US009333090B2

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

(10) **Patent No.: US 9,333,090 B2**
(45) **Date of Patent: May 10, 2016**

(54) **SYSTEMS FOR AND METHODS OF FUSING A SACROILIAC JOINT**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 170 days.

(21) Appl. No.: **13/946,790**

(22) Filed: **Jul. 19, 2013**

(65) **Prior Publication Data**

US 2014/0031935 A1 Jan. 30, 2014

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/475,695, filed on May 18, 2012, 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

(Continued)

(51) **Int. Cl.**
A61F 2/44 (2006.01)
A61F 2/30 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61F 2/4455*** (2013.01); ***A61B 17/1626*** (2013.01); ***A61B 17/1739*** (2013.01); ***A61B 17/1757*** (2013.01); ***A61B 17/7055*** (2013.01); ***A61B 17/7074*** (2013.01); ***A61F 2/30988*** (2013.01); ***A61F 2/4611*** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC A61F 2/4455; A61F 2/4611
See application file for complete search history.

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(57) **ABSTRACT**

Systems for and methods of fusing a sacroiliac joint are provided which include an implant assembly adapted to be inserted into the joint space defined by the bones of a sacrum and an ilium, a delivery tool and means for inserting the implant assembly into the joint. The implant assembly includes a body disposed intermediate distal and proximate end portions thereof and having oppositely disposed side members adapted to expandably engage the sacroiliac joint following insertion of the assembly into the joint space. A tool is provided and provides a means for placing the implant assembly adjacent the sacroiliac joint, inserting it into the joint space and expanding means are thereafter applied to expand the oppositely disposed side members into operative engagement with the joint.

150 Claims, 214 Drawing Sheets

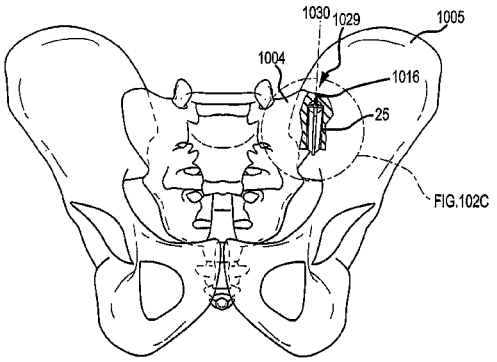
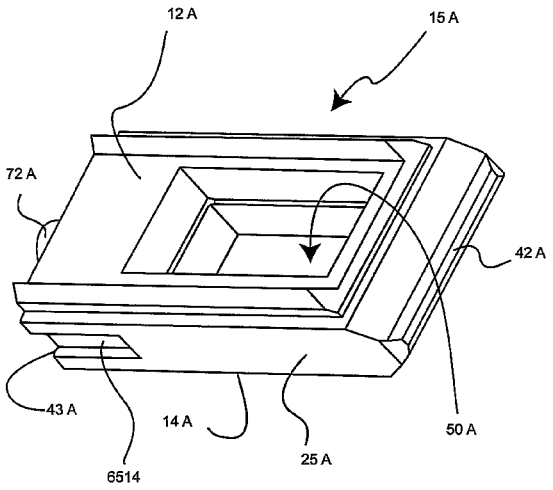


FIG.102C



Related U.S. Application Data

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. 61/800,120, filed on Mar. 15, 2013, provisional application No. 61/674,277, filed on Jul. 20, 2012, 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.**

A61B 17/16	(2006.01)
A61B 17/17	(2006.01)
A61F 2/46	(2006.01)
A61B 17/02	(2006.01)
A61B 17/70	(2006.01)
A61B 17/86	(2006.01)
A61B 17/00	(2006.01)

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

CPC *A61B 17/025* (2013.01); *A61B 17/7043* (2013.01); *A61B 17/8645* (2013.01); *A61B 2017/0046* (2013.01); *A61F 2002/304* (2013.01); *A61F 2002/30163* (2013.01); *A61F 2002/30382* (2013.01); *A61F 2002/30401* (2013.01); *A61F 2002/30428* (2013.01); *A61F 2002/30484* (2013.01); *A61F 2002/30504* (2013.01); *A61F 2002/30509* (2013.01); *A61F 2002/30579* (2013.01); *A61F 2002/30601* (2013.01); *A61F 2002/30622* (2013.01); *A61F 2002/30774* (2013.01); *A61F 2002/30828* (2013.01); *A61F 2002/30995* (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)

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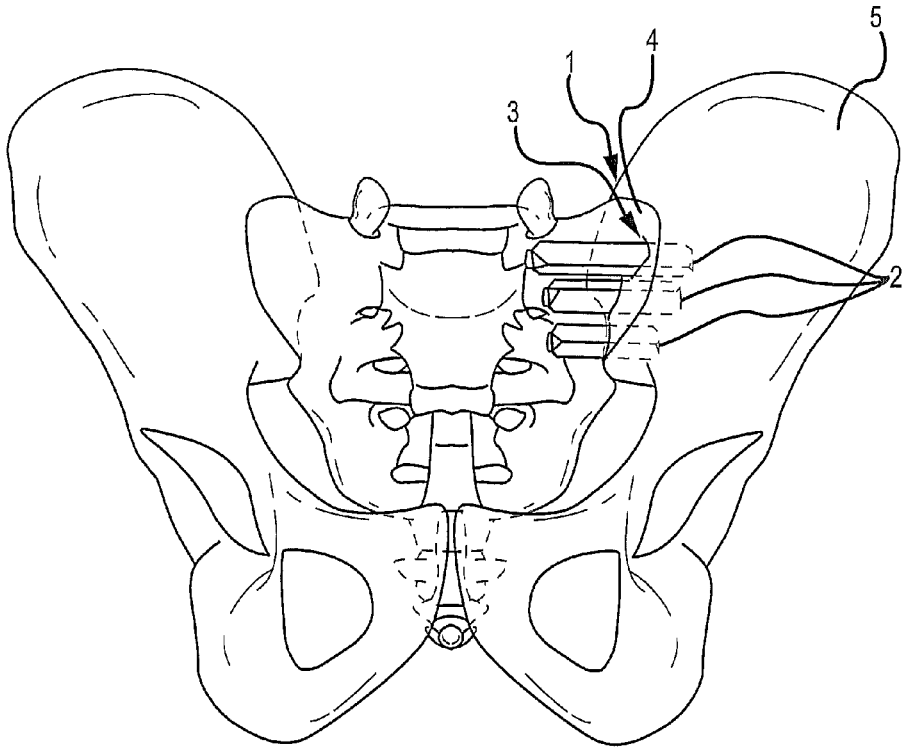

FIG.1
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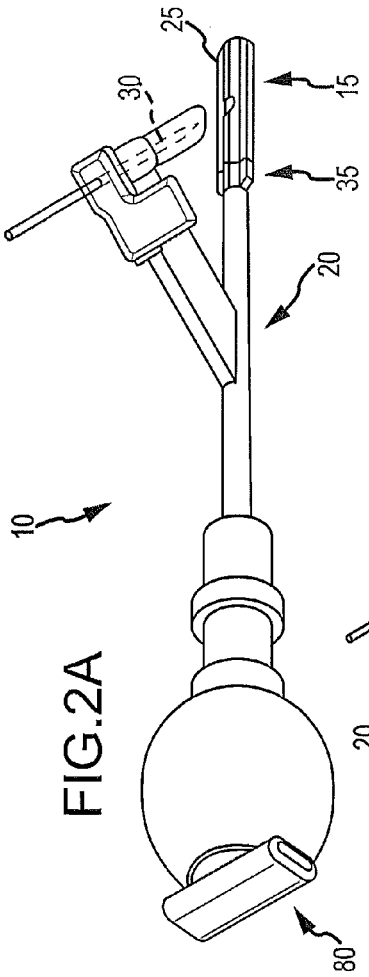


FIG.2A

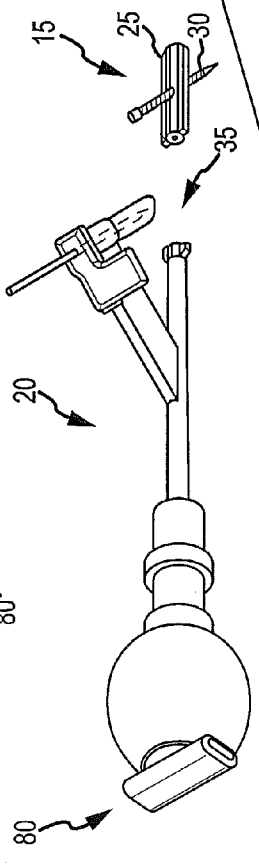


FIG.2B

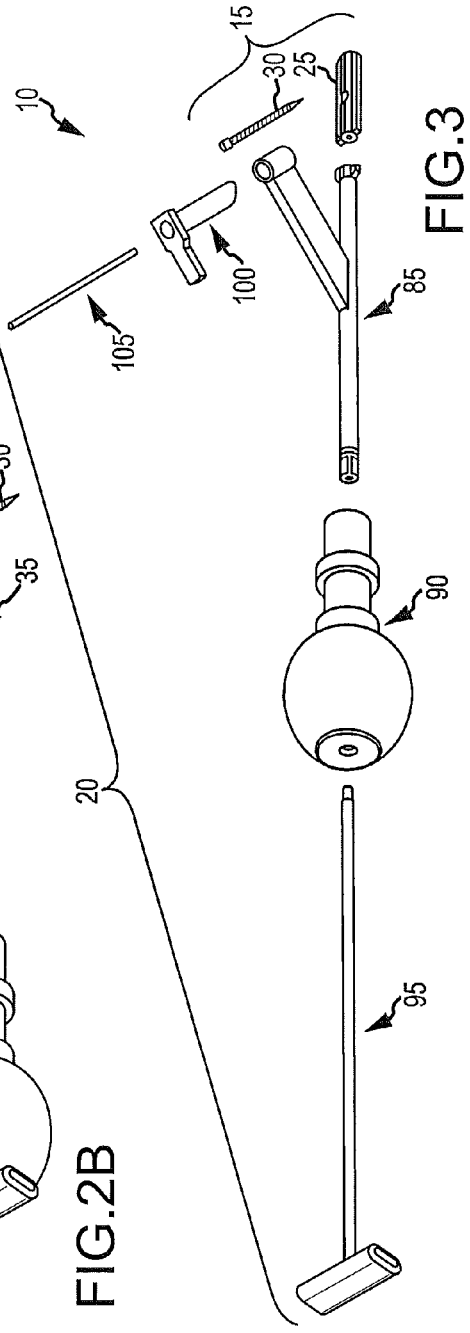


FIG.3

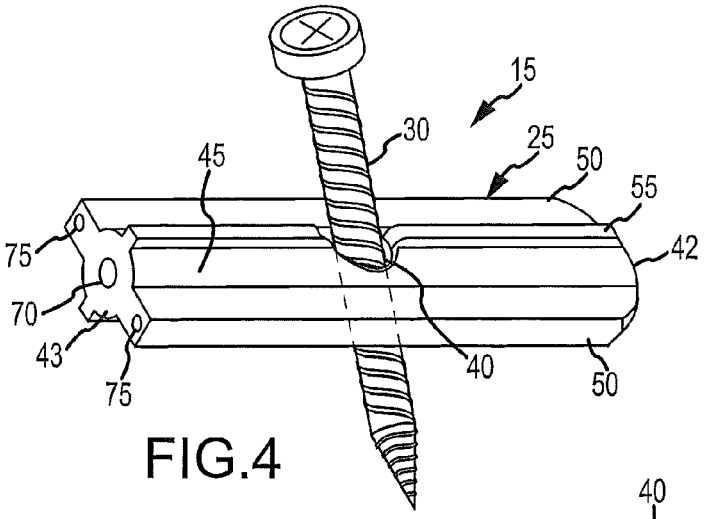


FIG.4

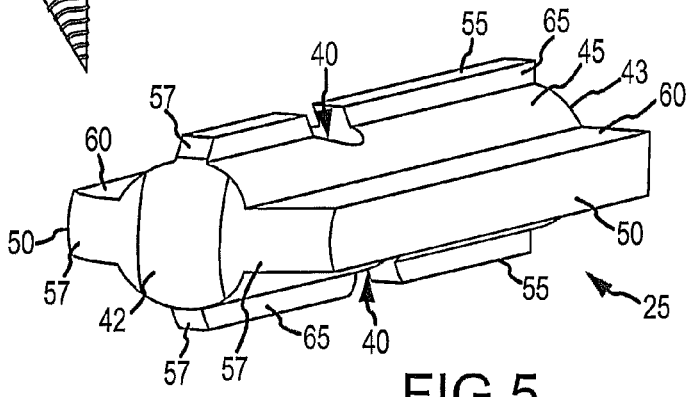


FIG.5

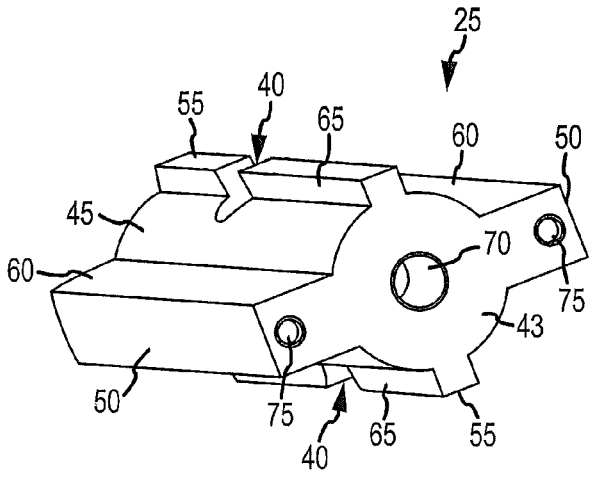


FIG.6

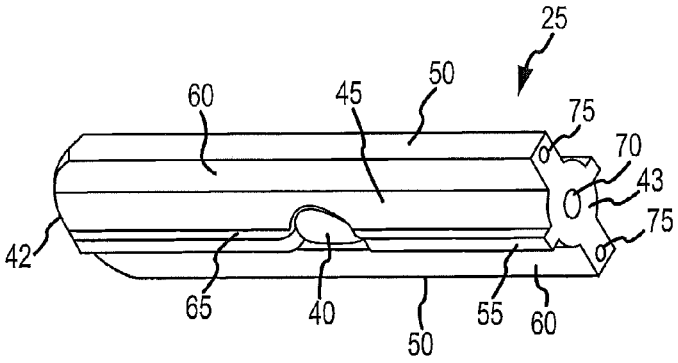


FIG.7

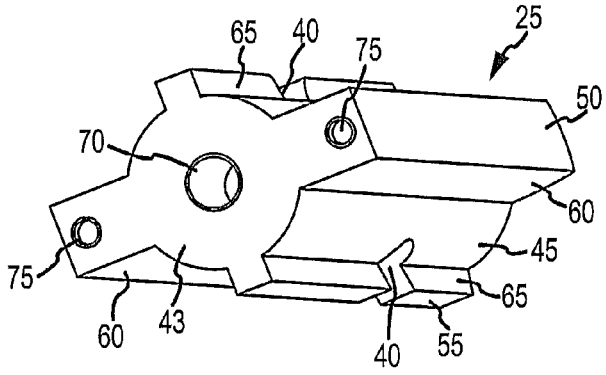
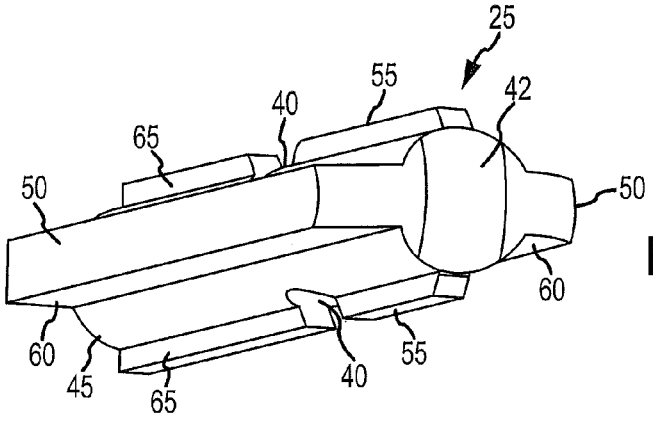


FIG.8



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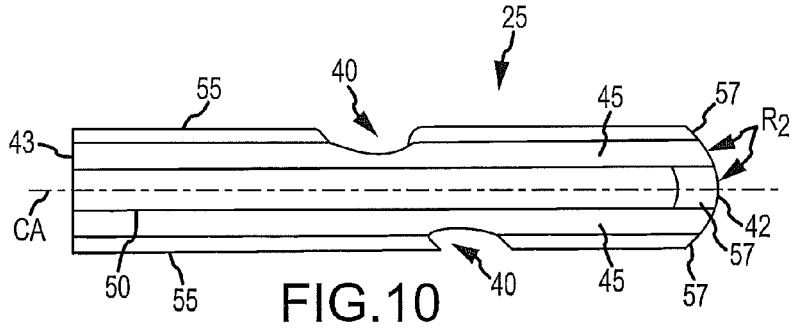

FIG.10

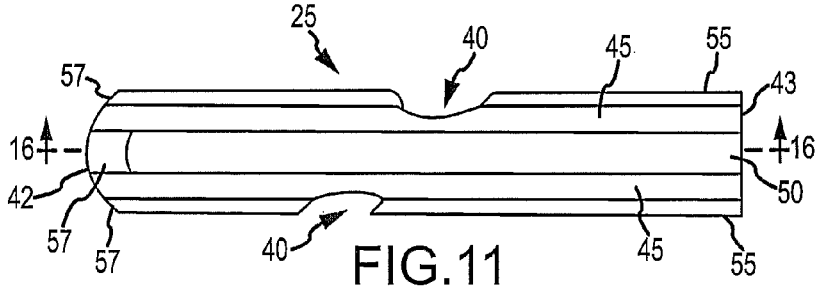

FIG.11

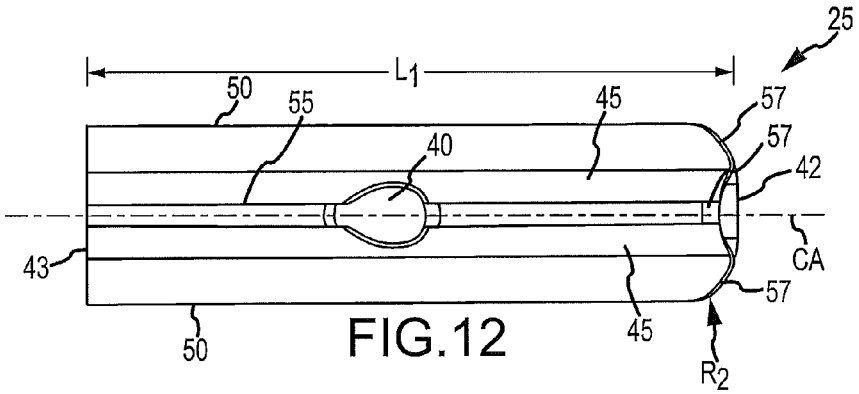

FIG.12

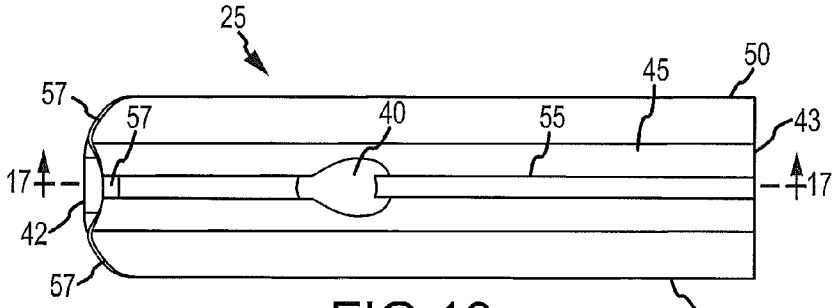

FIG.13

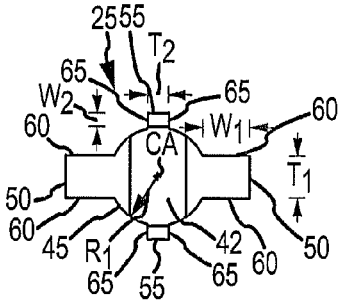

FIG.14

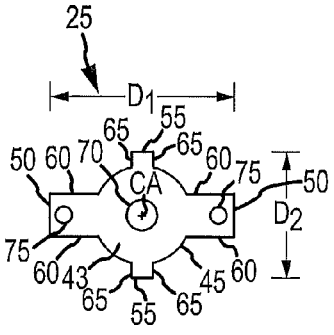

FIG.15

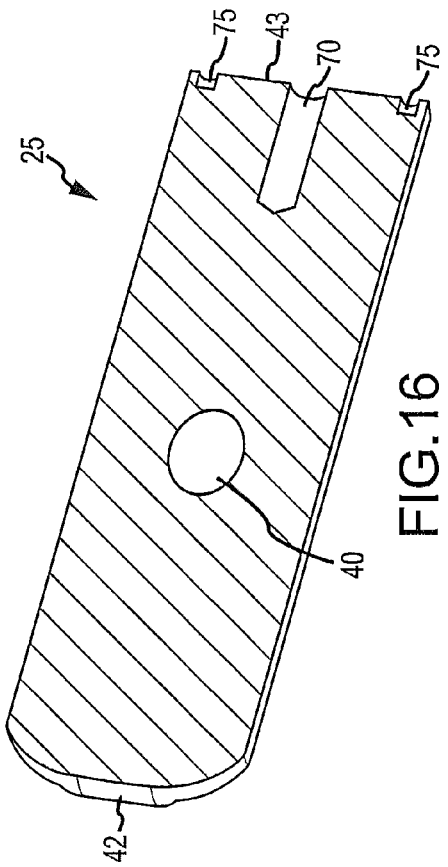

FIG.16

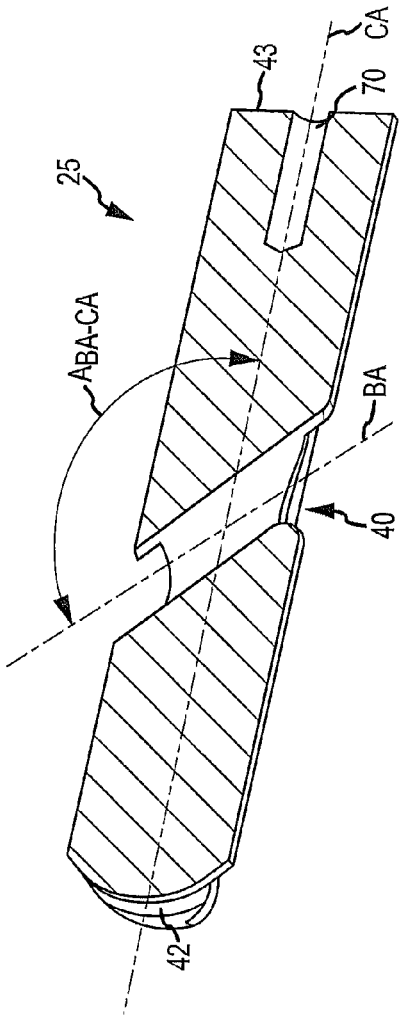

FIG.17

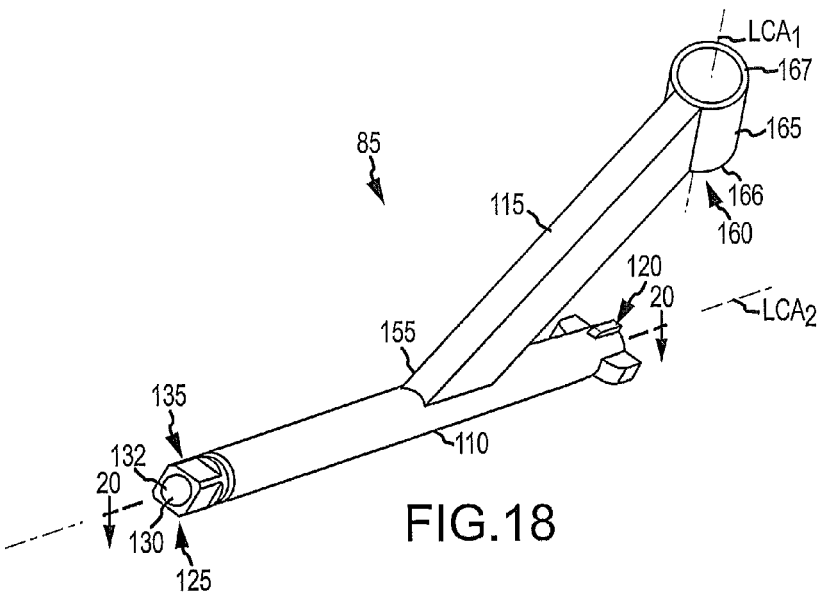
LCA1
167
165
85
166
115
160
120
20
LCA2
155
135
110
132
20
130
125

