in edge faces **7150** and small opposed radial members terminating **7153** in edge faces **7151**, the small opposed radial members **7153** being generally perpendicular to the large opposed radial members **7149**.

As illustrated in FIG. **76**, the implant **25** includes a proximal end **43** for being removably coupled to the extreme distal end **35** of the delivery tool **20**. Specifically, in one embodiment, the implant proximal end **43** includes a bores **70** that extends distally into the implant from the proximal end **43**. The bores **70** may be blind holes in that they each only have a single opening, which is at the proximal end **43**. Alternatively, the bores **70** may be configured as holes that communicate between the implant proximal end **43** and implant center opening **50**. The bores **70** may be threaded or otherwise configured so as to allow mechanical engagement with a distal end of a retainer feature of the delivery tool **20**, the retainer feature being used to secure the implant **25** off of the distal end **35** of the delivery tool **20**, as described in detail below.

As indicated in FIGS. **72-76**, the implant body **45** includes side edge surfaces **7150** of the large radial members and side edge surfaces **7151** of the small radial members that extend between the proximal end **43** and the distal end **42**. The center opening **50** is defined in the body **45** so as to extend through an inner region of the large radial members **7149** and through the entirety of the small radial members **7153** such that side edge surfaces **7151** of the small radial members **7153** are not continuous distal to proximal but instead from a distal region and a proximal region separated by center opening **50**.

As illustrated in FIGS. **72-76**, in one embodiment, the implant body **45** includes generally planar lateral side surfaces **7060** of the large radial members **7149**. In some embodiments, the lateral side surfaces **7060** may be generally spaced apart by a distance or body thickness that is generally continuous over the entirety of the surfaces **7060**. However, as can be understood from FIGS. **13** and **14**, in some embodiments, the distance or body thickness may vary along the length of the implant body **45**

In one embodiment, the planar lateral side surfaces **7060** may be substantially smooth. However, in other embodiments, as indicated in FIGS. **72-76**, the planar lateral side surfaces **7060** may have multiple serrated features **7061** configurations and spacing **7062** oriented so as to prevent proximal migration of the implant **25** once implanted in the sacroiliac joint. The anti-migration features **7061** are generally evenly distributed along the planar surfaces **7060**. Anti-migration features may also be defined in the outer surface faces **7151** of the small radial members **7153** in the form of notches **7063**. While the anti-migration features are depicted as being serrated features **7061** or notches **7063**, in other embodiments the anti-migration features may be in the form of other types of surface texturing or protrusions in the form of cylinders, trapezoids, squares, rectangles, etc. Further, although the anti-migration features are depicted in the form of unidirectional serrated features or notches on large and small radial members of the implant **25**, the invention is not so limited and, as to particular embodiments, can be configured to have of the anti-migration features arranged in multiple directions, unidirectional, or a combination of multiple direction on some surfaces of the implant and unidirectional on other surfaces of the implant. Accordingly, the anti-migration features can be so arranged on the various surfaces of the implant so as to prevent undesired migration in particular directions due to the forces present at the sacroiliac joint **1000**.

As can be understood from FIGS. **72-76**, the anchor **30** includes bone engagement features **30**A radially extending from a center axle **30**B about which the anchor **30** is pivotally coupled to the implant body **45** so as to be capable of rotating or pivoting within the confines of the center opening **50**. The center axle **30**B is generally coaxially arranged with a longitudinal center axis of the implant body **45**, as can be understood from FIG. **77**, which is an isometric view of another version of the implant having a rotating integral anchor.

As illustrated in FIG. **77**, the proximal end **30**C of the anchor **30** may include an engagement feature (e.g., hex-head) for engagement by a complementarily shaped distal end **7111** of a tool (e.g. hex-head wrench or screwdriver) extending through the delivery tool **20** to cause the anchor **30** to rotate about its axle **30**B within the center opening **50** defined in the implant body **45** so as to bring the engagement features **30**A of the anchor **30** into anchoring engagement with the sacrum and ilium bordering the sacroiliac joint space. When the implant **15** is delivered into the sacroiliac joint space via the delivery tool, the anchor **30** is rotationally positioned in the opening **50** such that the engagement features **30**A are each in alignment with the small radial members **7153** or, alternatively, in alignment with the large radial members **7149**. Thus, the engagement features **30**A are protected from interaction with the bone of the sacrum or ilium by being so aligned with the one set of the radial members. Once the implant **15** is positioned as desired in the sacroiliac joint space, the anchor **30** can be caused to rotate about its axle **30**B so as to cause its engagement members **30**A to engage the sacrum and ilium in an anchoring fashion. The anchor **30** may have a locking mechanism such as, for example, a pawl tooth or ratchet arrangement, a setscrew, or etc., to prevent the anchor **30** from reverse rotating such that the engagement members **30**A ceasing to anchor within the bone of the sacrum and ilium.