FIG.18

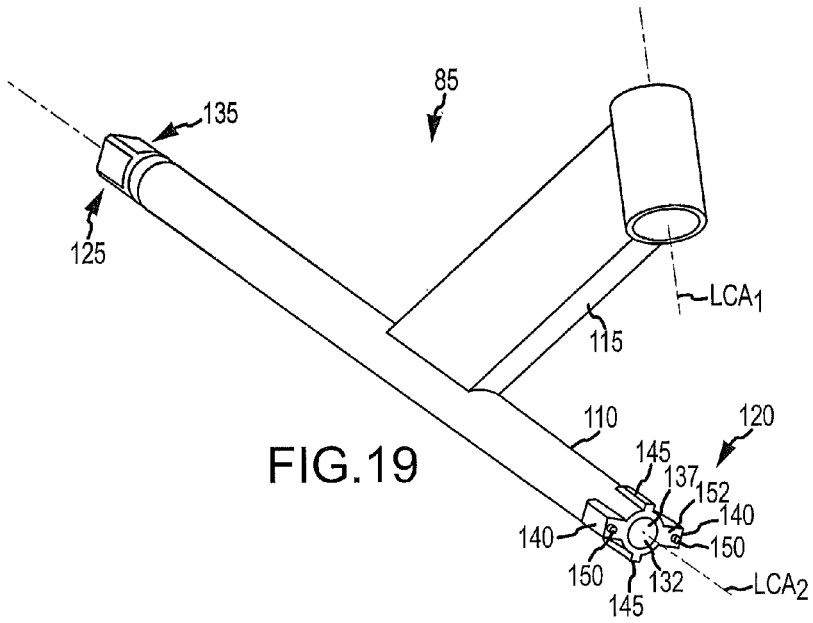
85
135
125
LCA1
115
110
120
145
137
152
140
140
150
150
132
145
LCA2

FIG.19

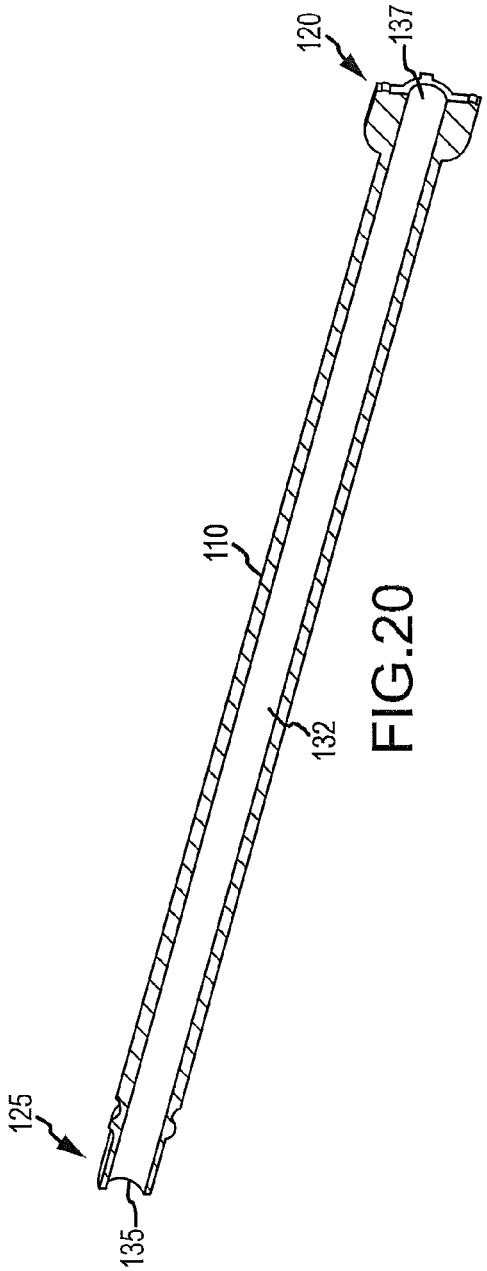

FIG.20

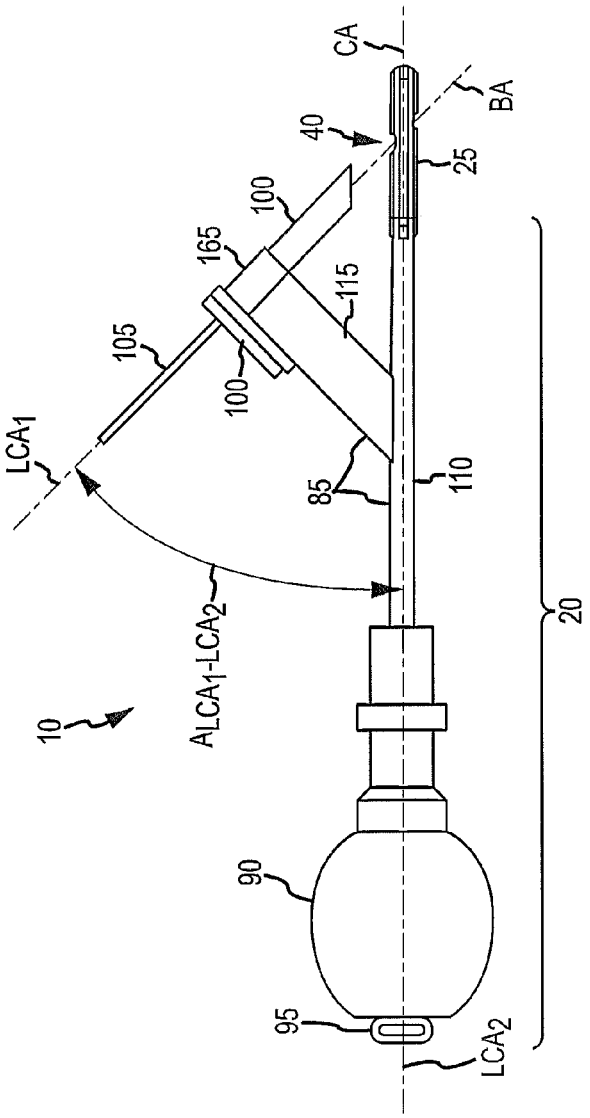
CA
BA
40
25
100
165
115
105
100
LCA1
85
110
ALCA1-LCA2
20
10
90
95
LCA2

FIG.21A

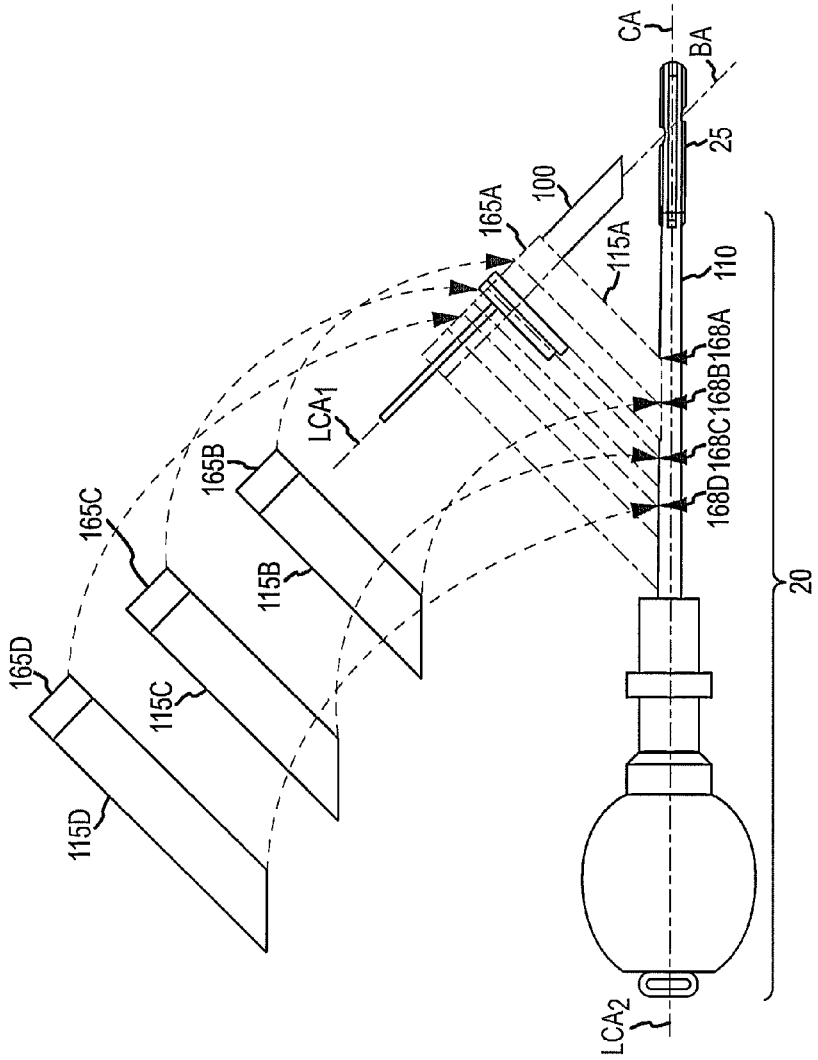
CA
BA
25
100
165A
115A
110
168A
168B
168C
168D
LCA1
165B
115B
165C
115C
165D
115D
20
LCA2

FIG.21B

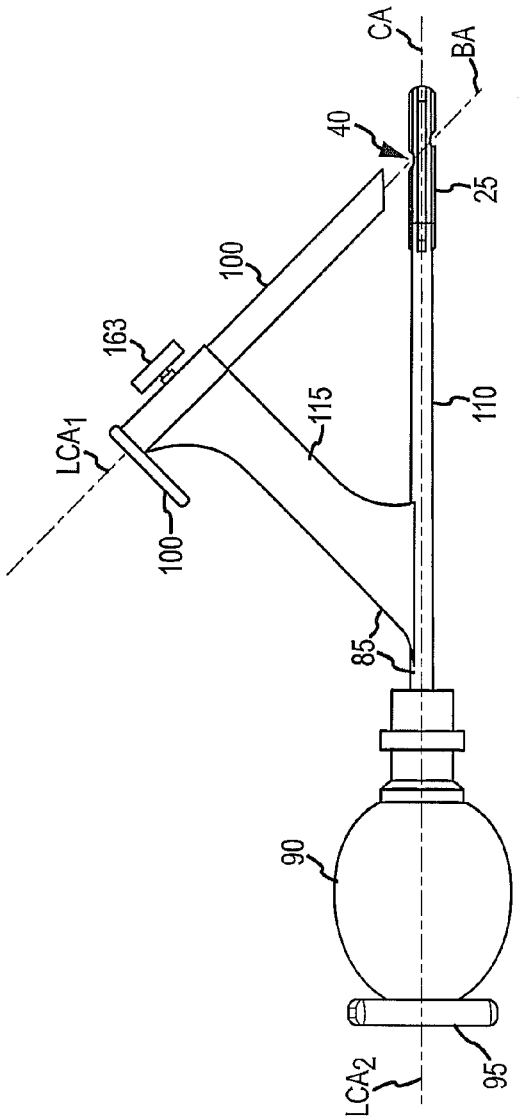

FIG.21C

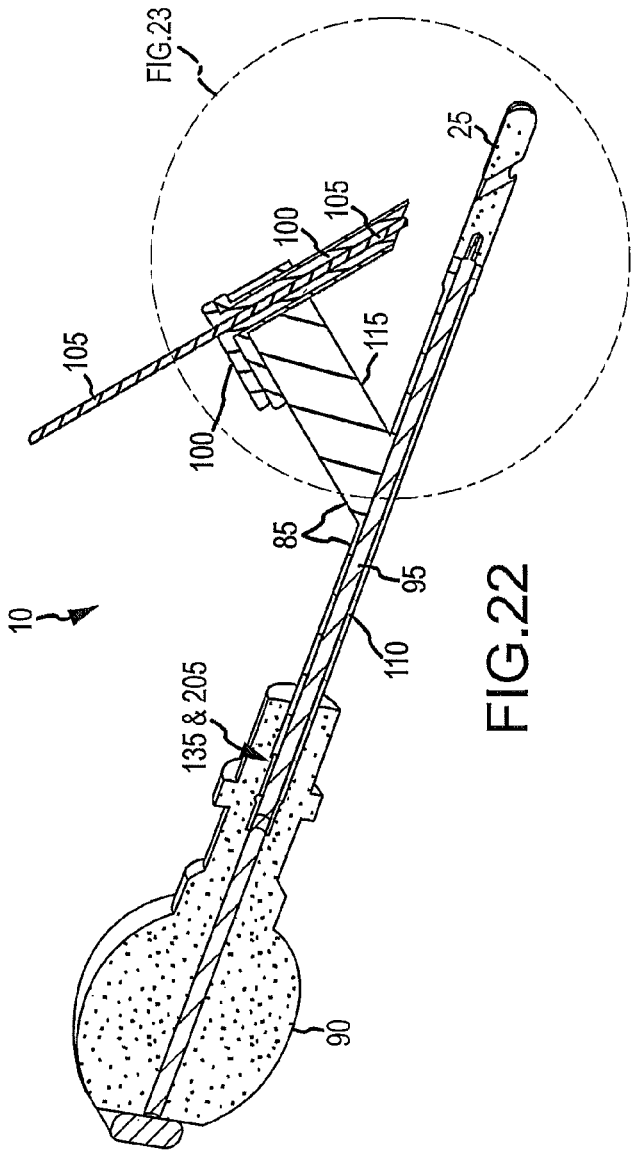

FIG.22

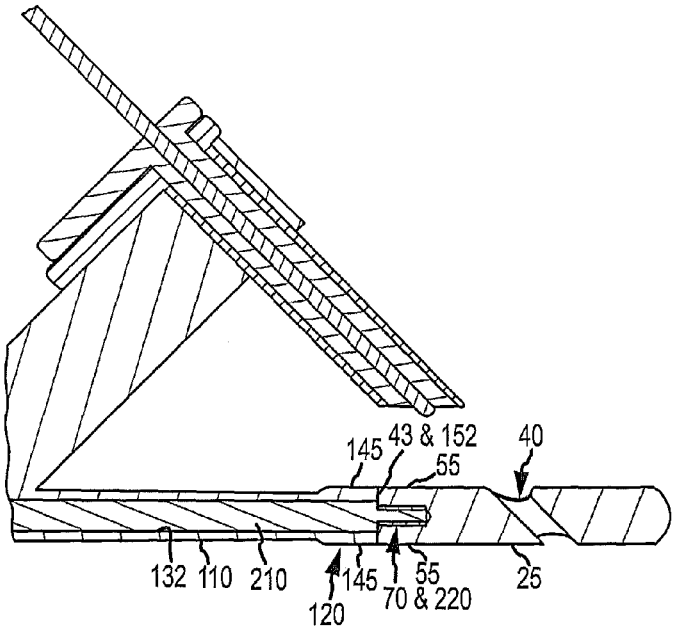
145
43 & 152
55
40
132
110
210
120
145
55
70 & 220
25

FIG.23

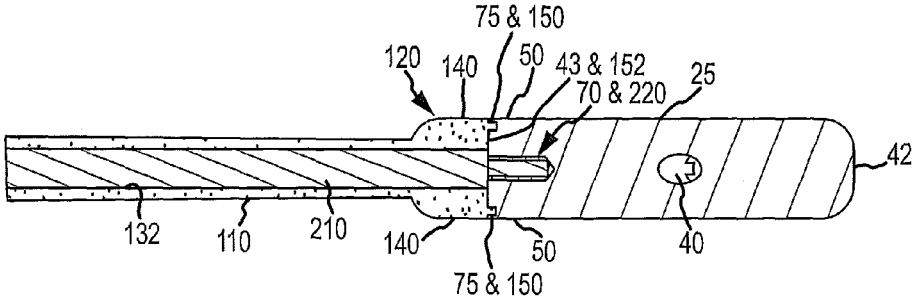
75 & 150
120
140
50
43 & 152
70 & 220
25
42
132
110
210
140
50
40
75 & 150

FIG.24

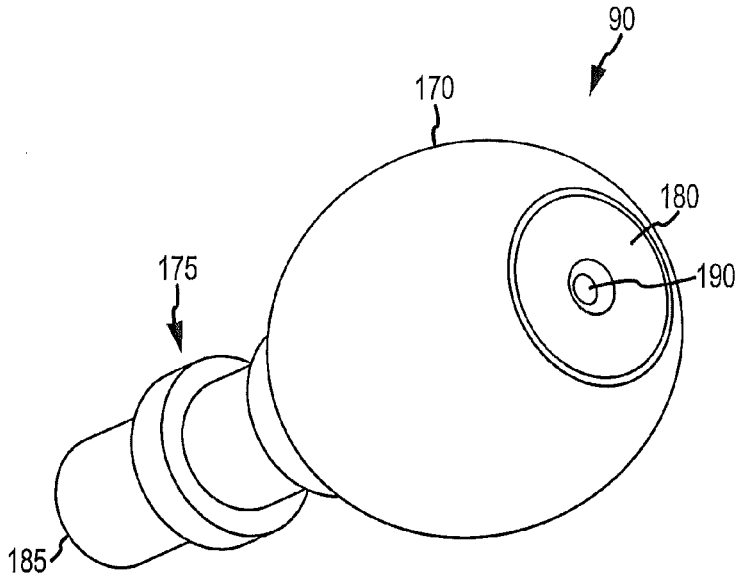

FIG.25

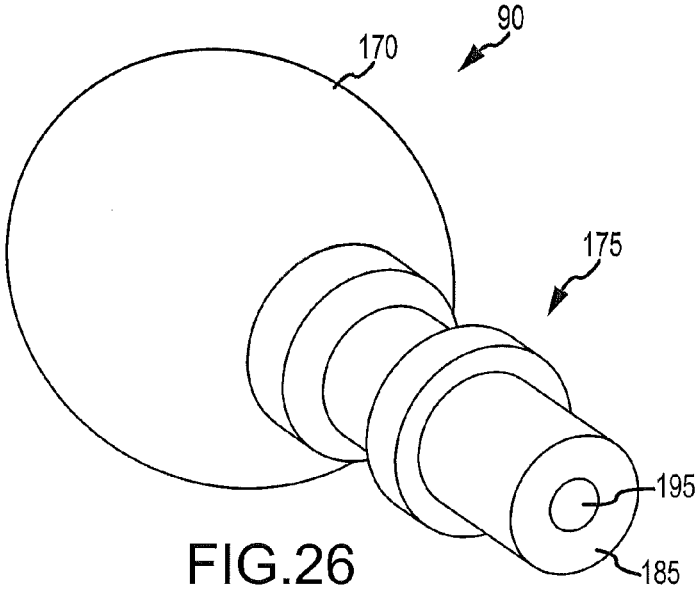

FIG.26

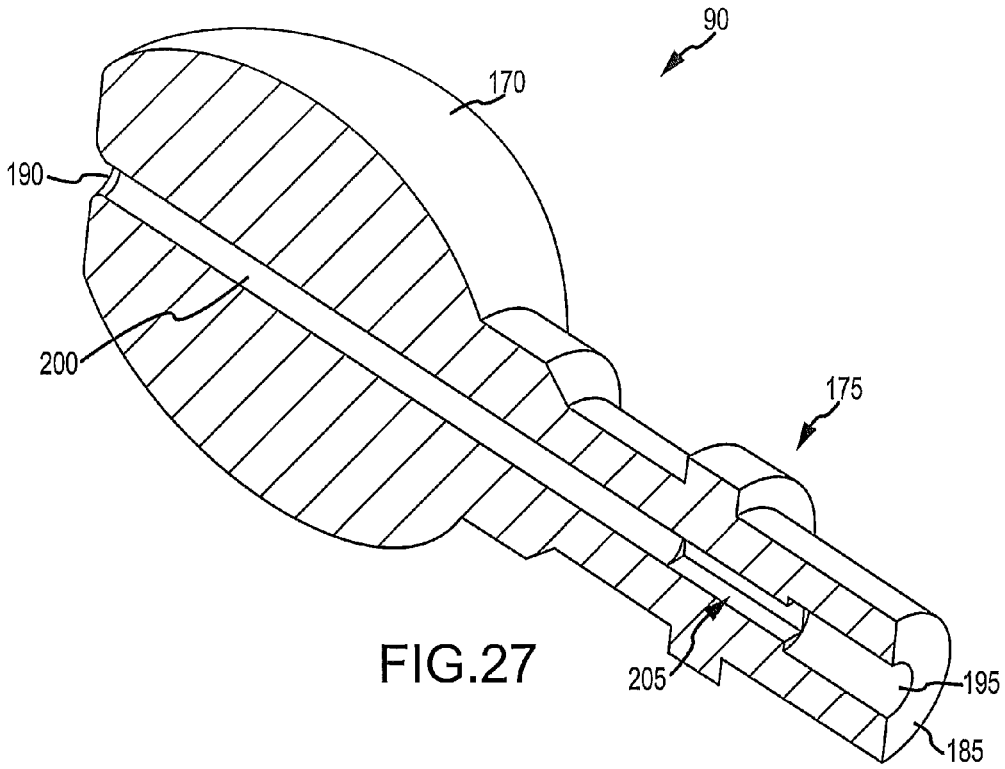

FIG.27

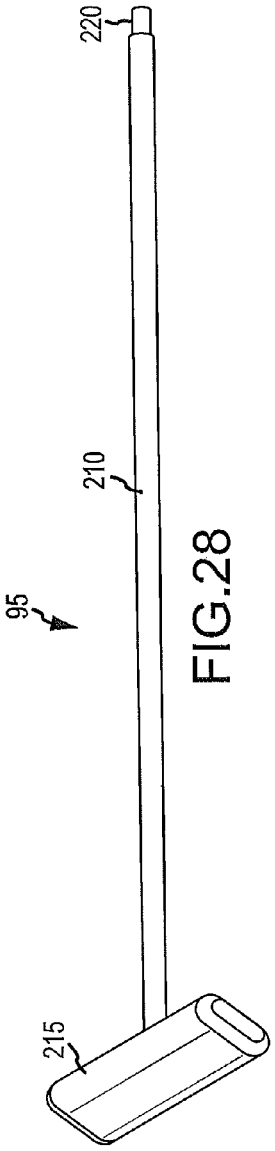

FIG.28

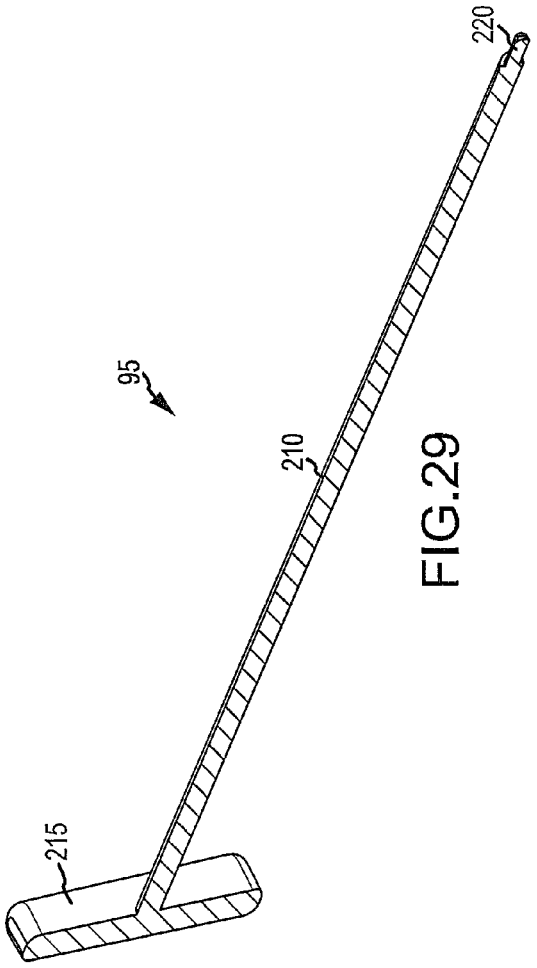

FIG.29

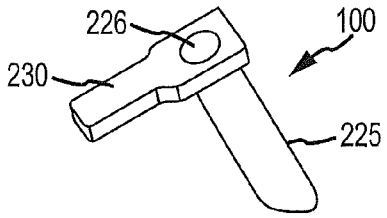

FIG.30A

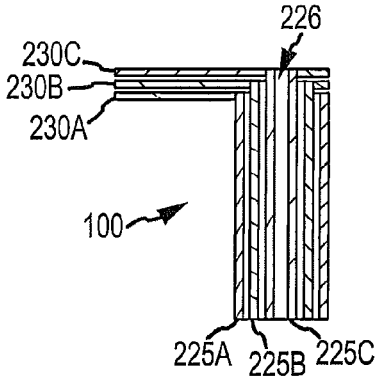

FIG.30B

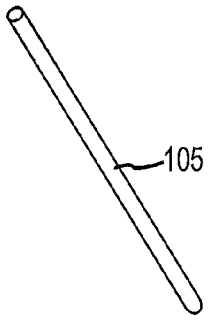

FIG.31

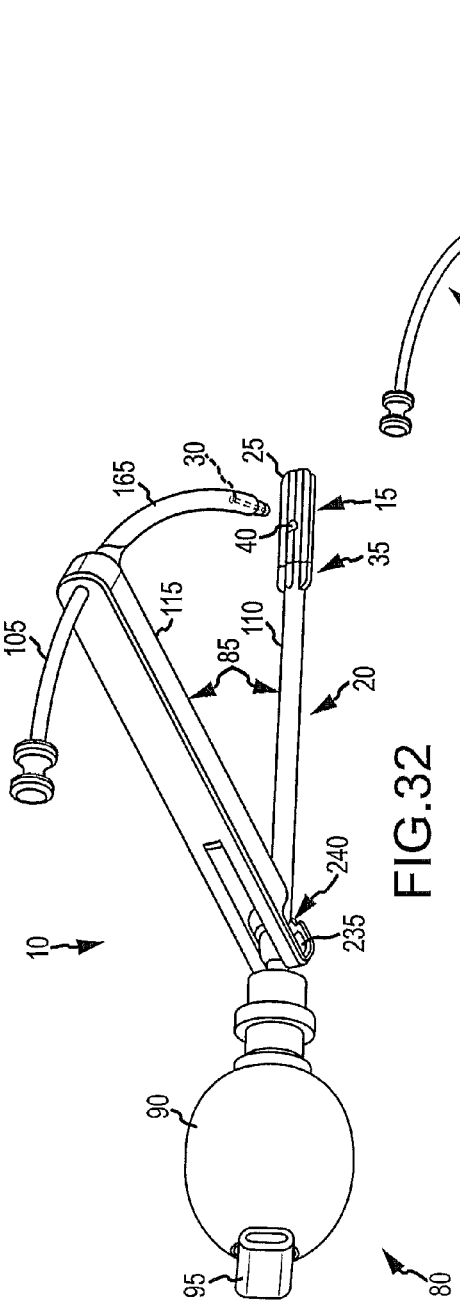
165
30
25
15
40
35
115
110
105
85
20
240
235
10
90
95
80

FIG.32

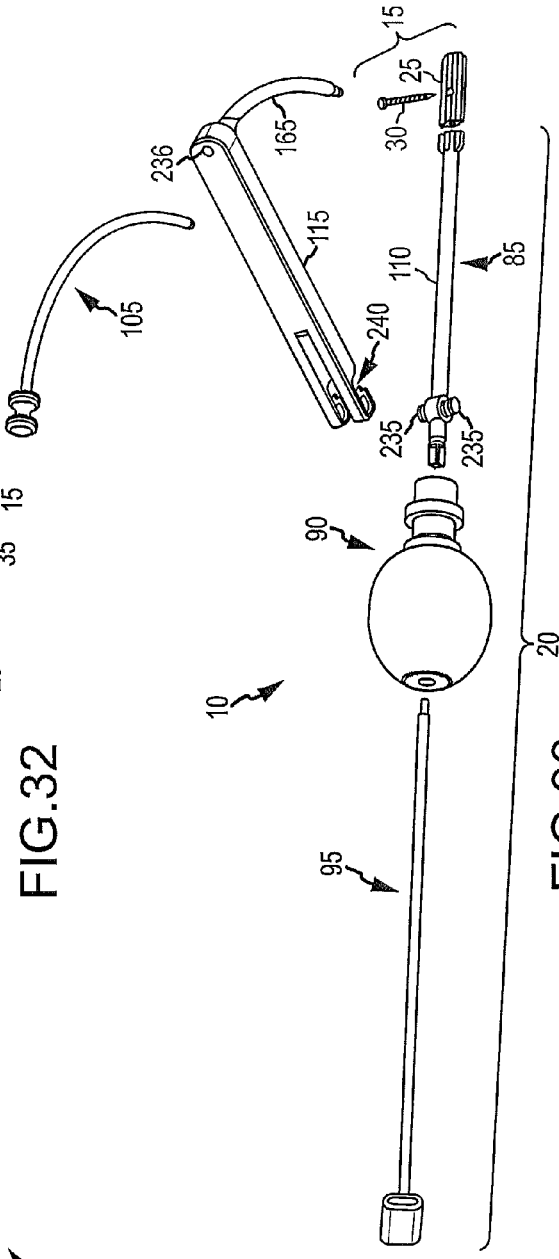
15
25
30
165
236
115
110
85
105
240
235
235
90
10
95
20

FIG.33

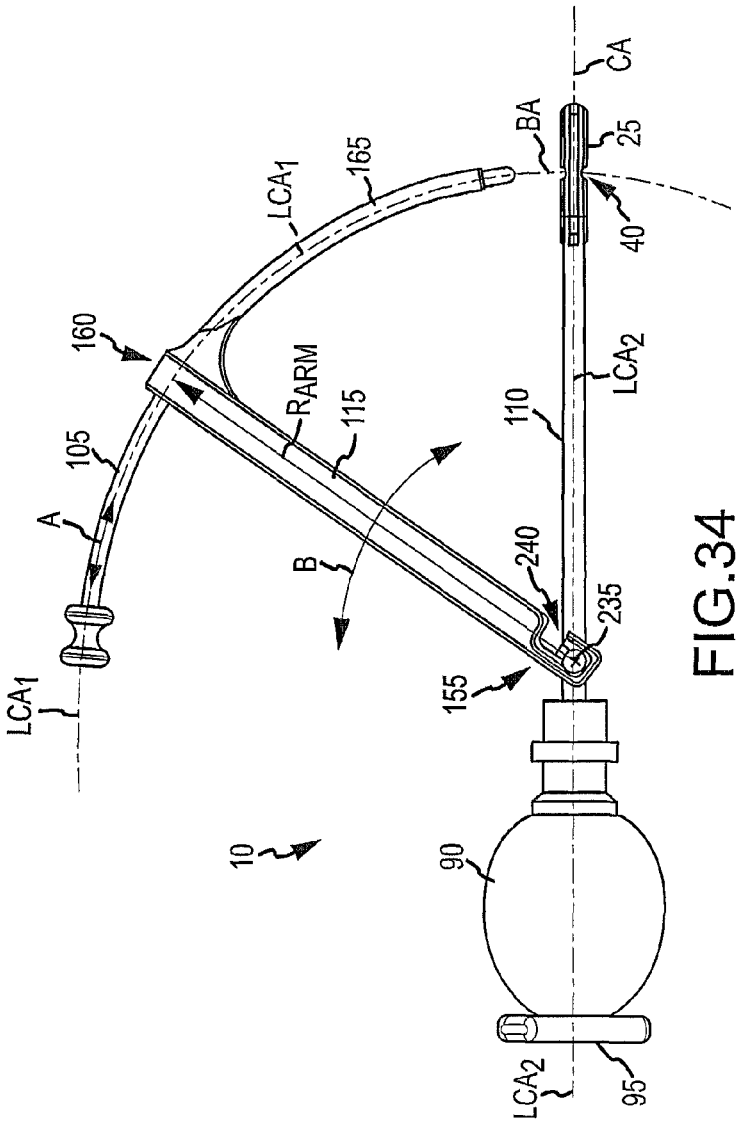
CA
BA
25
40
165
LCA1
160
RARM
115
105
110
LCA2
A
B
240
235
155
LCA1
10
90
LCA2
95

FIG.34

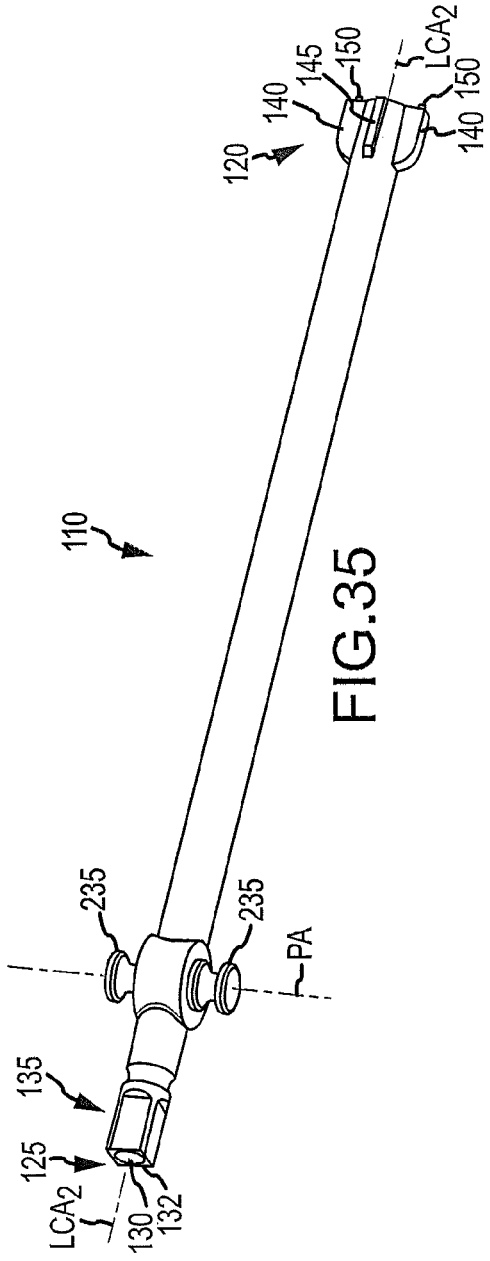

FIG.35

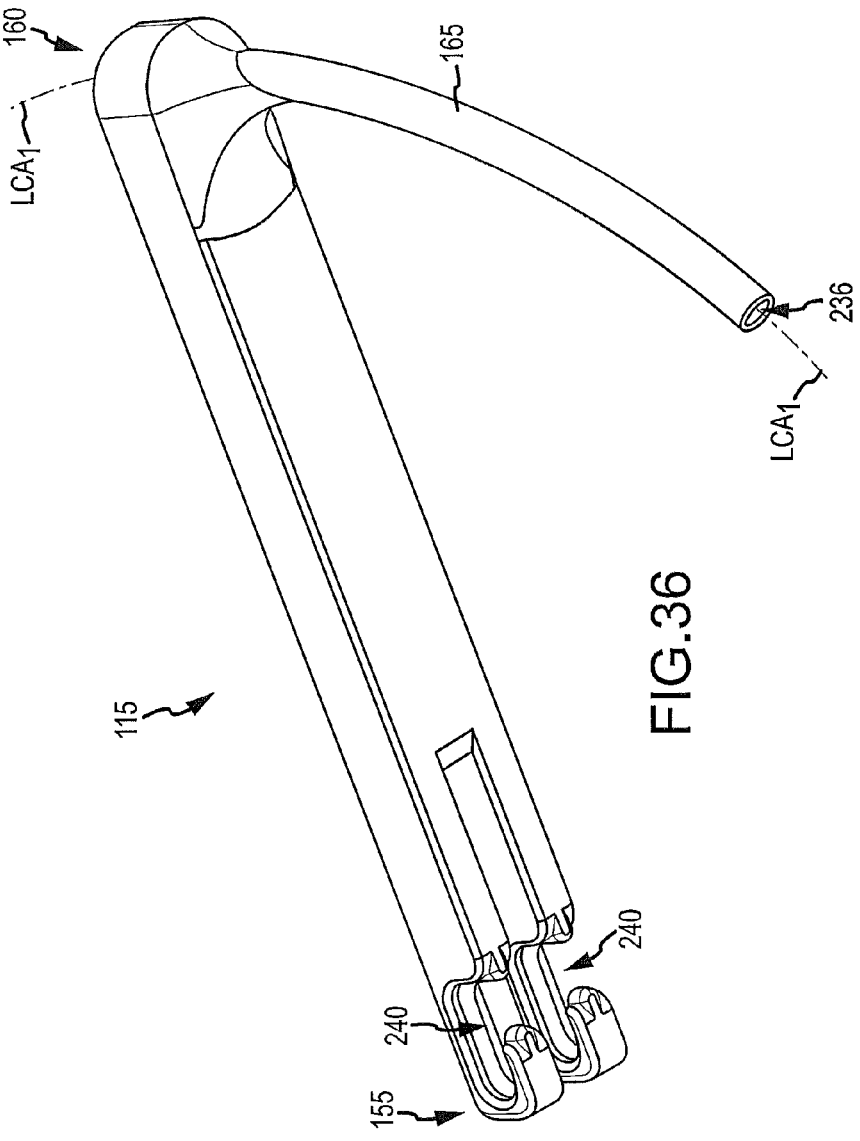

FIG.36

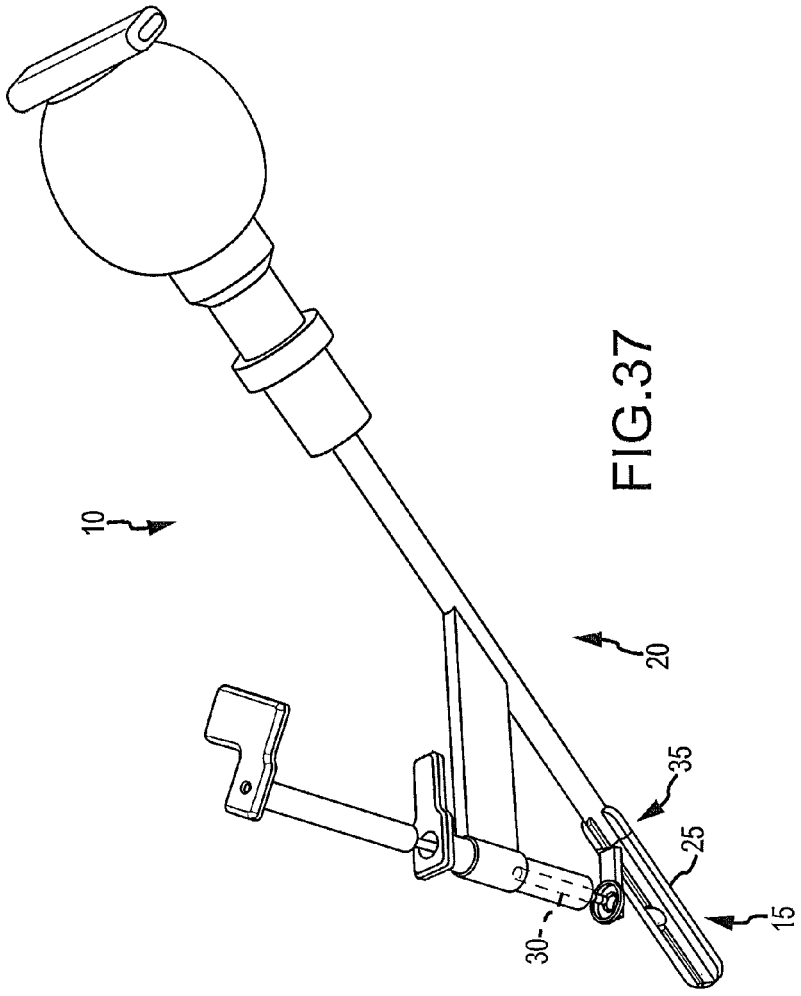

FIG.37

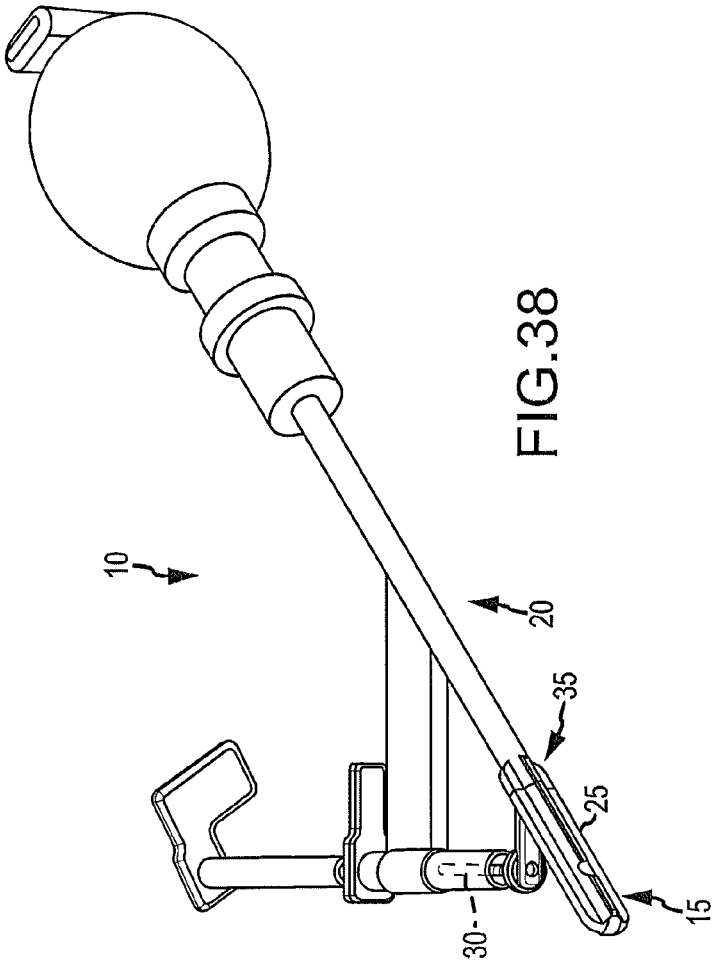

FIG.38

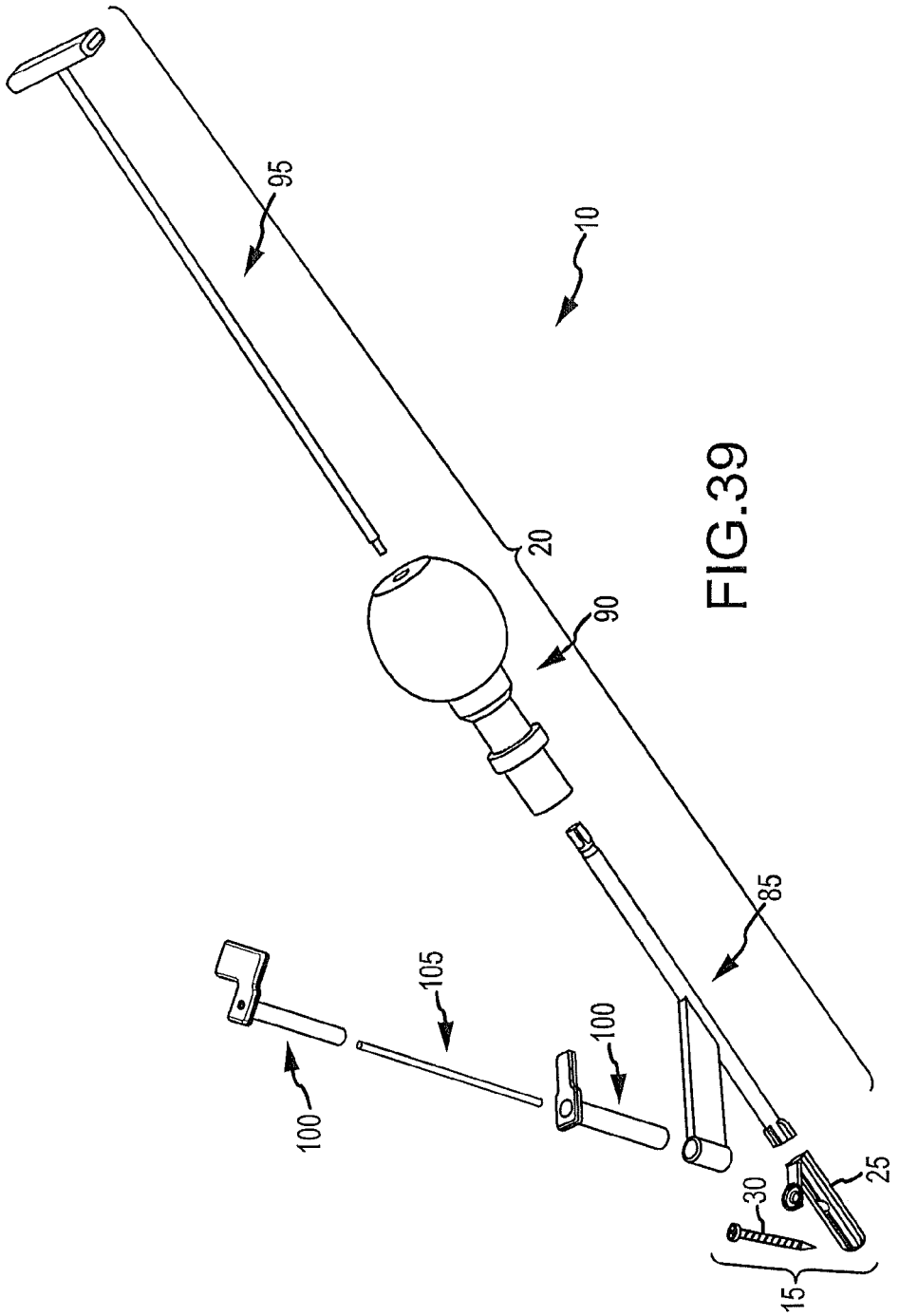

FIG.39

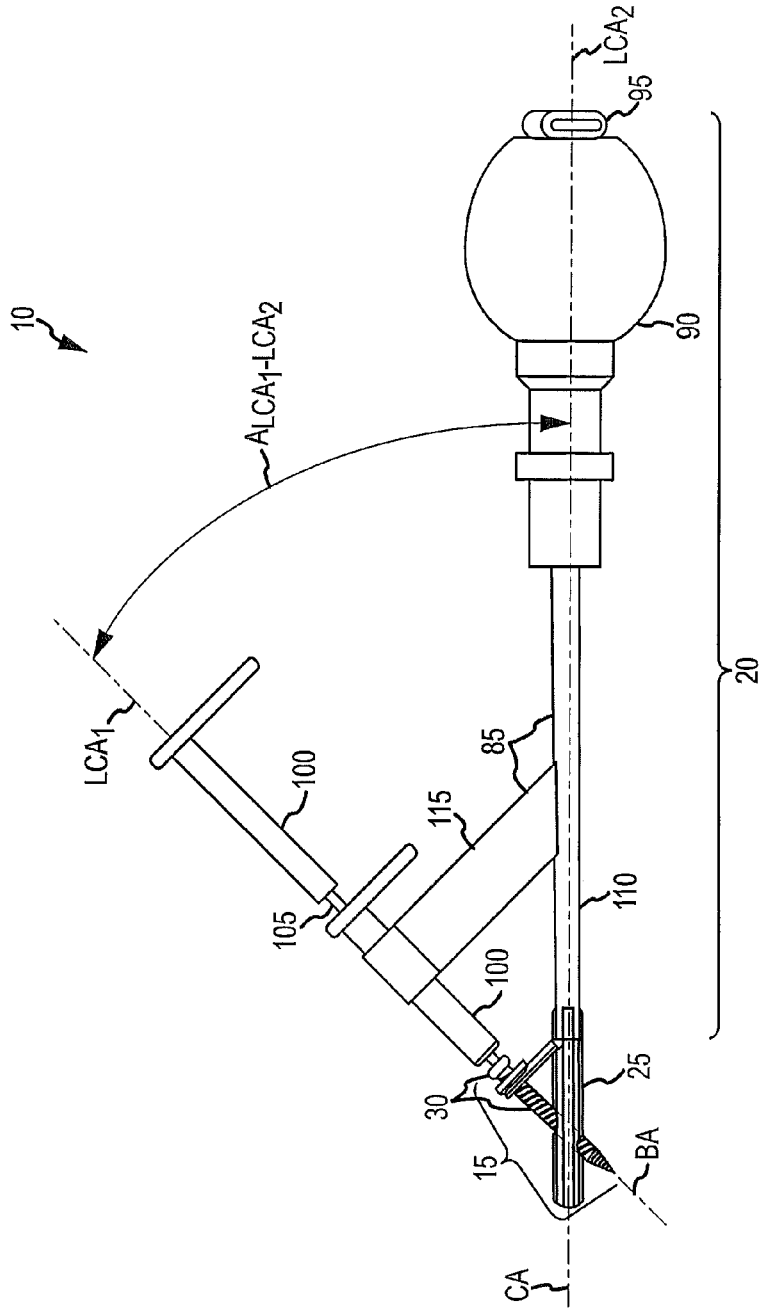
10
$\angle LCA_1\text{-}LCA_2$
LCA_1
LCA_2
95
90
100
105
115
85
110
100
25
30
15
BA
CA
20