As can be understood from a comparison of the anchors **30** of the embodiments of FIGS. **72** and **77** and further as can be understood from the same respective anchors shown alone in FIGS. **78** and **79**, the engagement features **30**A may vary. For example, as shown in FIGS. **72** and **78**, in one embodiment, the engagement features **30**A may be in the form of longitudinally extending blades **30**A supported off of radially extending pairs of arms **30**D from the axle **30**B. In another embodiment, as depicted in FIGS. **77** and **79**, the engagement features **30**A may be in the form of radially extending arms **30**D terminating in tapered points **30**E with an optional radially extending edge **30**F.

In one embodiment, as illustrated in FIGS. **80-84**, which are various isometric, side and end views of another implant **15**, the implant **15** may be free of radially extending members and simply have a body **45** with the opening **50** and the anchor **30** pivotably supported therein. The rest of the feature of the implant **15** may be generally the same as already described, the implant body **15** having a generally rectangular shape with tapered distal end **42** and tapered proximal end **43**. As can be understood from FIGS. **80-84**, the engagement feature **30**A of the anchor **30** may be in the form of a hook. Such an anchor embodiment may be employed with the implants of FIGS. **72-79** or the anchors embodiments of those figures may be employed with the implant of FIGS. **80-84**.

In one embodiment, the implants **25** of FIGS. **72-84** may be machined, molded, formed, or otherwise manufactured from stainless steel, titanium, ceramic, polymer, composite, bone or other biocompatible materials. The anchor member **30** may be machined, molded, formed or otherwise manufactured from similar biocompatible materials.

In one embodiment, a delivery tool **20** for use with the implant embodiments of the FIGS. **72-84** may be configured as illustrated in FIG. **85**. Such a tool **20** may have an implant arm **110** formed mainly of a sleeve **110**Z and a retainer rod **110**X. The retainer rod **110**X may be received coaxially within the sleeve **110**Z.

The retainer rod **110**X includes a shaft **10030** that distally terminates in opposed arms **10032**, which in turn terminate in retainer arms or prong arms **140**. As shown in FIG. **85**, when the rod **110**X is free of the sleeve **110**Z, the opposed arms **10032** are biased apart, resulting in a space-apart distance indicated by arrow D that is sufficiently wide to allow the implant **25** to be received between the prong arms **140** at the rod distal end **120**.

As indicated in FIG. **85**, the sleeve **110**Z includes a distal end **10040**, a proximal end **10042**, and slots **10044** that extend into the hollow interior of the shaft of the sleeve **110**Z. The slots **10044** provide opening into the hollow interior to facilitate sterilization of the sleeve **110**Z via an autoclave. A knurled gripping surface **10046** is defined near the sleeve proximal end **10042** so as to facilitate rotation of the sleeve relative to the rod when the threads **110**Y are being threadably engaged.

As can be understood from a comparison of FIG. **85**, when the sleeve **110**Z is advanced distally over the retainer rod **110**X, complementary threads **110**Y on both the sleeve **110**Z and retainer rod **110**X can be engaged and the sleeve can be rotatably driven distally by said thread engagement. Alternatively, a lever or other mechanical arrangement may be provided to cause the sleeve to be driven distally. The sleeve **110**Z advancing distally causes prong arms **140** of the retainer rod **110**X to draw toward one another and in turn cause the portion of the retainer rod which couples to the implant **25** to grasp the implant. The complementary threads when engaged may prevent proximal movement of the sleeve **110**Z relative to the rod **110**X and allow the coupling of implant and retainer rod to continue throughout the course of the procedure. While the tool **20** is coupled to the implant **15**, a hex-head wrench or screwdriver **7111** may be extended down a central lumen of the shaft **10030** to engage the hex-head end **30**C (see FIG. **77**) of the anchor **30** of the implant to cause its engagement features **30**A to rotate into anchoring engagement with the sacrum and ilium. After implantation the sleeve **110**Z may be caused to move proximally along the retainer rod **110**X in order to decouple the aforementioned tool and implant arrangement.

The foregoing merely illustrates the principles of the invention. Various modifications and alterations to the described embodiments will be apparent to those skilled in the art in view of the teachings herein. It will thus be appreciated that those skilled in the art will be able to devise numerous systems, arrangements and methods which, although not explicitly shown or described herein, embody the principles of the invention and are thus within the spirit and scope of the present invention. From the above description and drawings, it will be understood by those of ordinary skill in the art that the particular embodiments shown and described are for purposes of illustrations only and are not intended to limit the scope of the present invention. References to details of particular embodiments are not intended to limit the scope of the invention.