FIG.40

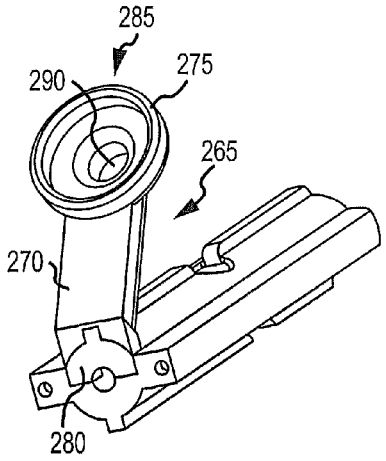

FIG.41

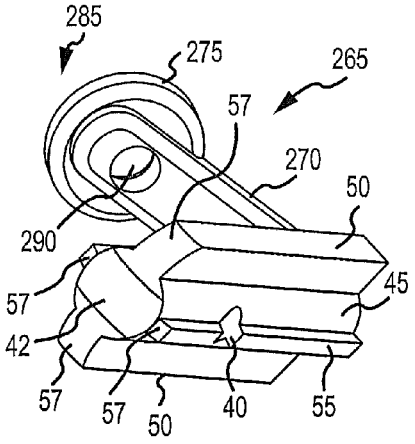

FIG.42

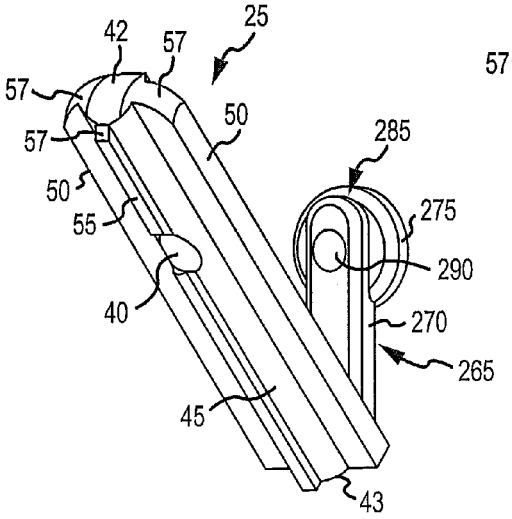

FIG.43

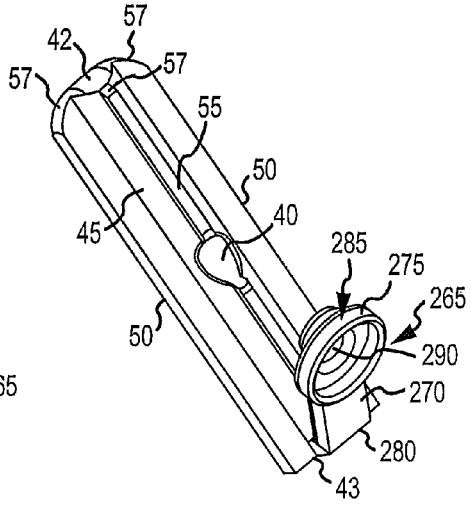

FIG.44

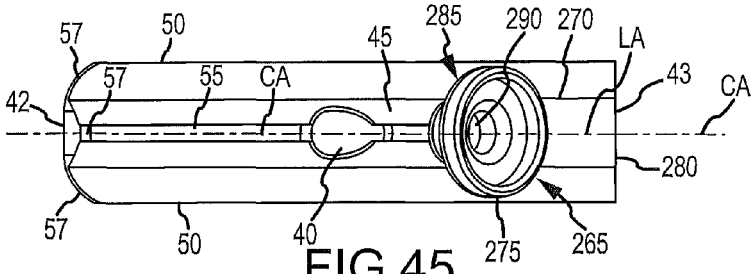

FIG.45

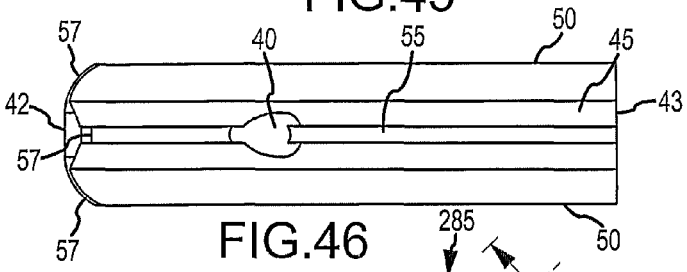

FIG.46

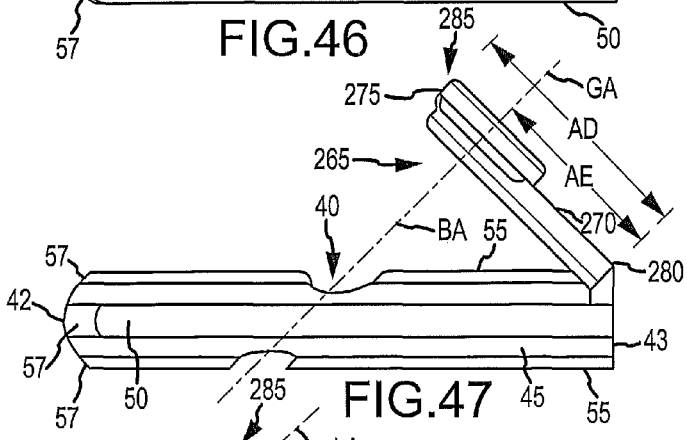

FIG.47

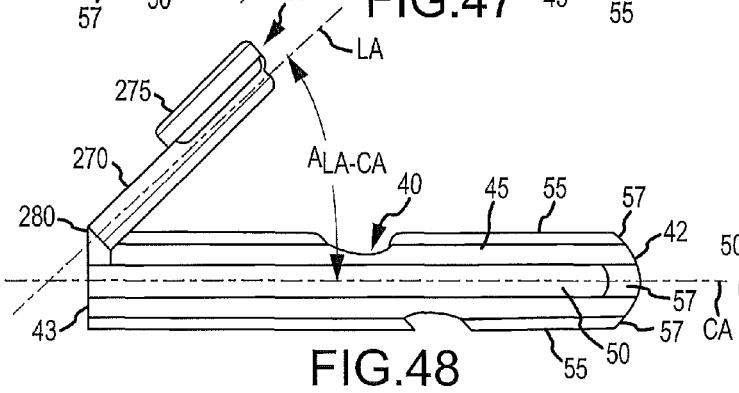

FIG.48

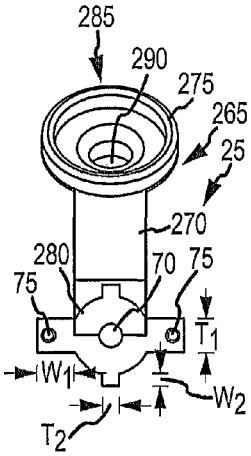

FIG.49

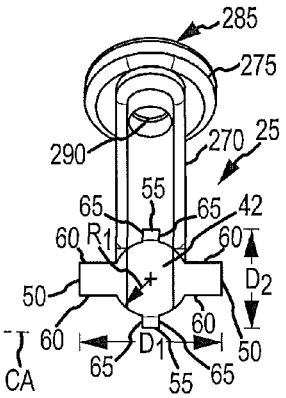

FIG.50

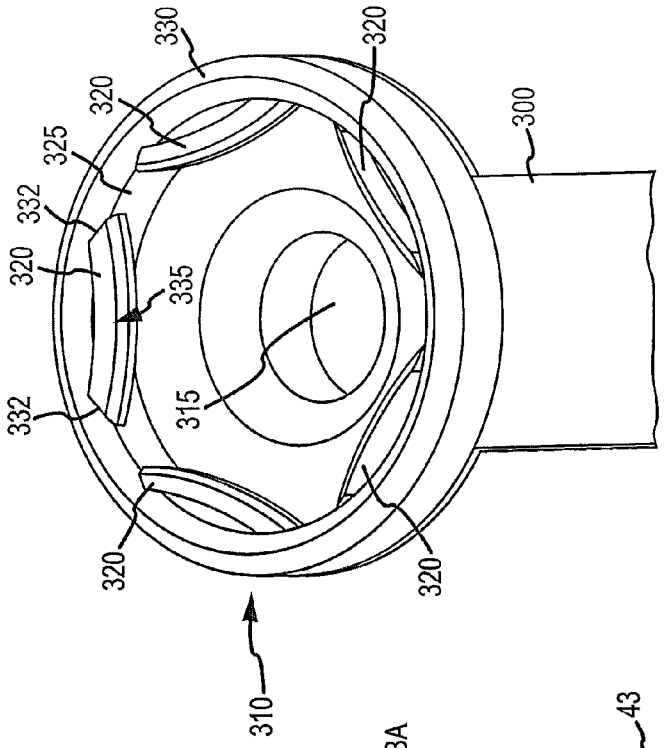

FIG.53

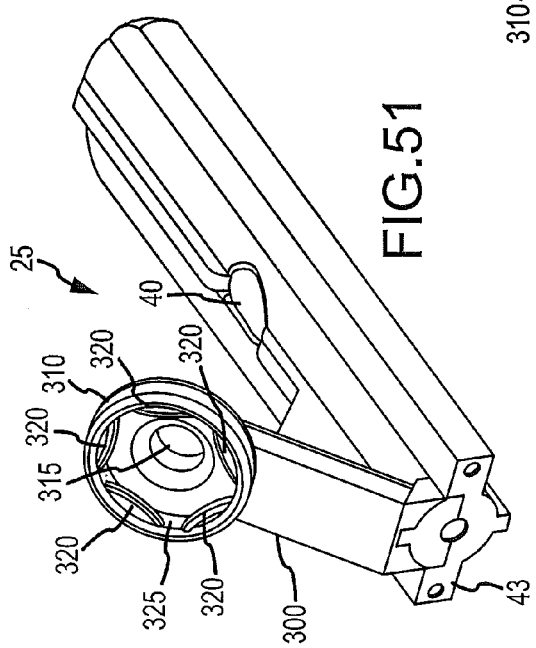

FIG.51

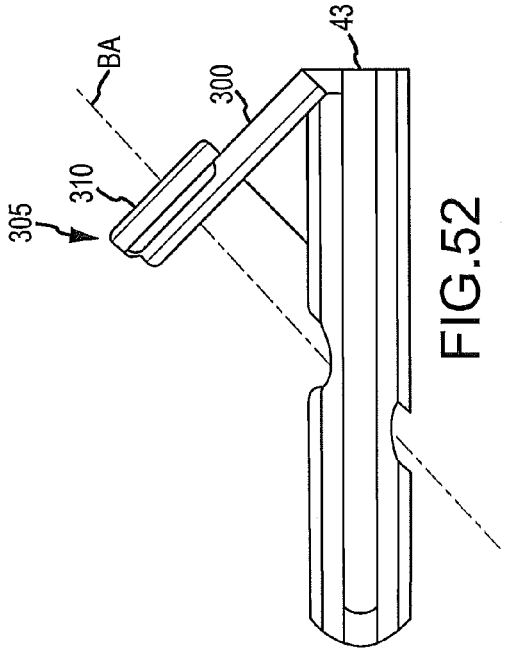

FIG.52

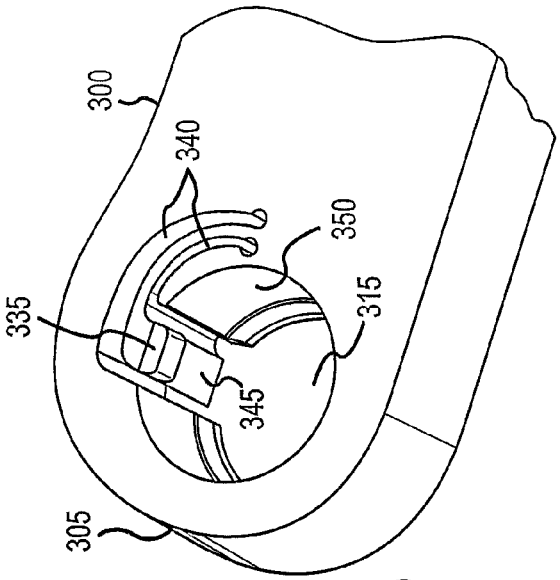

FIG.55

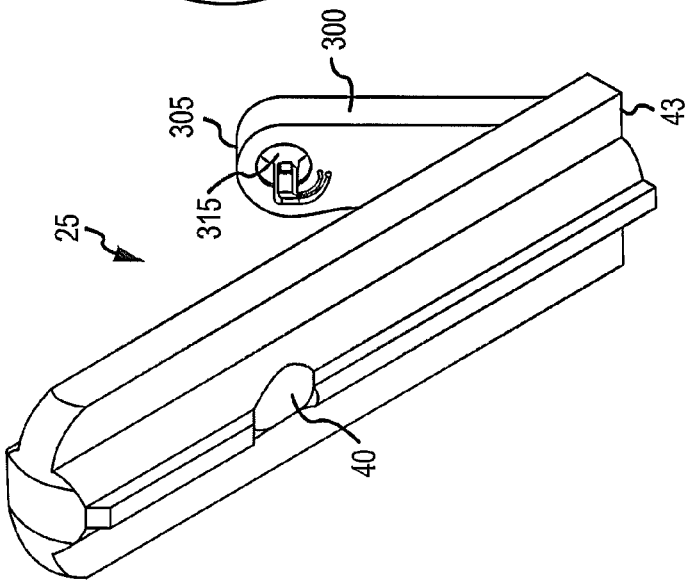

FIG.54

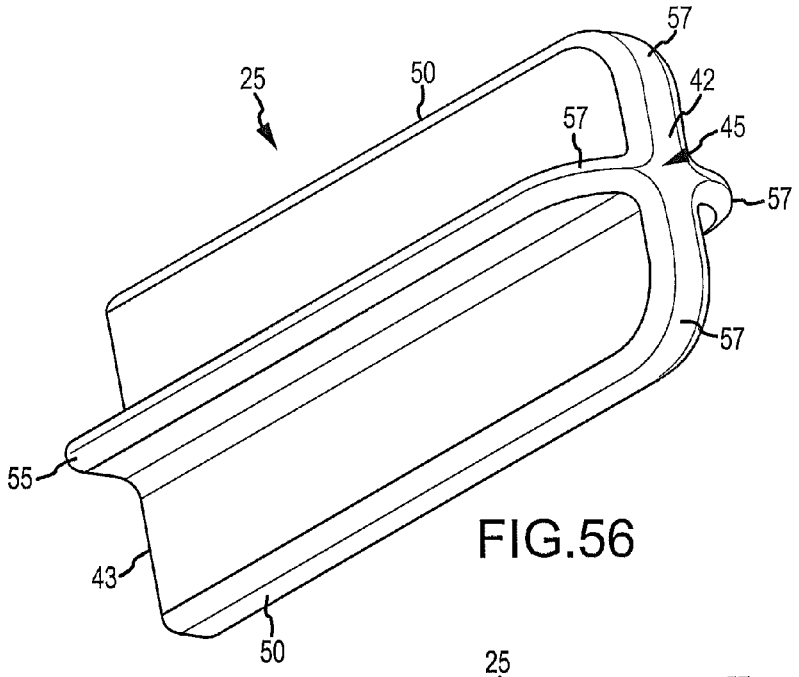

FIG.56

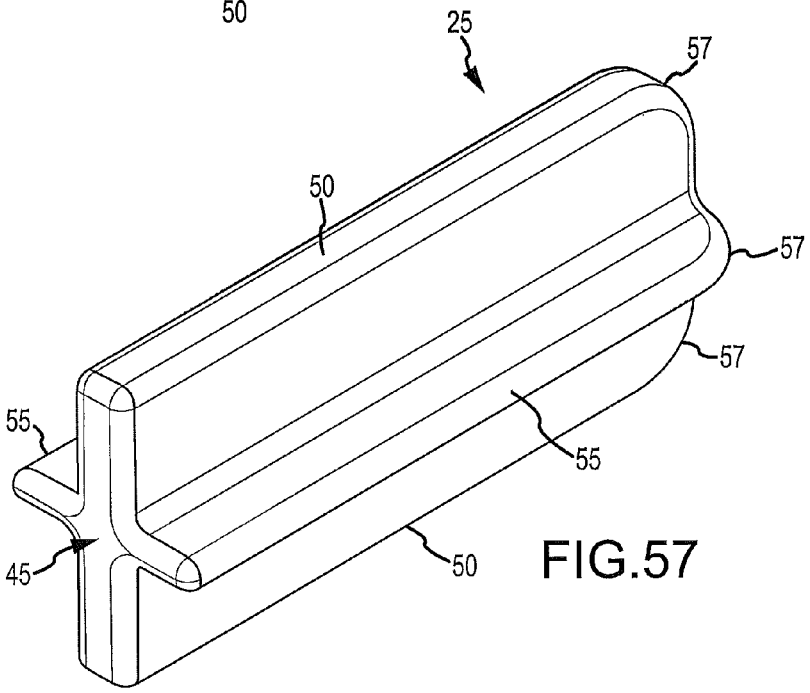

FIG.57

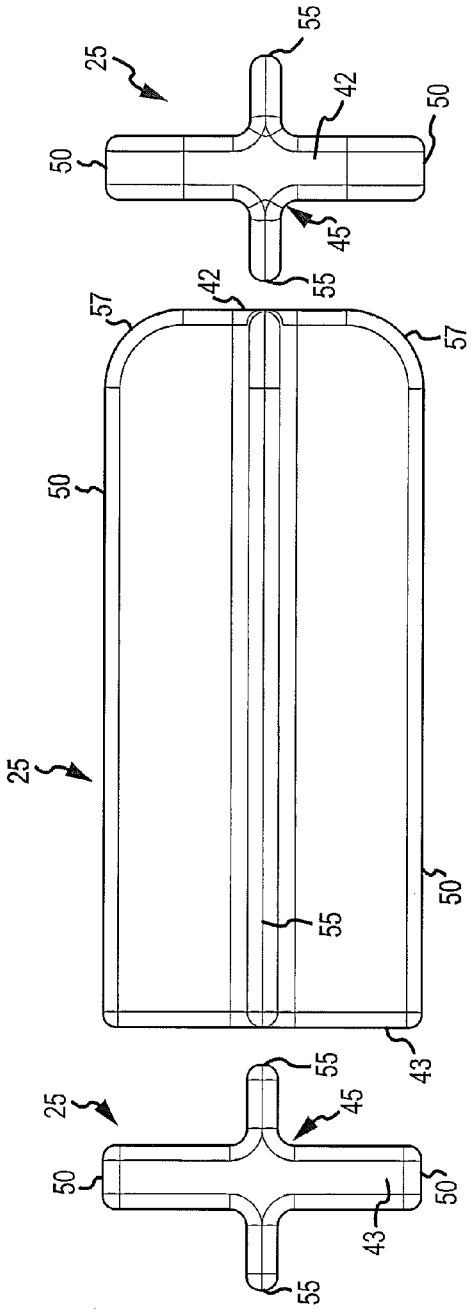

FIG.60

FIG.58

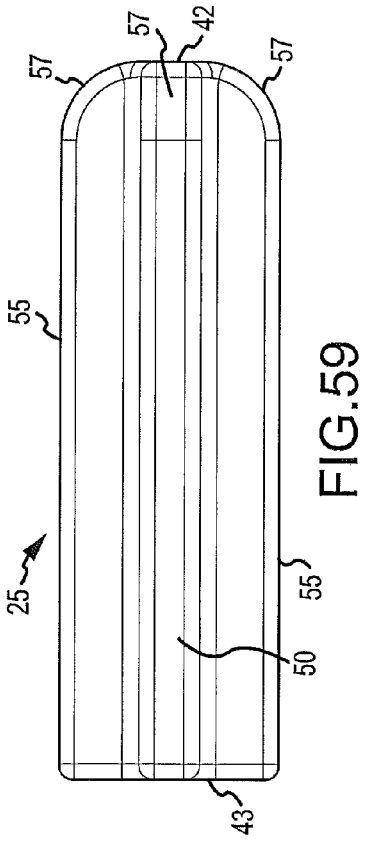

FIG.59

FIG.61

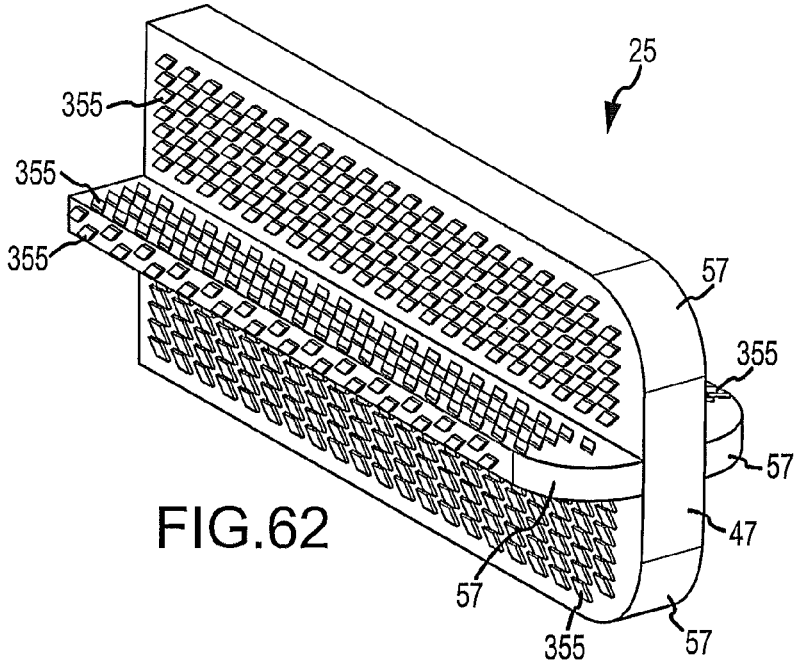
25
355
355
355
57
355
57
47
57
355
57

FIG.62

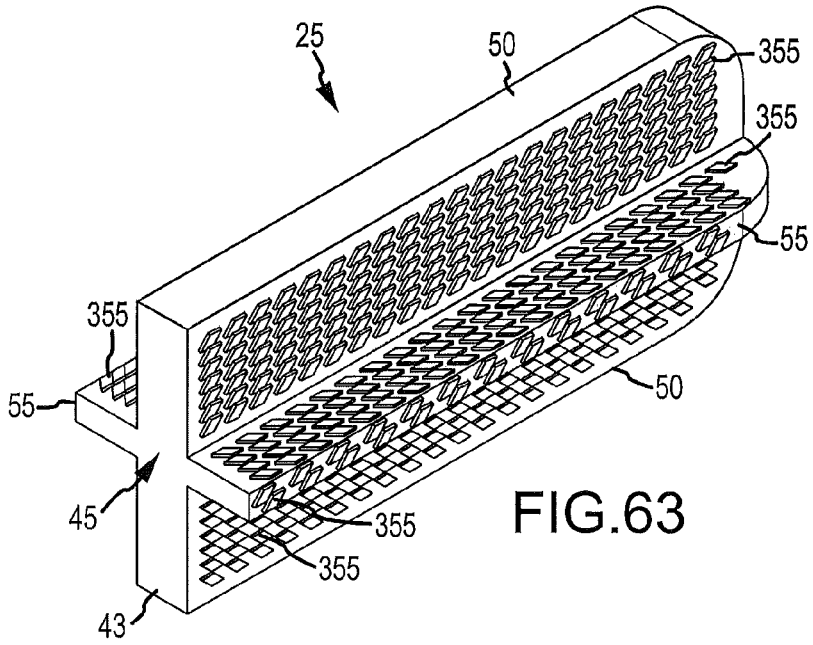
25
50
355
355
55
355
55
45
355
355
43
50

FIG.63

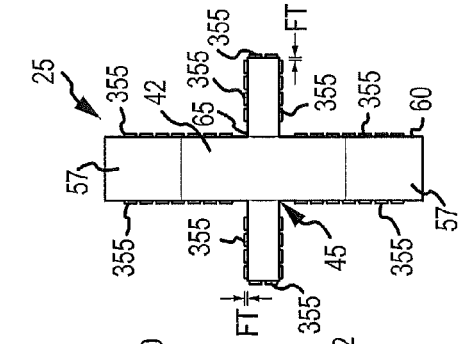

FIG.66

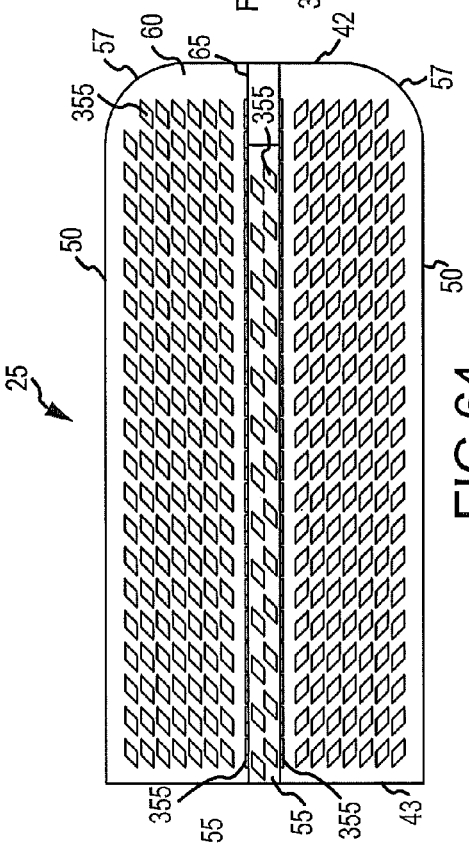

FIG.64

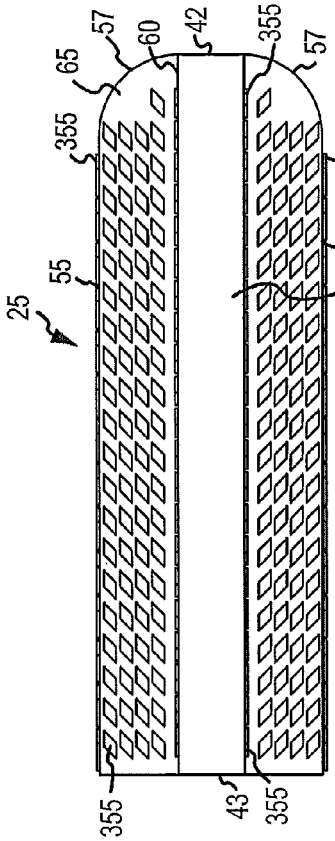

FIG.65

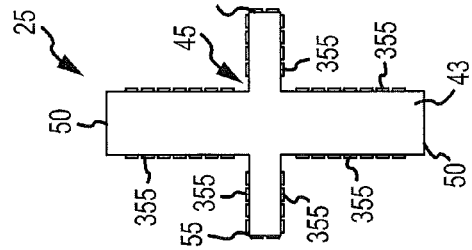

FIG.67

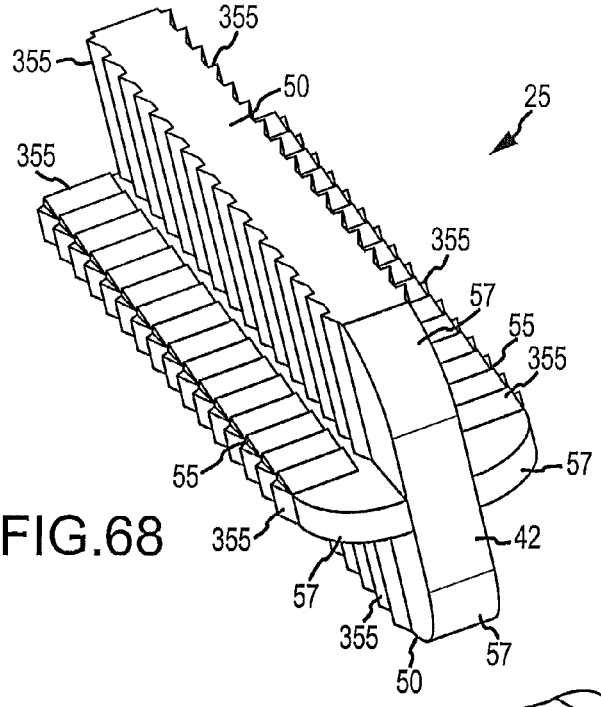
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FIG.68

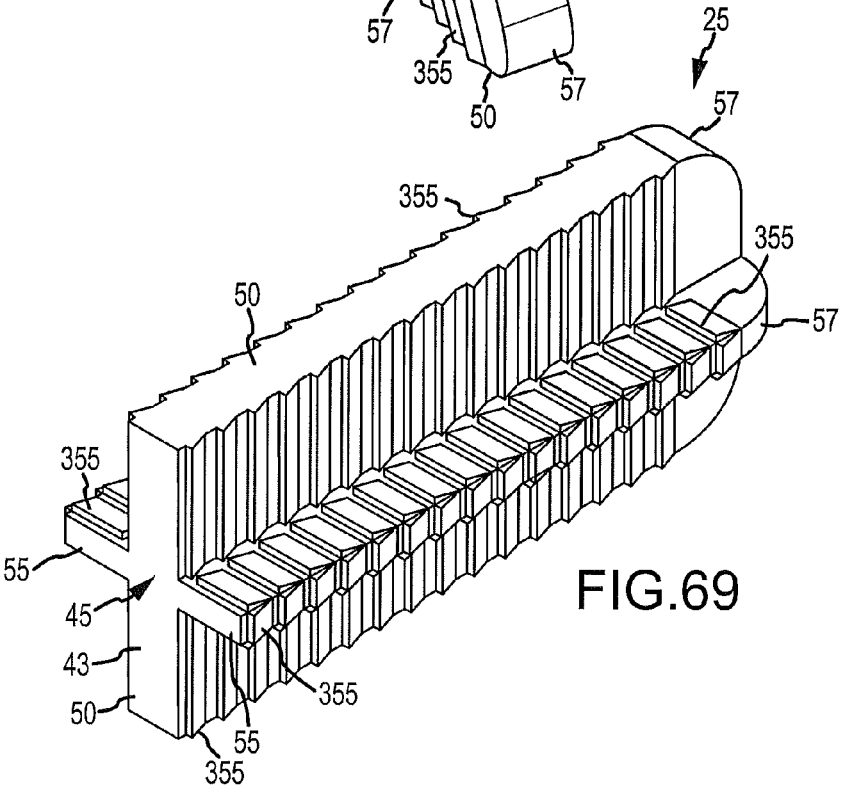
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FIG.69

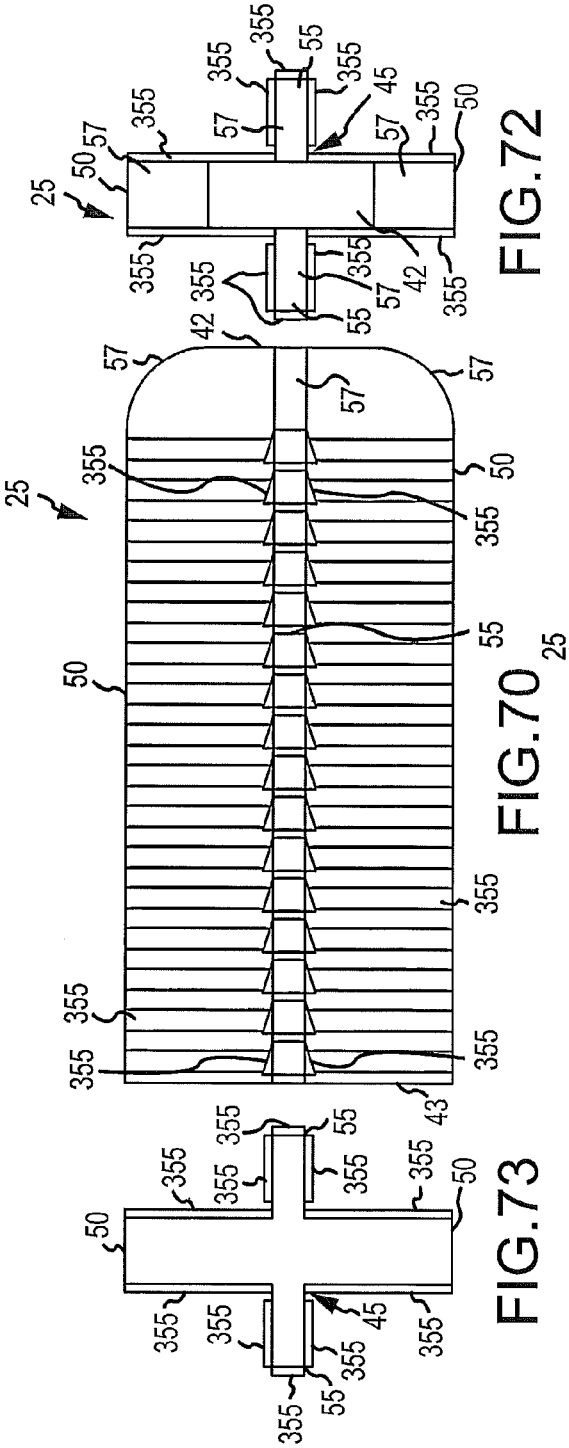


FIG.70

FIG.72

FIG.73

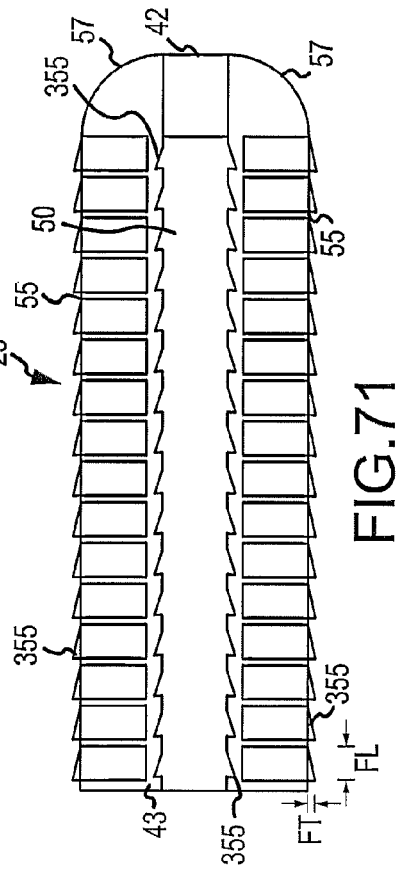


FIG.71

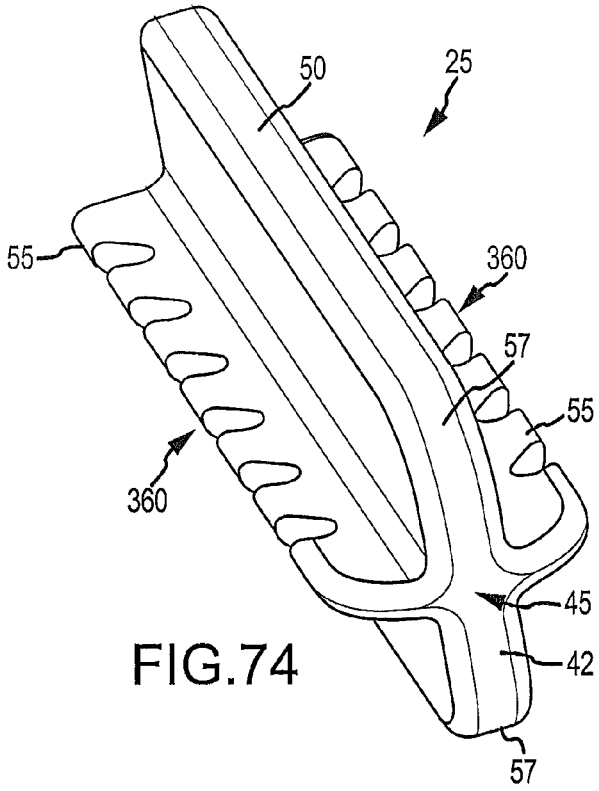


FIG.74

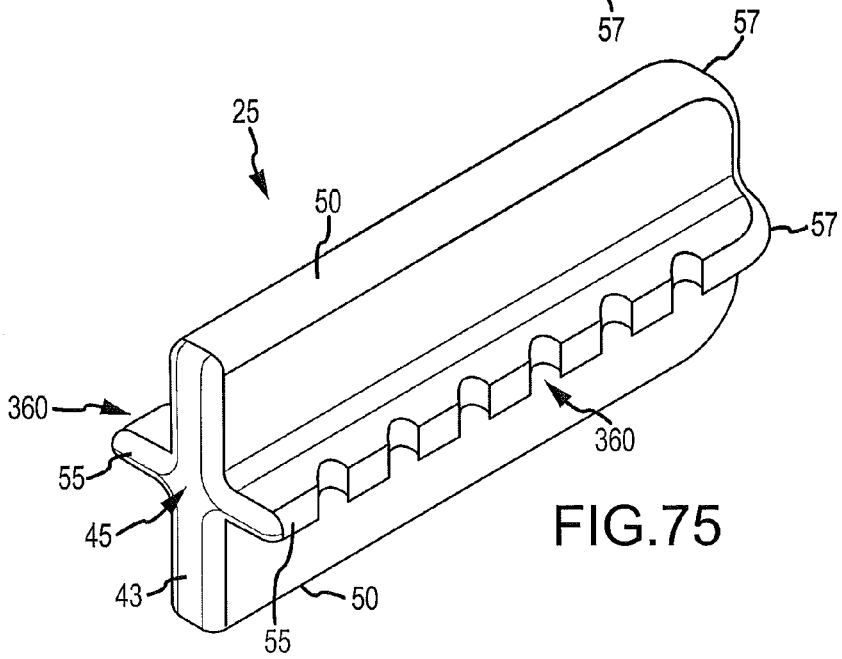


FIG.75

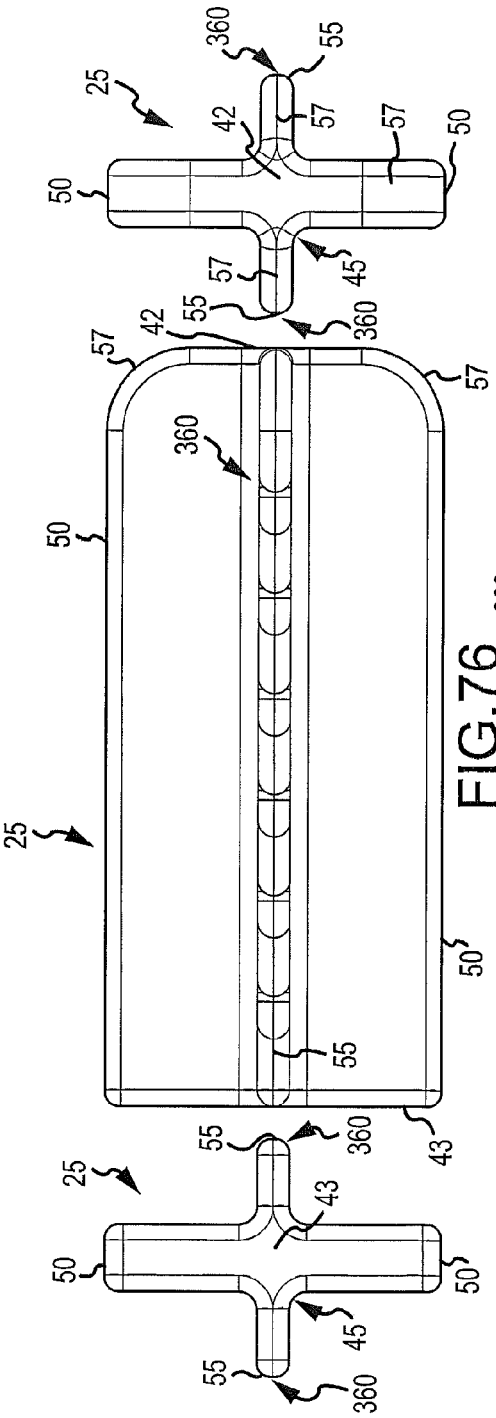


FIG.76

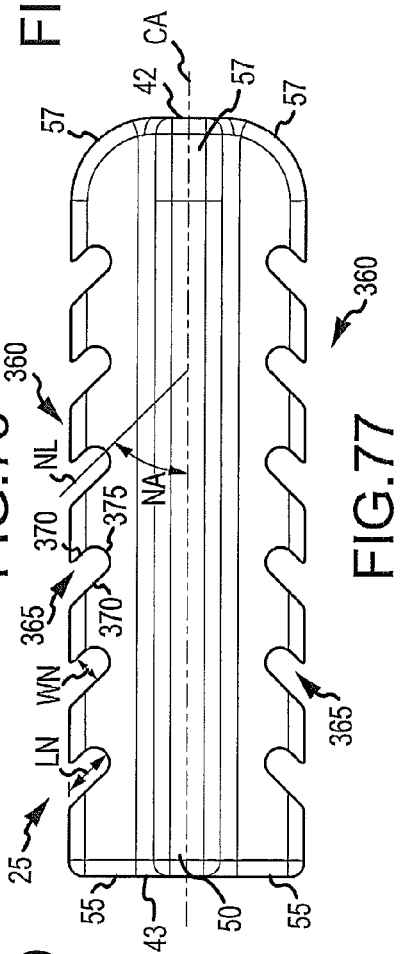


FIG.77

FIG.78

FIG.79

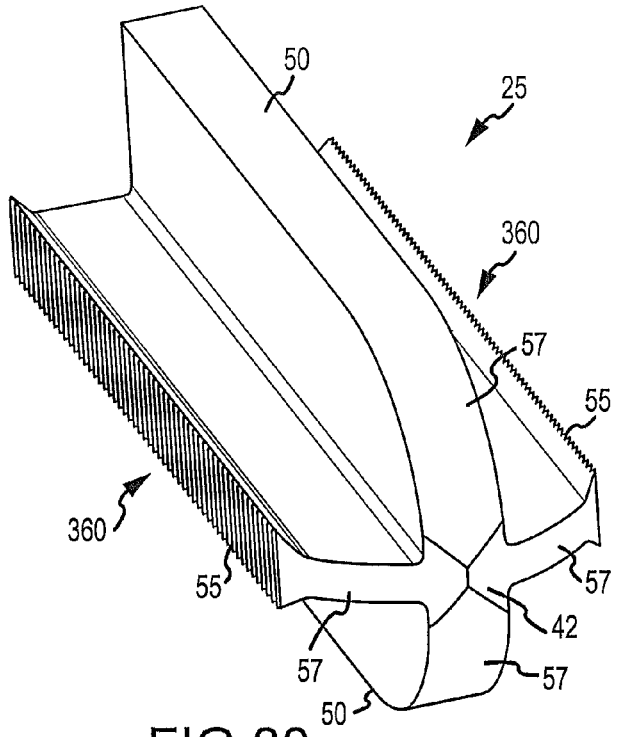


FIG.80

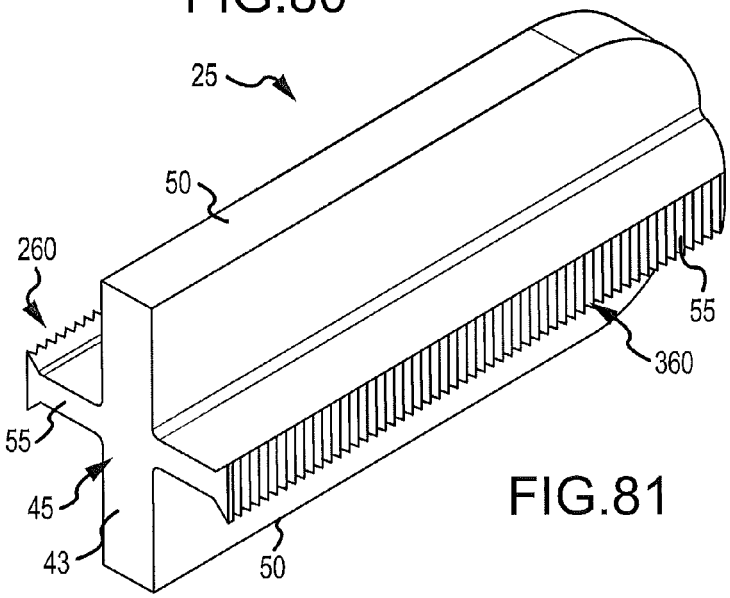


FIG.81

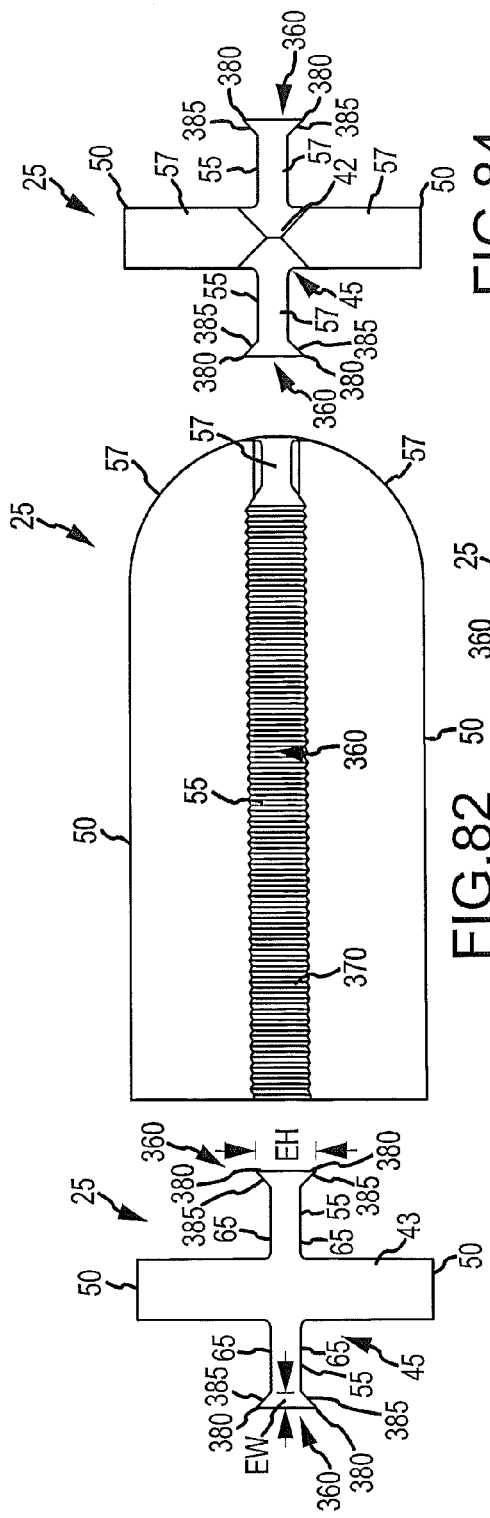


FIG.84

FIG.82

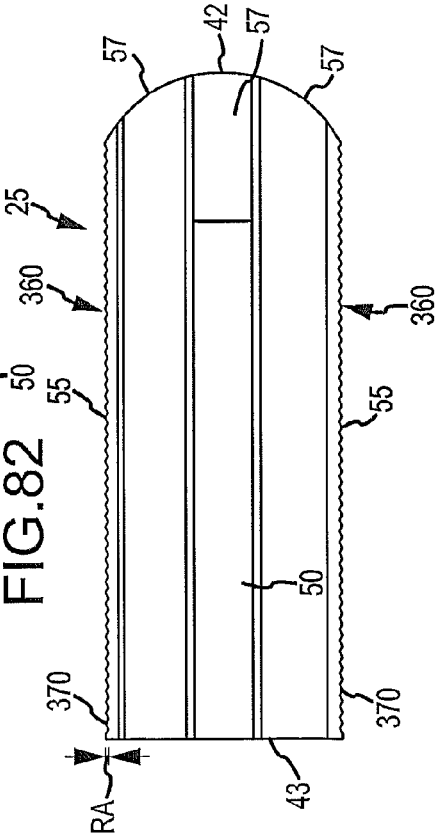
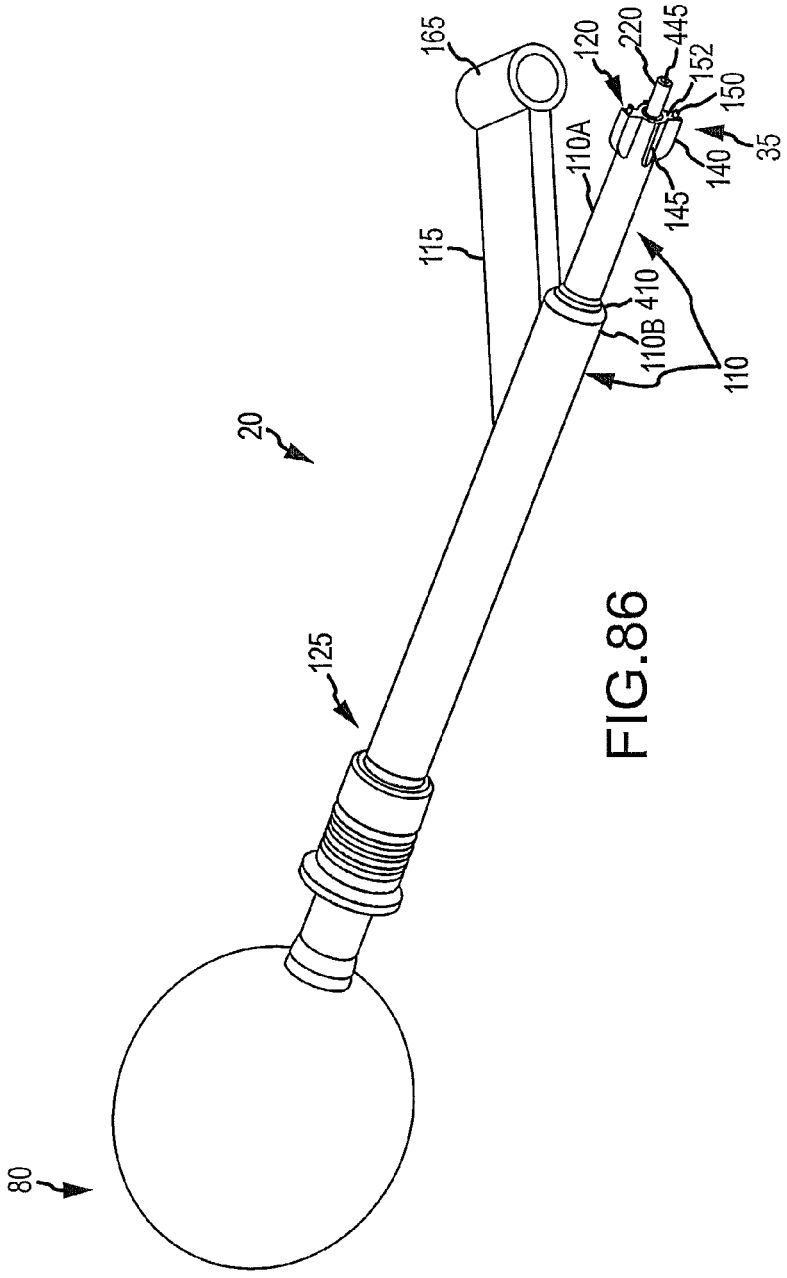


FIG.83

FIG.85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120
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110A
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110B
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20
125
80

FIG.86

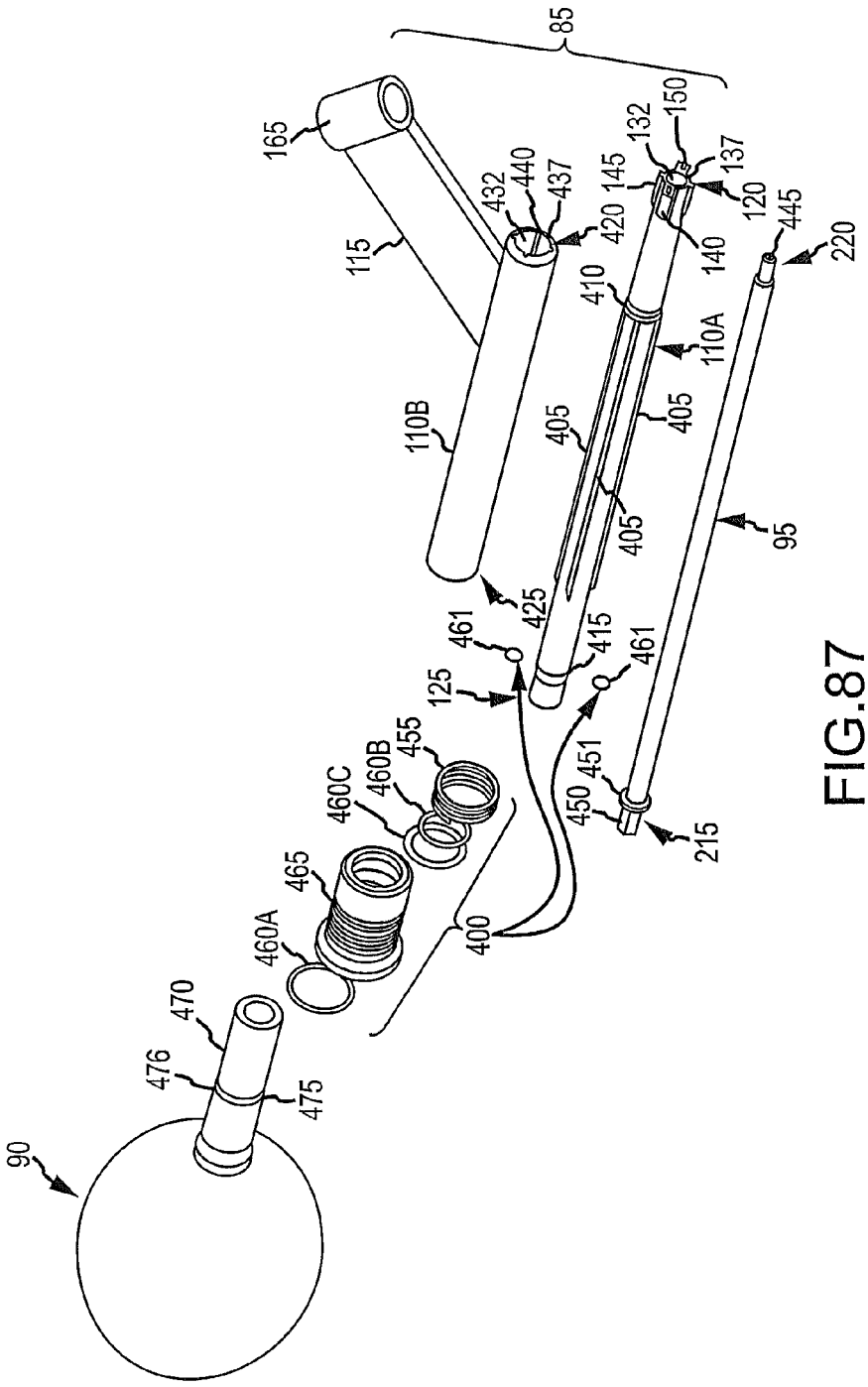
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FIG.87