What is claimed is:

1. A method of implanting an implant in a sacroiliac joint defined between a sacrum and an ilium, the method comprising:

positioning the implant in the sacroiliac joint such that a first lateral side of the implant faces and contacts a sacrum surface of the sacroiliac joint and a second lateral side of the implant faces and contacts an ilium surface of the sacroiliac joint, the first and second lateral sides being opposite the implant from each other;

acting at a proximal end of the implant to cause an anchor to transition from a recessed condition to a deployed condition, the deployed condition being when a bone engagement portion of the anchor extends from an outer surface of the implant into bone defining at least a portion of the sacroiliac joint, the recessed condition being when the bone engagement portion does not extend from the outer surface of the implant; and

using the implanted implant as an attachment point for structural components of a spinal support system.

2. The method of claim **1**, wherein the anchor is configured to displace within a passage extending distal-lateral from a proximal opening of the passage when the anchor transitions from the recessed condition to the deployed condition.

3. The method of claim **2**, wherein the displacement includes sliding.

4. The method of claim **3**, wherein the anchor is a nail.

5. The method of claim **3**, wherein the anchor has blade-like configuration and the passage has a slot-like configuration.

6. The method of claim **3**, wherein acting at the proximal end of the implant to cause the anchor to transition from the recessed condition to the deployed condition includes pushing or impacting on a proximal end of the anchor.

7. The method of claim **6**, further comprising selectively releasably coupling the proximal end of the implant to a distal end of an insertion tool and then employing the insertion tool to deliver the implant into and position the implant in the sacroiliac joint.

8. The method of claim **7**, further comprising displacing a member of the insertion tool relative to the rest of the insertion tool and against the proximal end of the implant to cause the anchor to transition from the recessed condition to the deployed condition.

9. The method of claim **8**, wherein the displacing of the member of the insertion tool is sliding displacement.

10. The method of claim **1**, wherein the anchor is configured to displace within a passage extending generally distal from a proximal opening of the passage when the anchor transitions from the recessed condition to the deployed condition.

11. The method of claim **1**, wherein the anchor is configured to displace within a passage extending generally lateral from a proximal opening of the passage when the anchor transitions from the recessed condition to the deployed condition.

12. The method of claim **11**, wherein the displacement includes rotation.

13. The method of claim **12**, wherein the anchor is a screw.

14. The method of claim **13**, wherein the passage has a bore-like configuration.

15. The method of claim **13**, wherein acting at the proximal end of the implant to cause the anchor to transition from the recessed condition to the deployed condition includes applying a rotational force to a proximal end of the anchor.

16. The method of claim **15**, further comprising selectively releasably coupling the proximal end of the implant to a distal end of an insertion tool and then employing the insertion tool to deliver the implant into and position the implant in the sacroiliac joint.

17. The method of claim **1**, wherein the first and second lateral sides are offset from each other by a thickness of the implant that is less than a width of at least one of the first or second lateral sides.

18. The method of claim **1**, wherein the first and second lateral sides are generally planar.

19. The method of claim **18**, further comprising selectively releasably coupling the proximal end of the implant to a distal end of an insertion tool and then employing the insertion tool to deliver the implant into and position the implant in the sacroiliac joint.

20. The method of claim **1**, wherein when in the deployed condition the bone engagement portion of the anchor extends from at least one of the first or second lateral sides.

21. The method of claim **1**, wherein the anchor is pivotally supported about a pivot axis in the implant, and the anchor is configured to pivot about the pivot axis when the anchor transitions from the recessed condition to the deployed condition.

22. The method of claim **21**, wherein the pivot axis extends proximal-distal between the proximal end of the implant and a distal end of the implant.

23. The method of claim **21**, wherein the bone engagement portion of the anchor includes a blade-like edge extending generally parallel to the pivot axis.

24. The method of claim **21**, wherein the bone engagement portion of the anchor terminates in a tip extending radially outwardly from the pivot axis.

25. The method of claim **21**, wherein acting at the proximal end of the implant to cause the anchor to transition from the recessed condition to the deployed condition includes applying at the proximal end of the implant a torque to the anchor.

26. The method of claim **1**, wherein the spinal support system is configured to support across a patient hip structure.

27. The method of claim **1**, wherein the spinal support system is configured to support along a patient spinal column.

28. The method of claim **1**, wherein the implant enters the sacroiliac joint via a caudal access into the sacroiliac joint.

29. The method of claim **1**, wherein the implant enters the sacroiliac joint via a cranial access into the sacroiliac joint.

30. The method of claim **1**, wherein the implant enters the sacroiliac joint via an extra-articular access into the sacroiliac joint.