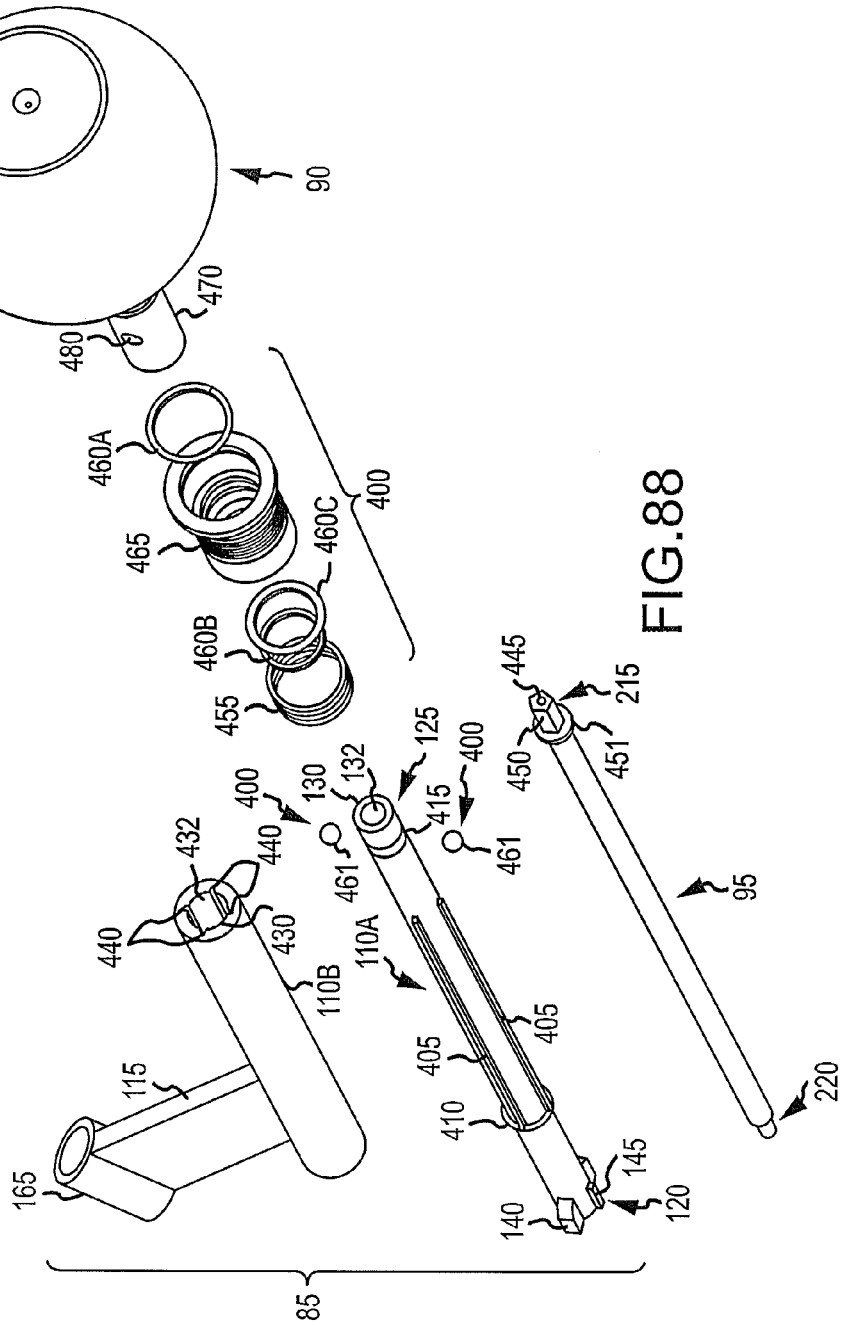
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FIG.88

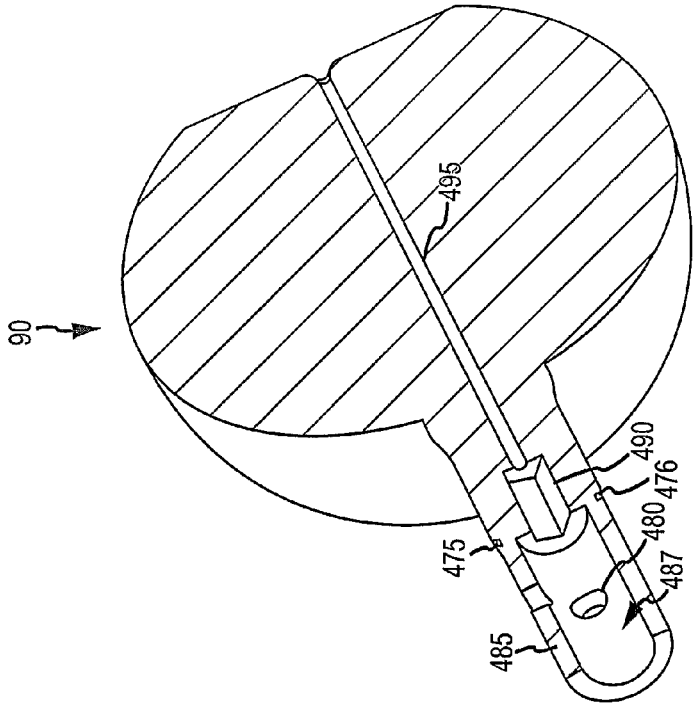
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FIG.90

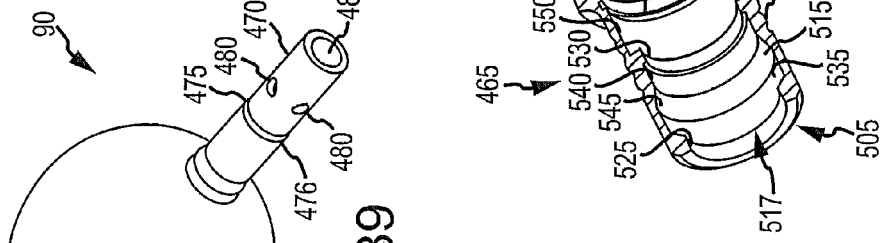
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FIG.89

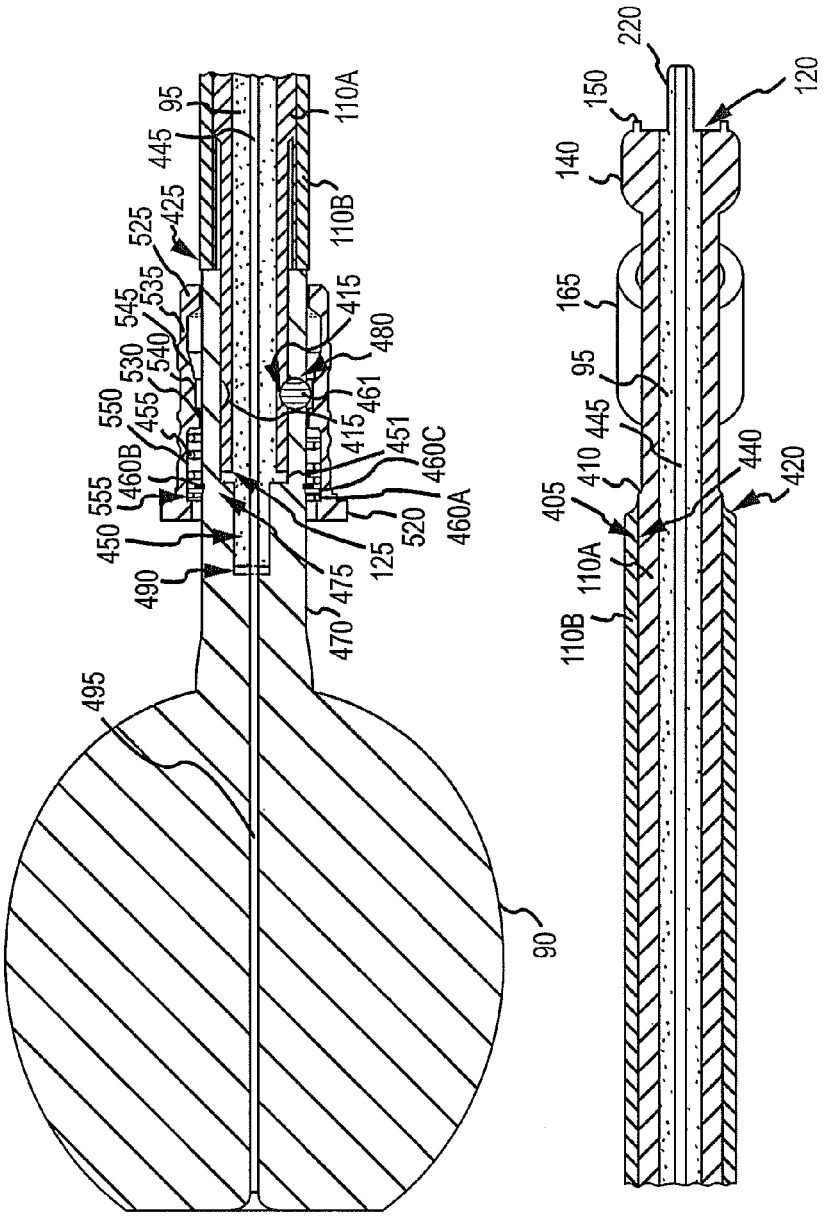
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FIG.91

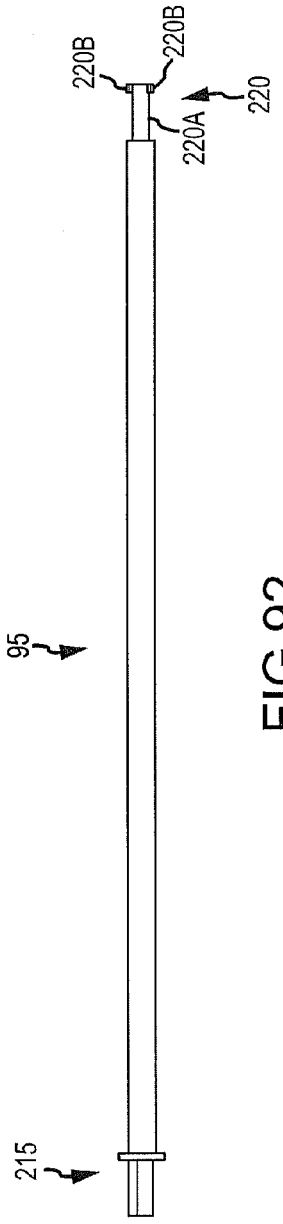


FIG.92

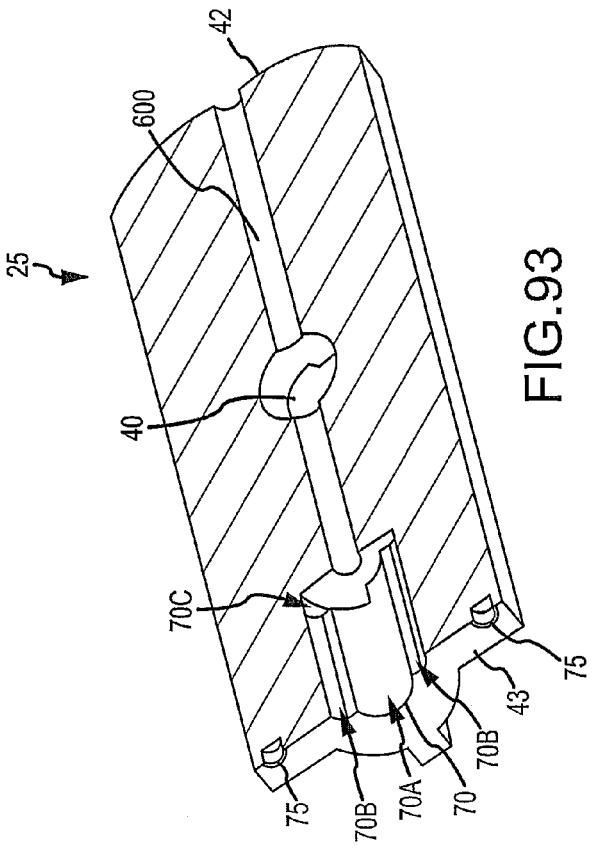


FIG.93

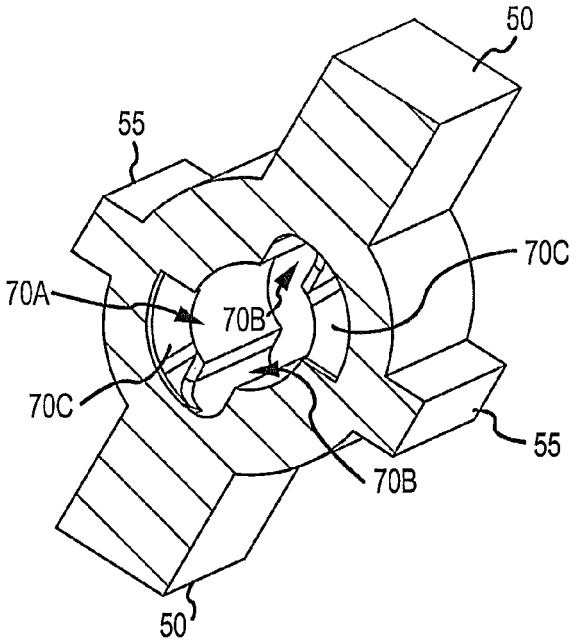
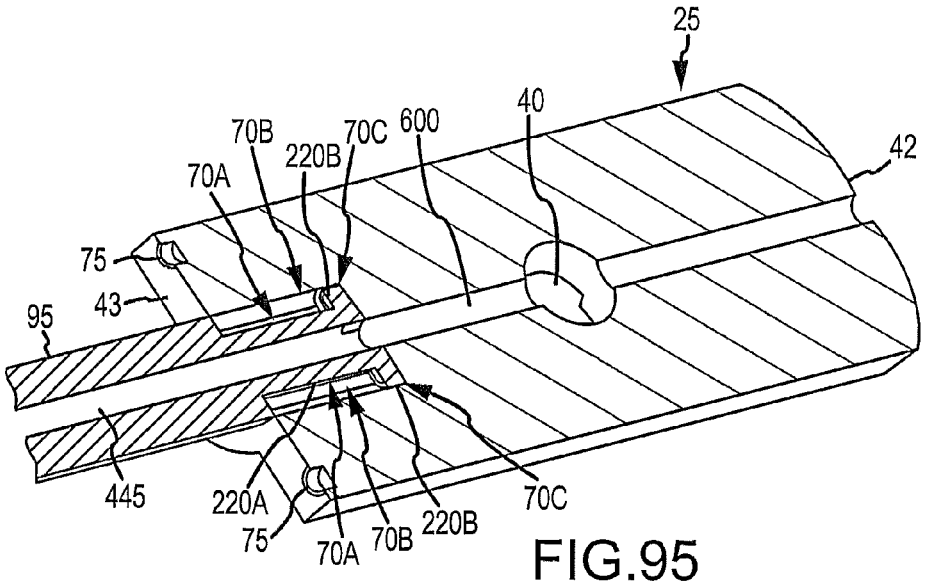


FIG.94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220B
70C

FIG.95

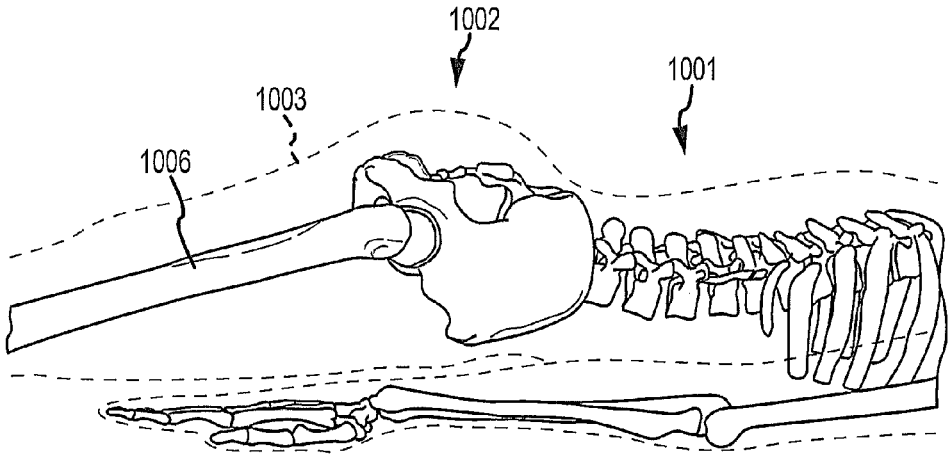

FIG.96A

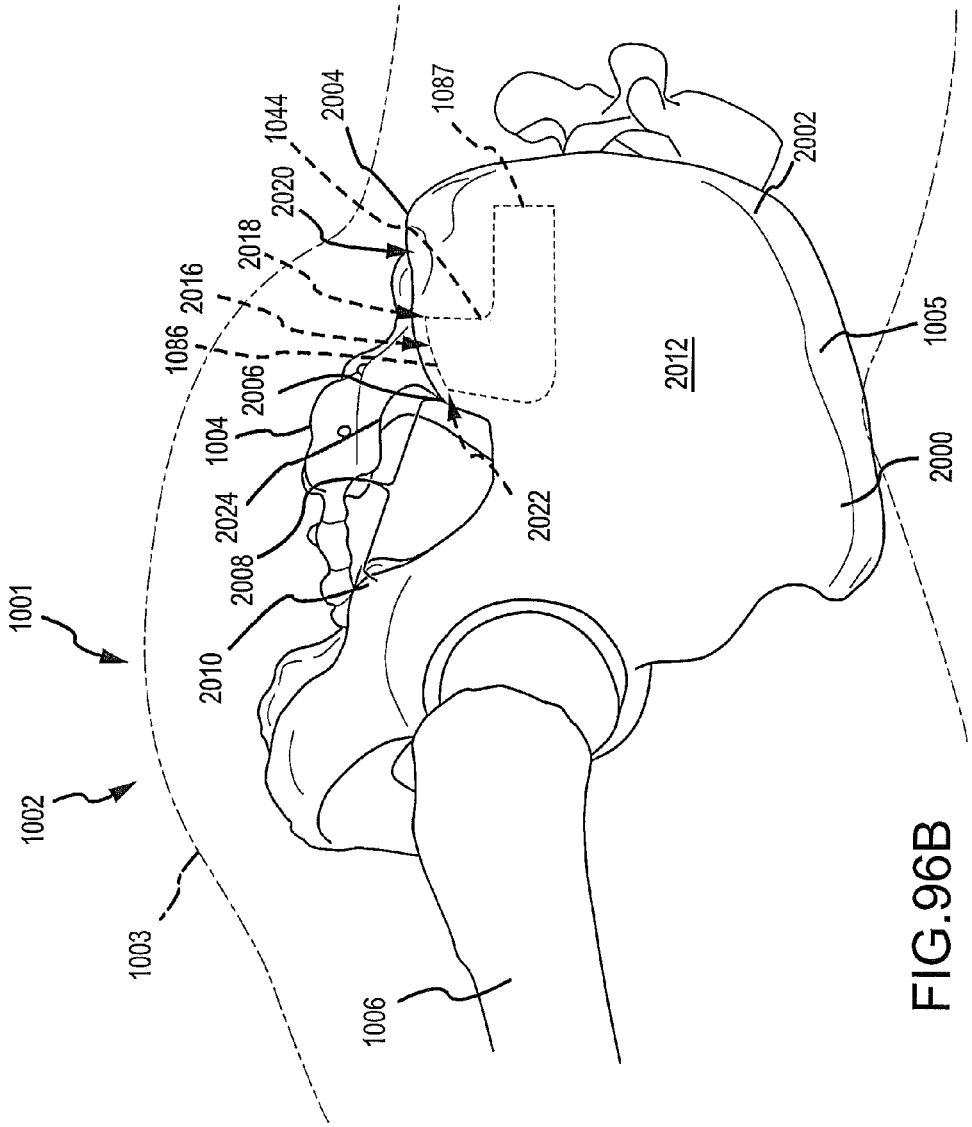
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FIG.96B

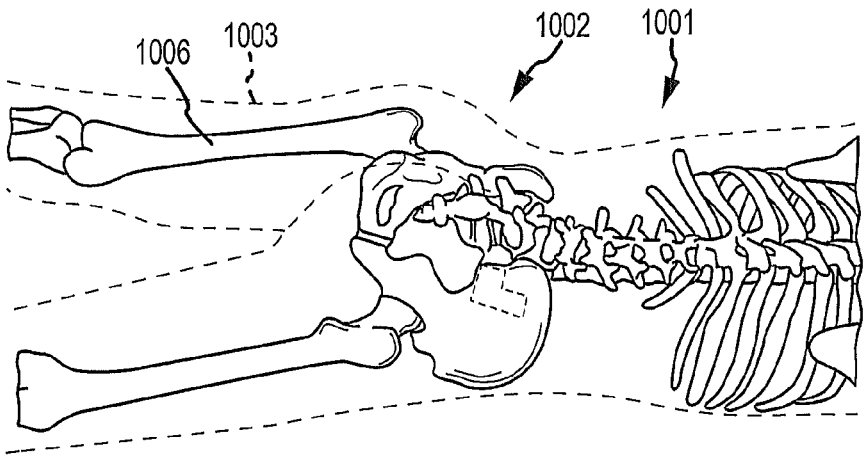

FIG.97A

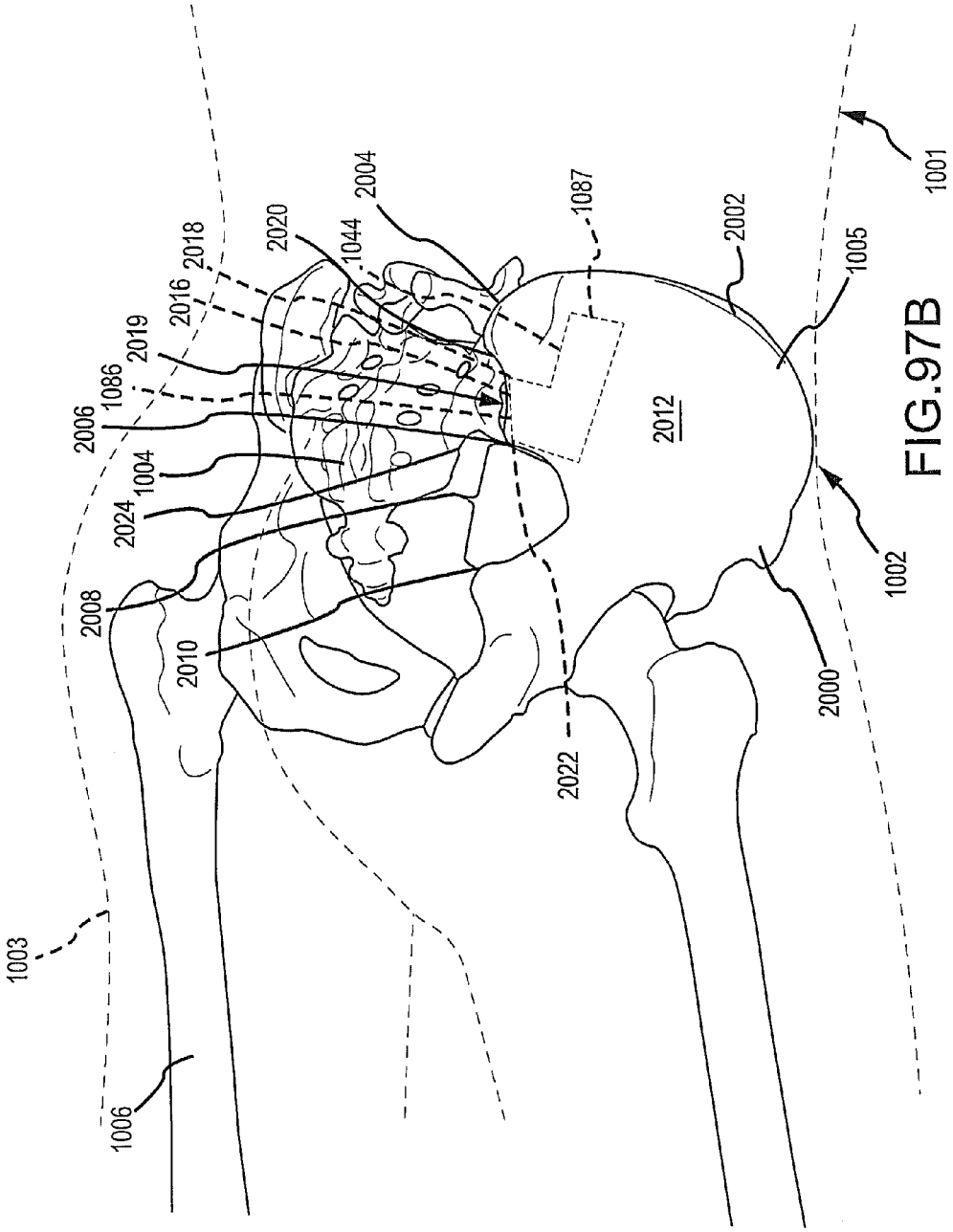
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FIG.97B