31. The method of claim **1**, wherein the implant enters the sacroiliac joint via crossing a sacroiliac joint inferior boundary.

32. The method of claim **31**, wherein the implant enters the sacroiliac joint via a patient entry point near a coccyx and a sacrotuberous ligament.

33. The method of claim **1**, wherein the implant comprises a coupling element at the proximal end of the implant.

34. The method of claim **33**, wherein the coupling element comprises a fastener portion at a distal end thereof and a coupling portion at a proximal end thereof, the fastener portion threadably received in the proximal end of the implant.

35. The method of claim 33, further comprising joining a spanning member to the coupling element.

36. The method of claim 35, wherein the spanning member comprises a rod.

37. The method of claim 35, wherein joining the spanning member to the coupling element comprises engaging a spirally threaded body with the coupling element such that the spanning member is sandwiched between the spirally threaded body and the coupling element.

38. The method of claim 35, further comprising implanting a device into at least one of a bone and a joint proximate the sacroiliac joint.

39. The method of claim 38, further comprising joining the spanning member to the device.

40. The method of claim 38, wherein the bone comprises at least one of the sacrum and the ilium.

41. The method of claim 38, wherein the bone comprises a vertebra.

42. The method of claim 38, wherein the joint proximate the sacroiliac joint comprises another sacroiliac joint spaced apart from the sacroiliac joint by the sacrum.

43. The method of claim 35, wherein the spanning member comprises a plate.

44. The method of claim 43, wherein the plate comprises at least one aperture through which a fastener portion of the coupling element is passable.

45. The method of claim 43, wherein the plate comprises at least one aperture through which a screw is passable and the method further comprising delivering the screw through the at least one aperture generally anteriorly and via an S1 pedicle location.

46. The method of claim 45, wherein the plate comprises a second aperture of the at least one aperture through which a second screw is passable and the method further comprising delivering the screw through the second aperture and into the sacrum, across the sacroiliac joint, and terminating in or through the ilium.

47. The method of claim 33, further comprising joining the coupling element to the proximal end of the implant.

48. The method of claim 33, wherein the coupling element comprises a coupling portion configured to join with a spanning member.

49. The method of claim 48, wherein the coupling portion comprises a cup coupled to the implant and having a pass-through element in which at least part of a spanning member is receivable therethrough.

50. The method of claim 49, wherein the cup is pivotally coupled to the implant.

51. The method of claim 49, wherein the cup is a generally cylindrical body.

52. The method of claim 49, wherein a locking body is engageable with the cup allowing the spanning member to be selectively placed in fixed relation to the cup.

53. The method of claim 1, wherein the implant is coupled to a spanning member in a multi-piece arrangement.

54. The method of claim 53, wherein the implant and spanning member are assembled during a surgery at the sacroiliac joint.

55. The method of claim 54, further comprising coupling the spanning member to the proximal end of the implant.

56. The method of claim 53, wherein the multi-piece arrangement is provided from a manufacturer with the spanning member being an extension of a proximal region of the implant.

57. The method of claim 53, wherein the spanning member comprises a rod.

58. The method of claim 53, wherein the spanning member comprises a plate.

59. The method of claim 58, wherein the plate comprises at least one aperture through which a fastener is passable.

60. The method of claim 59, further comprising delivering the fastener through the at least one aperture and into an S1 body of the sacrum.

61. The method of claim 59, further comprising delivering the fastener through the at least one aperture and into an S2 body of the sacrum, through the sacroiliac joint, and further into the ilium.

62. The method of claim 59, wherein the at least one aperture comprises a first and second aperture through which a first and second fastener, respectively, are passable, and the method further comprising delivering the first fastener through the first aperture and into an S1 body of the sacrum, and delivering the second fastener through the second aperture and into an S2 body of the sacrum, through the sacroiliac joint, and further into the ilium.

63. The method of claim 1, wherein the implant and a spanning member are coupled to each other and form of an integral, unitary construction.

64. The method of claim 63, wherein the spanning member comprises a rod.

65. The method of claim 63, wherein the spanning member comprises a plate.

66. The method of claim 65, wherein the plate comprises at least one aperture through which a fastener is passable.

67. The method of claim 66, further comprising delivering the fastener through the at least one aperture and into an S1 body of the sacrum.

68. The method of claim 66, further comprising delivering the fastener through the at least one aperture and into an S2 body of the sacrum, through the sacroiliac joint, and further into the ilium.

69. The method of claim 66, wherein the at least one aperture comprises a first and second aperture through which a first and second fastener, respectively, are passable, and the method further comprising delivering the first fastener through the first aperture and into an S1 body of the sacrum, and delivering the second fastener through the second aperture and into an S2 body of the sacrum, through the sacroiliac joint, and further into the ilium.

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