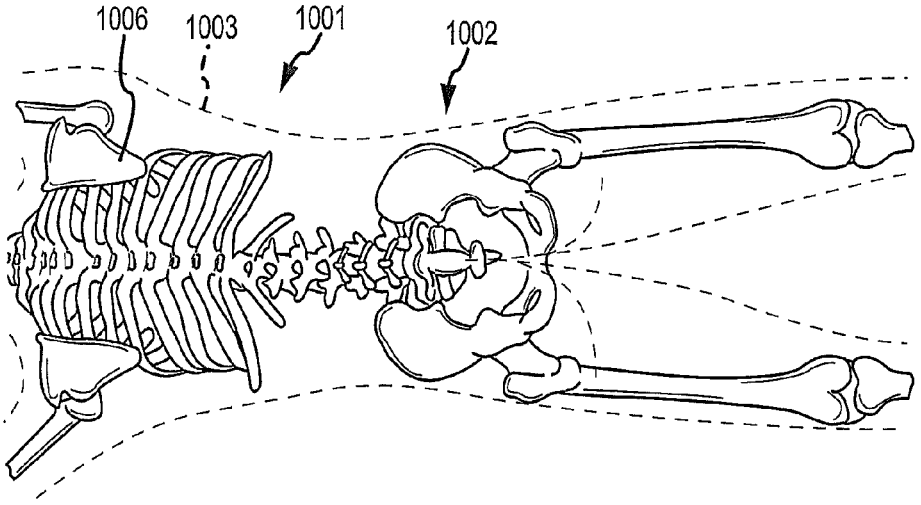
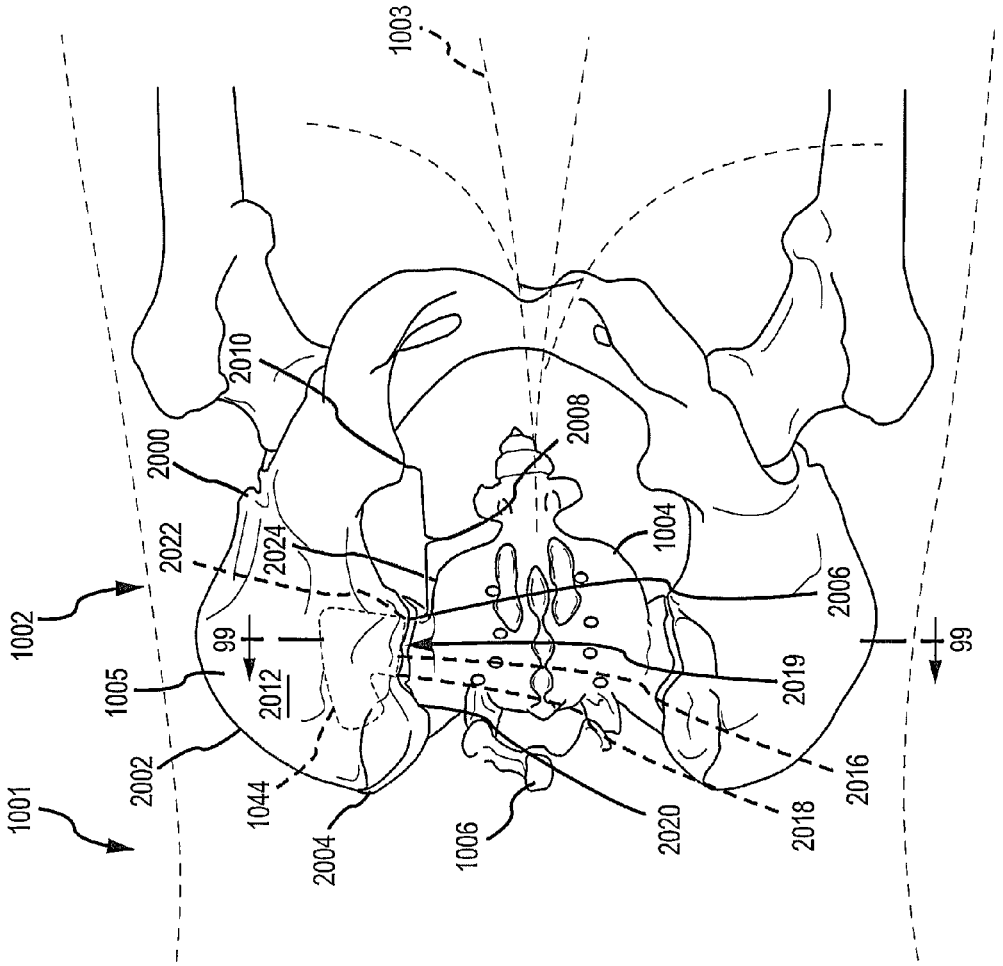


FIG.98A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2016
1001

FIG.98B

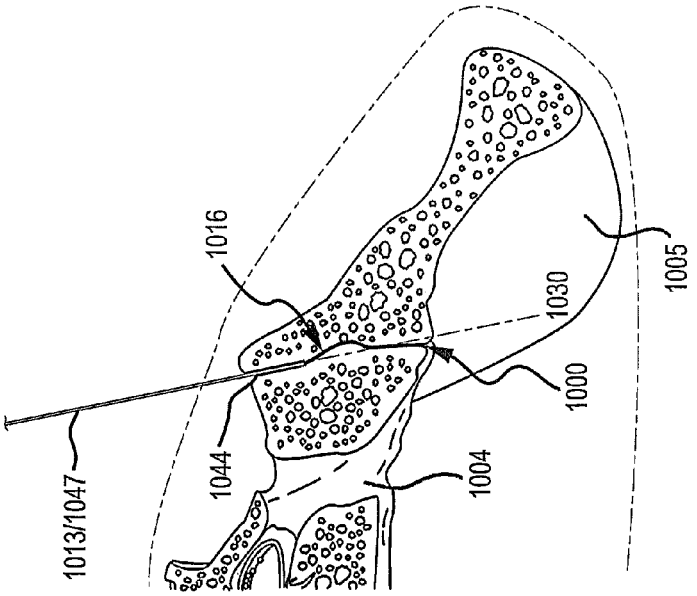


FIG.99B

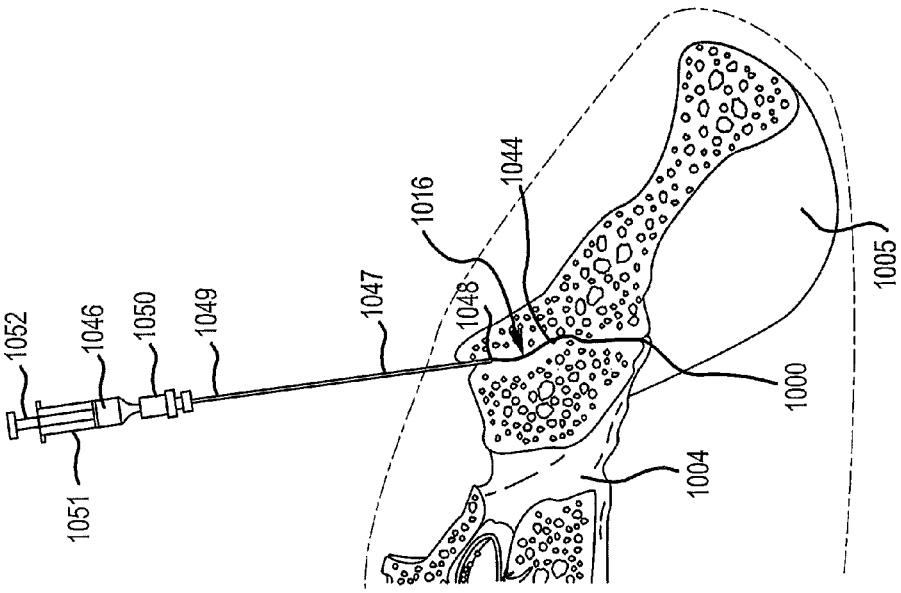


FIG.99A

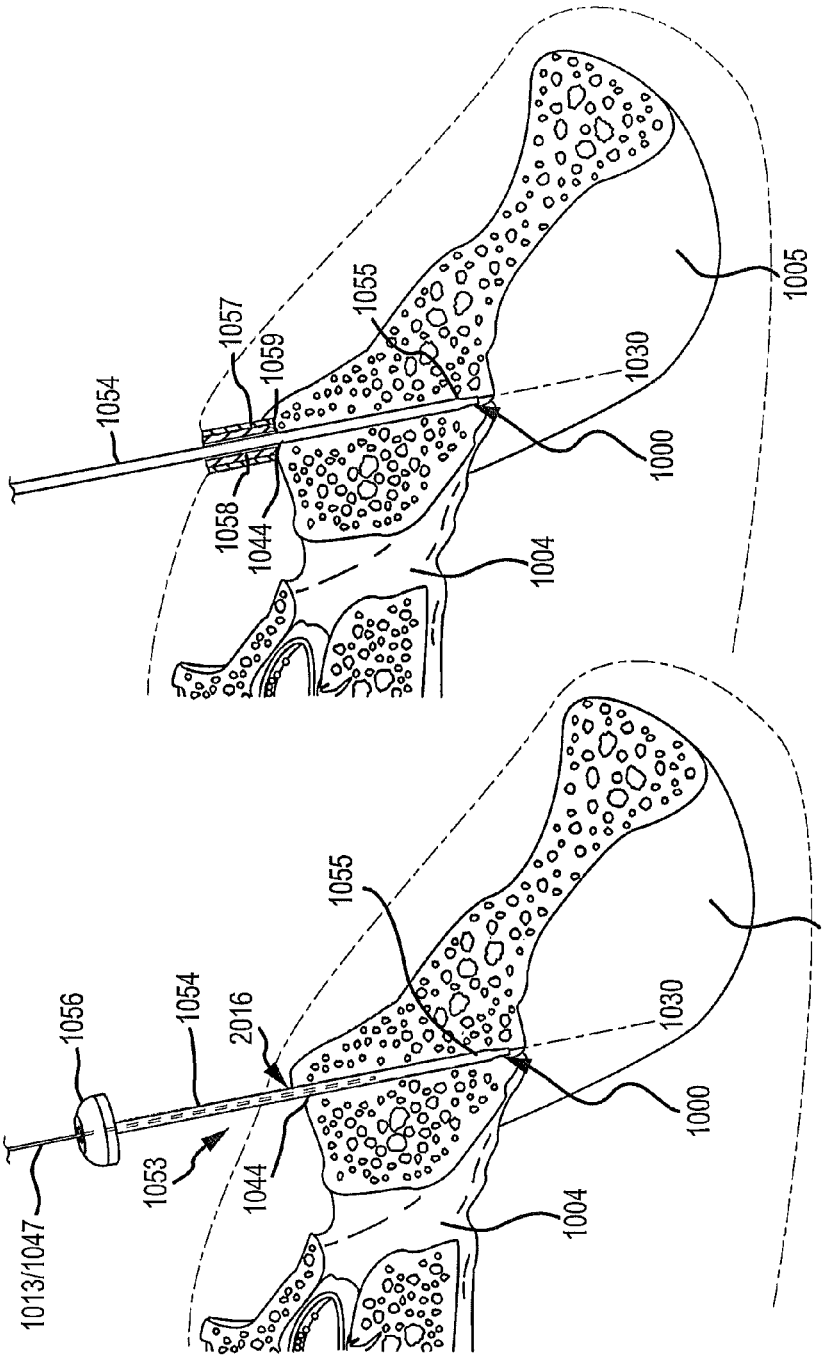


FIG.99D

FIG.99C

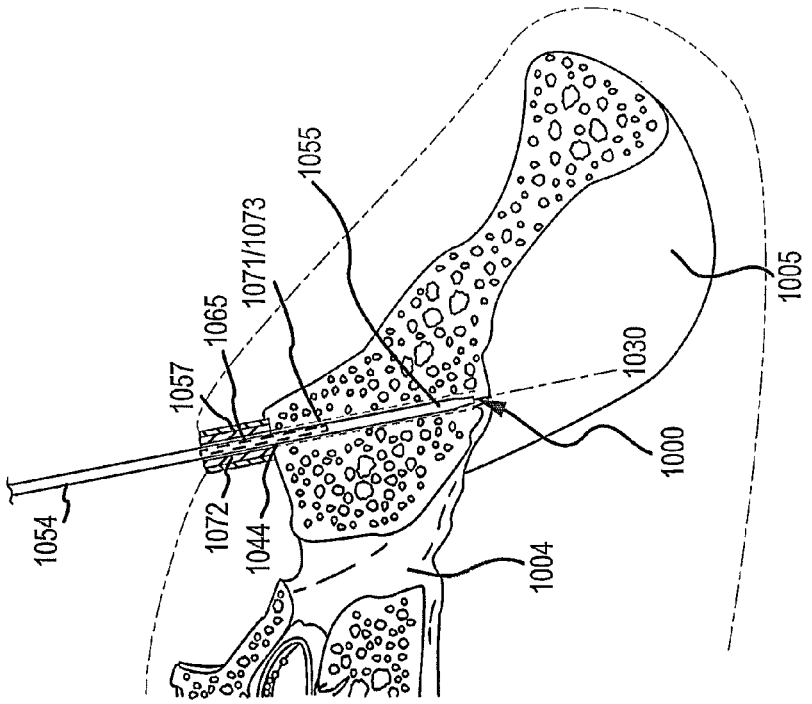


FIG.99F

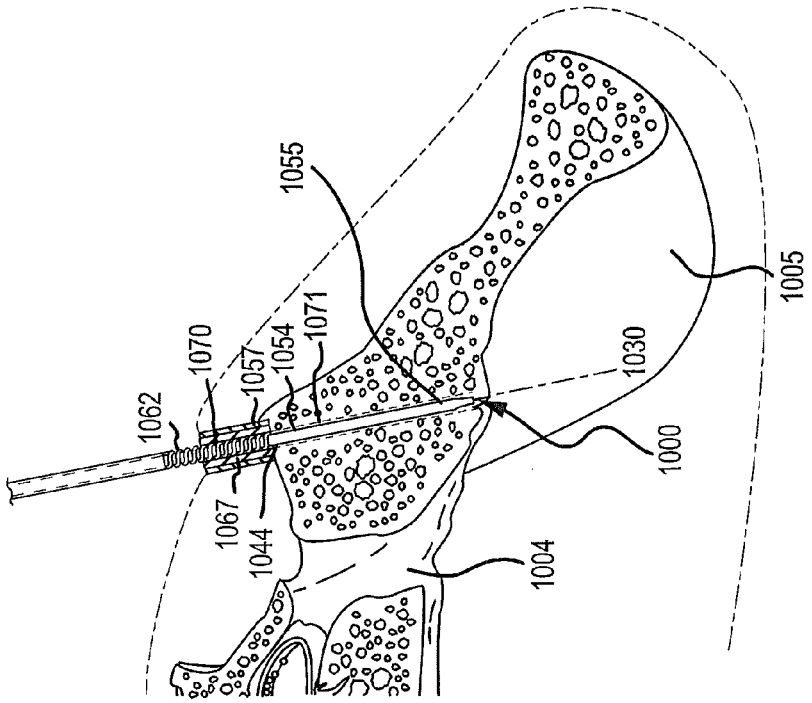


FIG.99E

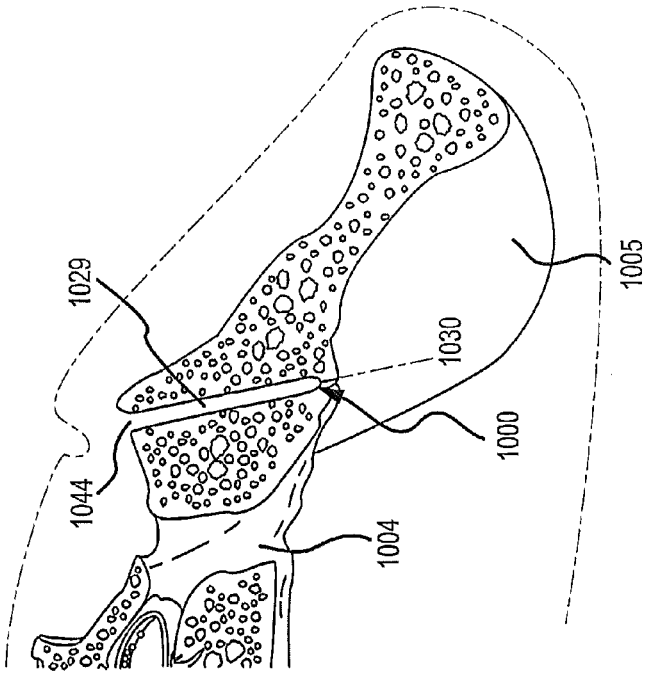


FIG.99H

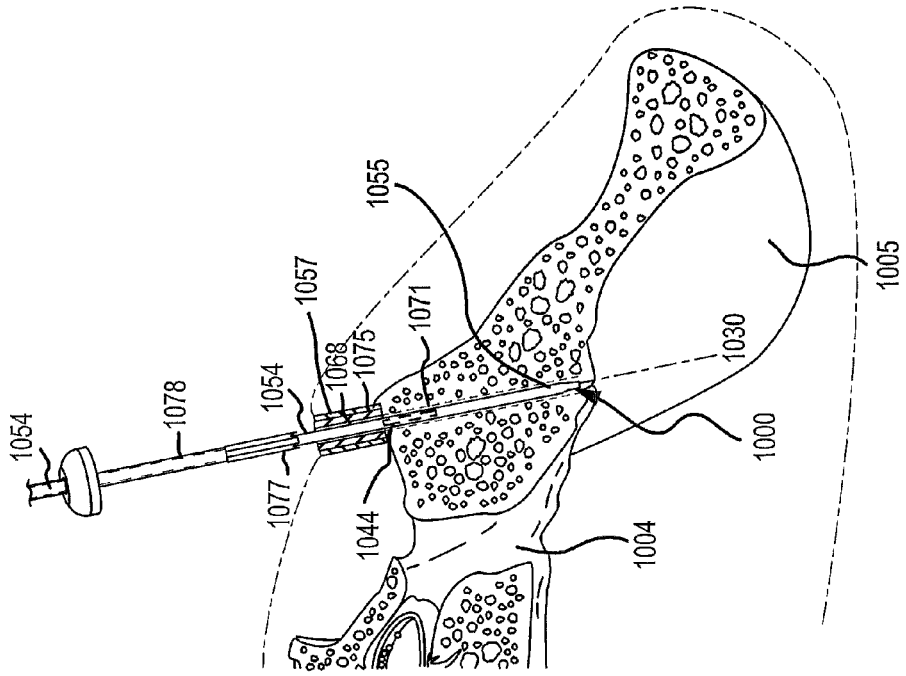


FIG.99G

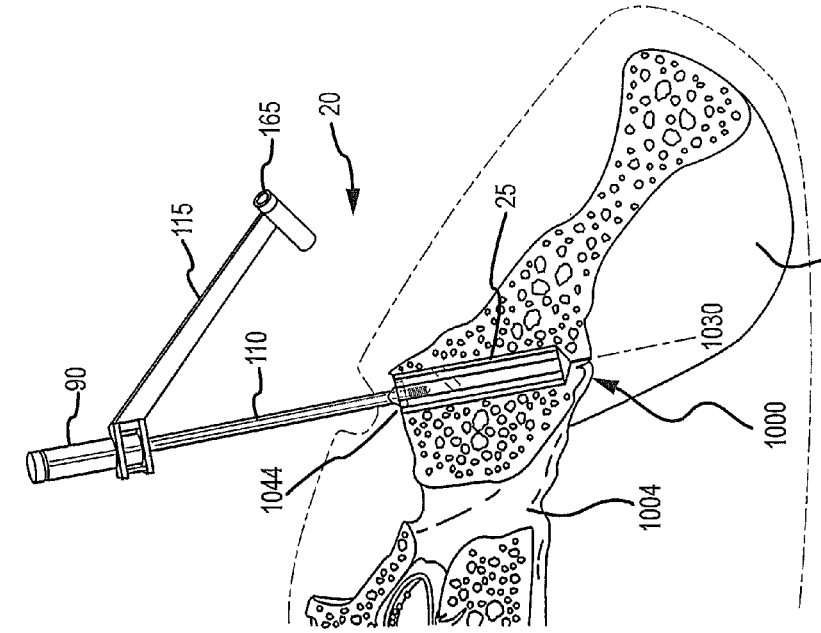


FIG.99J

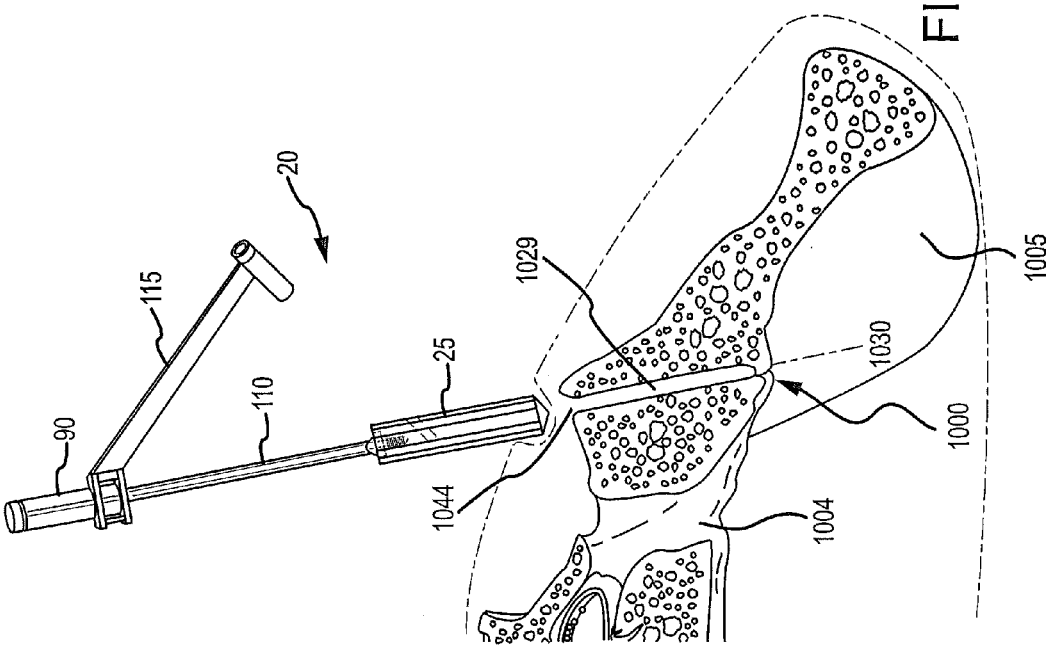


FIG.99I

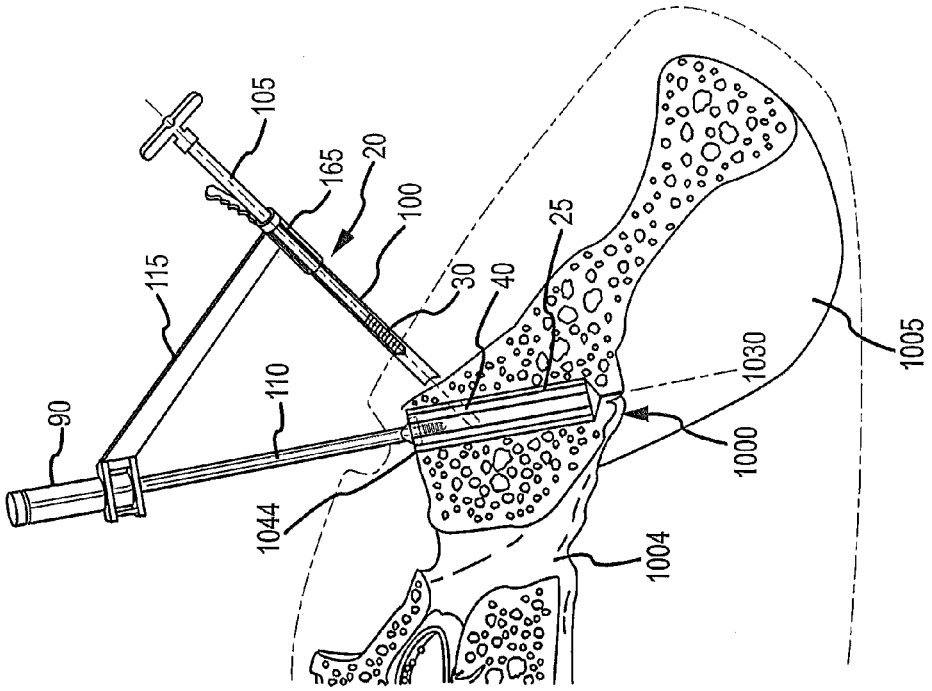


FIG.99L

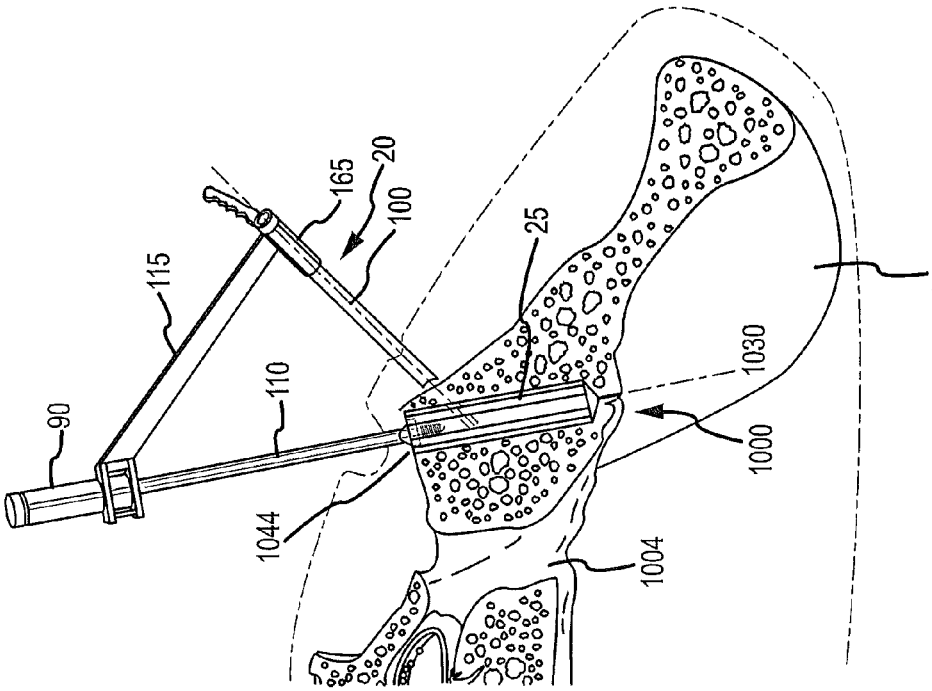


FIG.99K

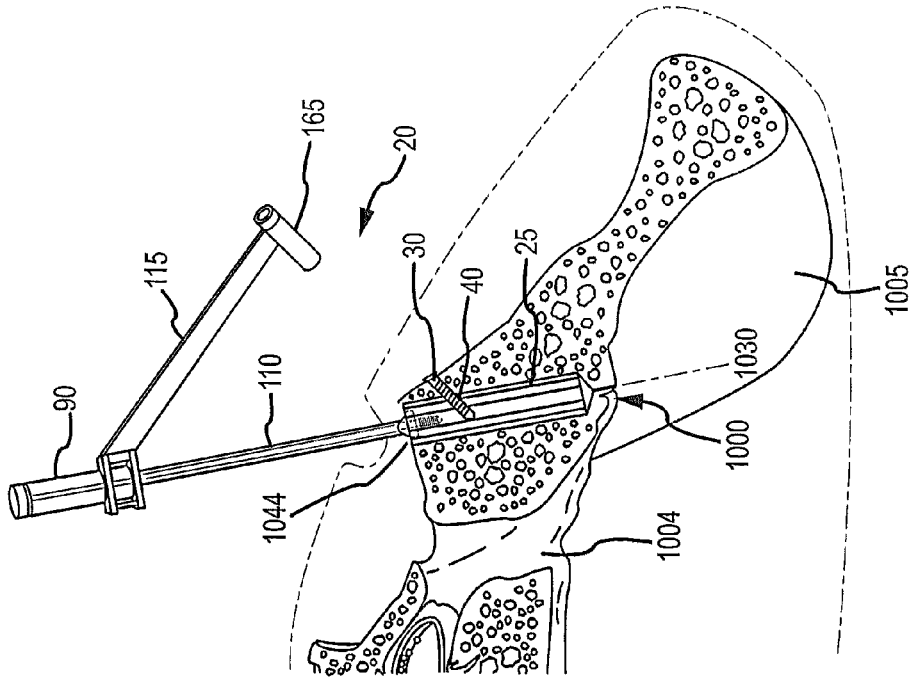


FIG.99N

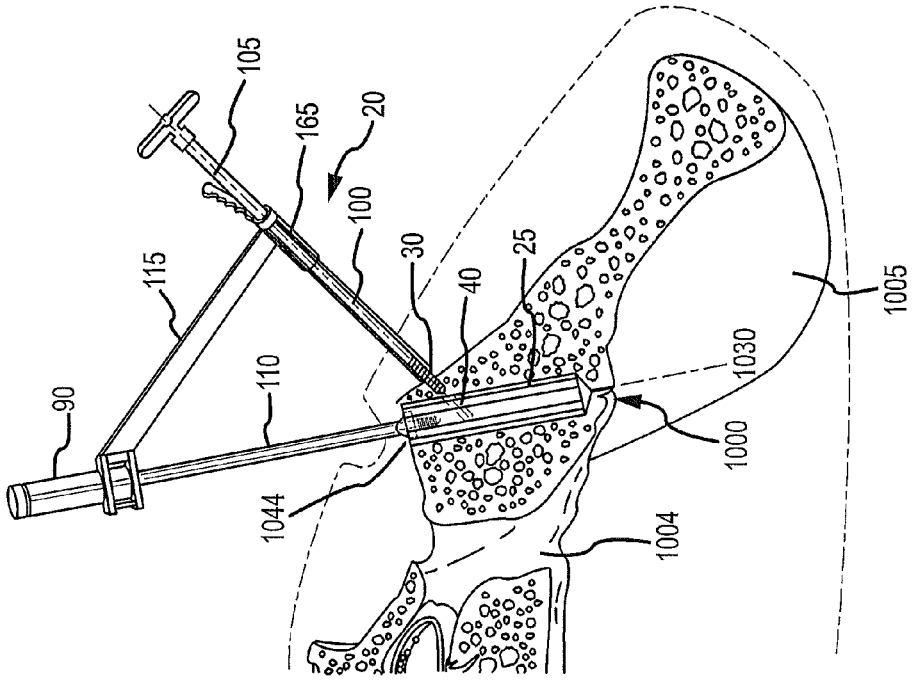


FIG.99M

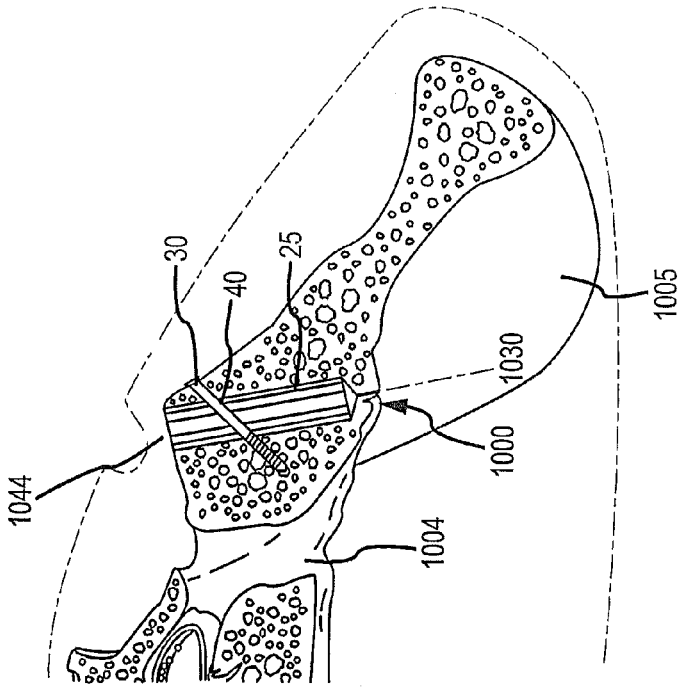


FIG.99P

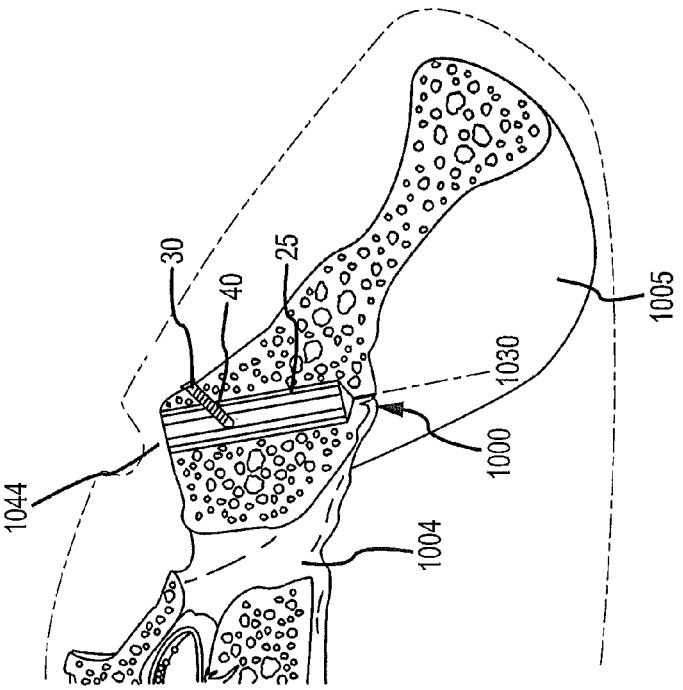


FIG.99O

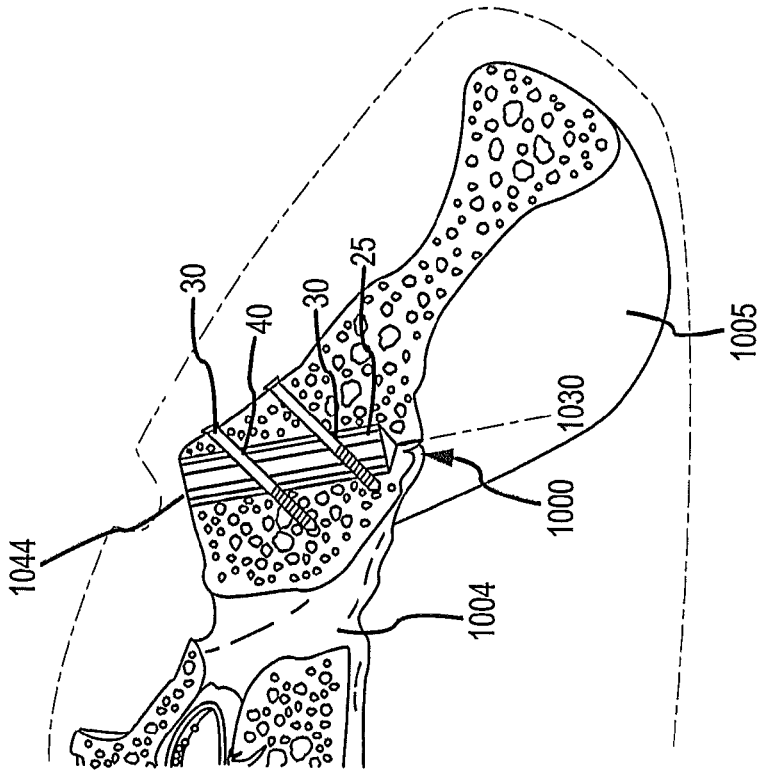


FIG.99Q

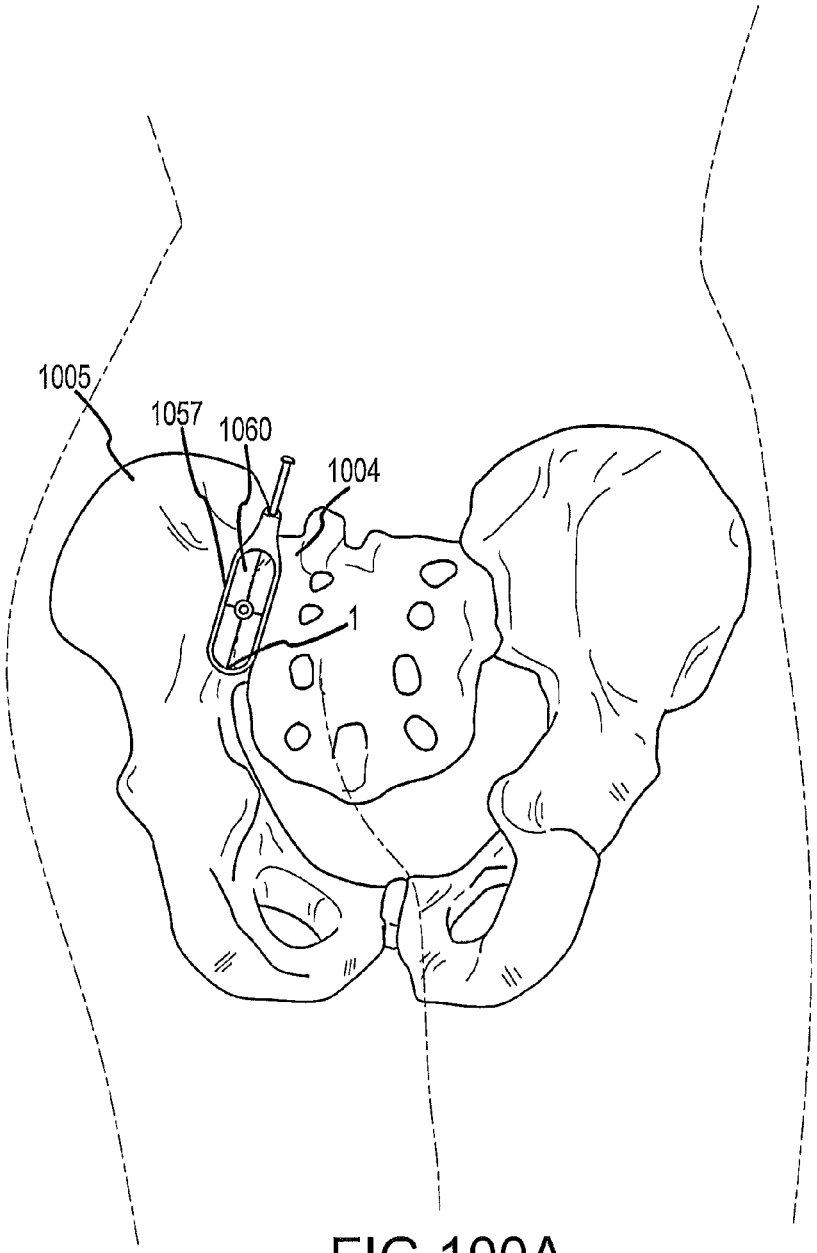


FIG.100A

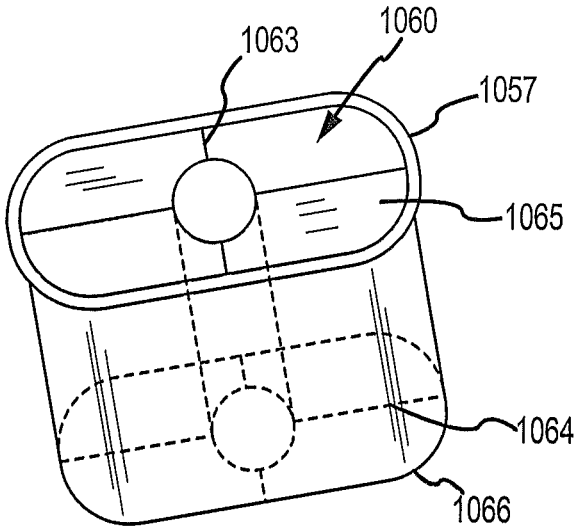


FIG.100B

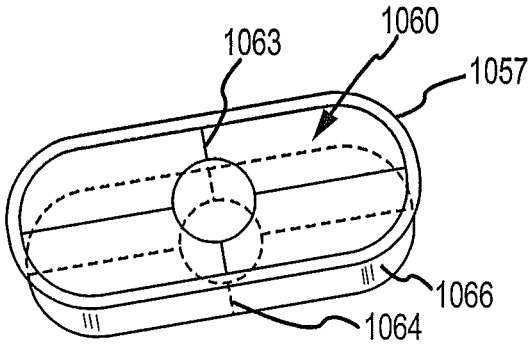


FIG.100C

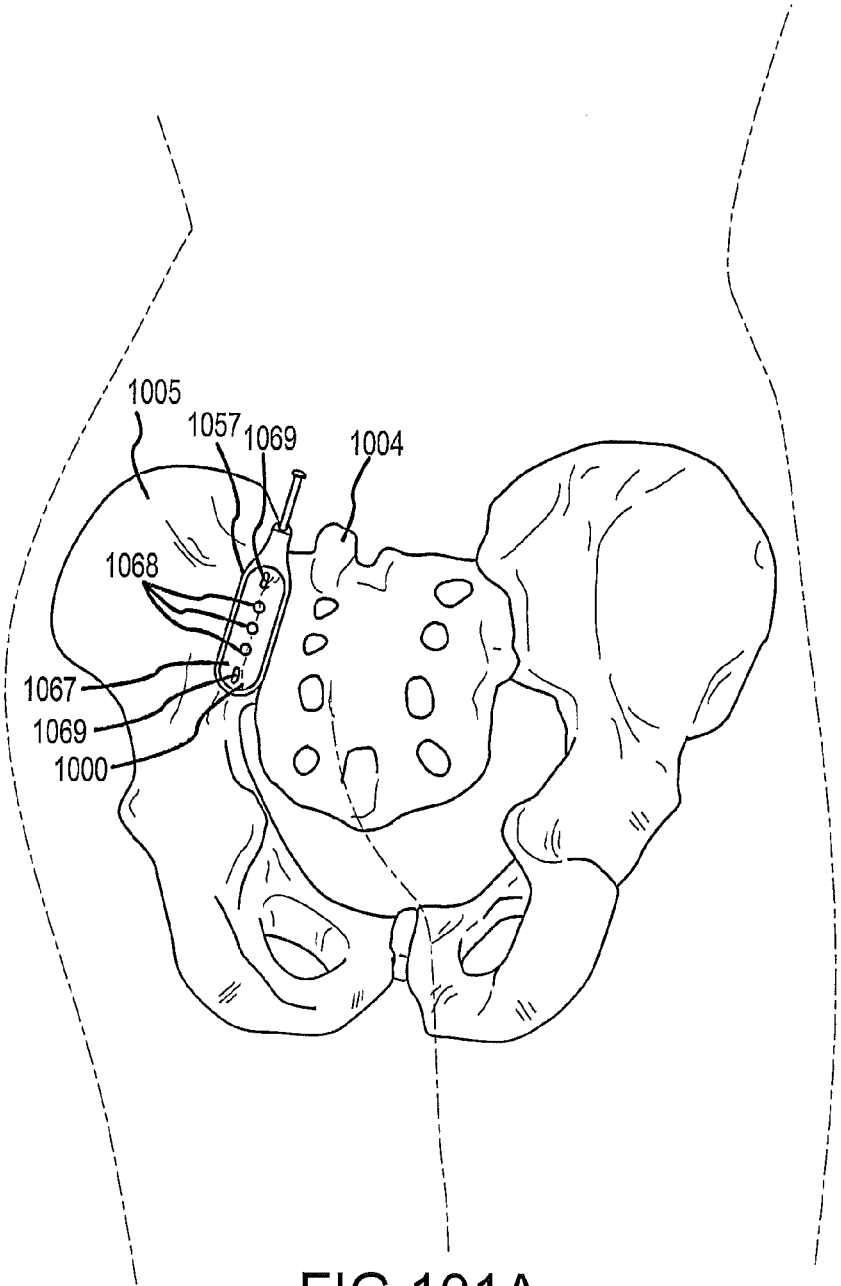


FIG.101A

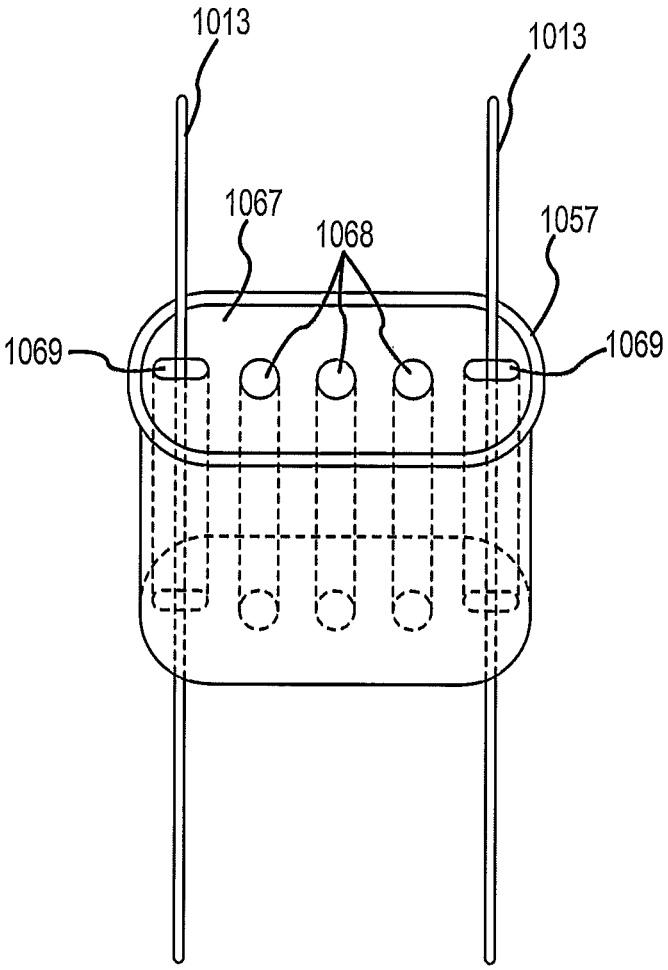


FIG.101B

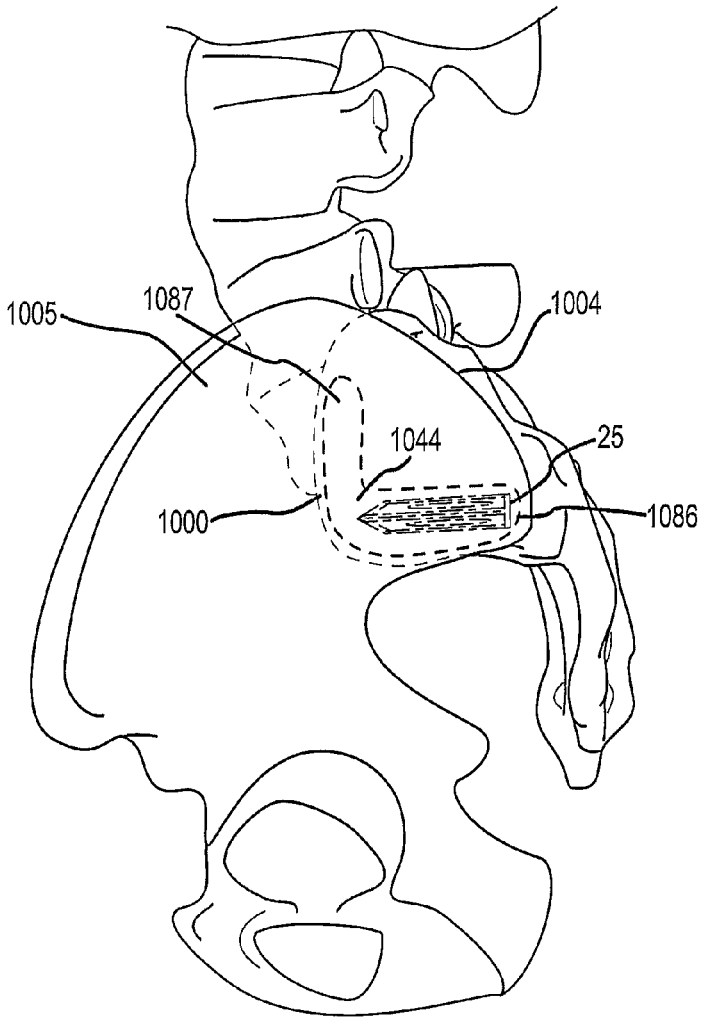


FIG.102A

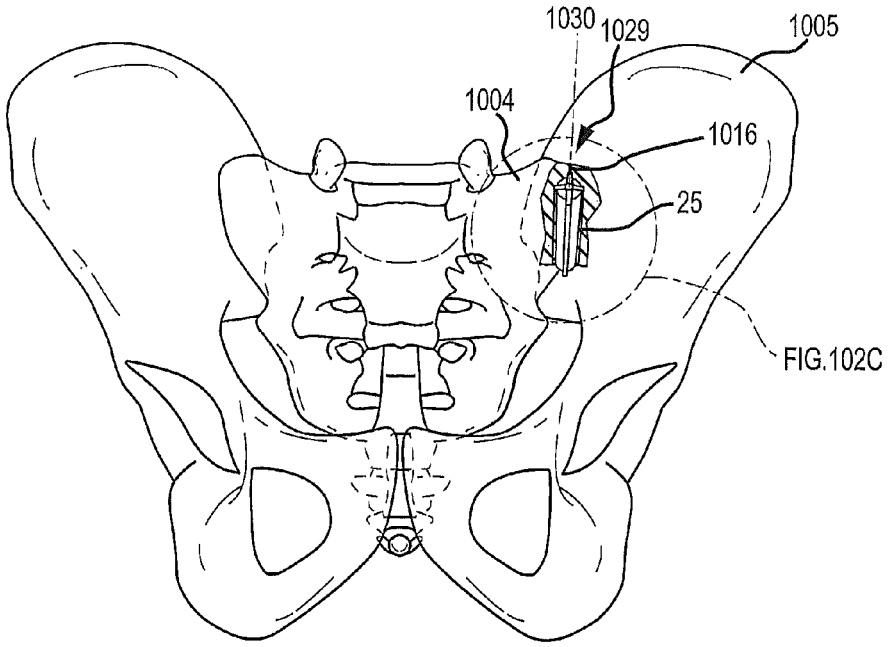


FIG.102B

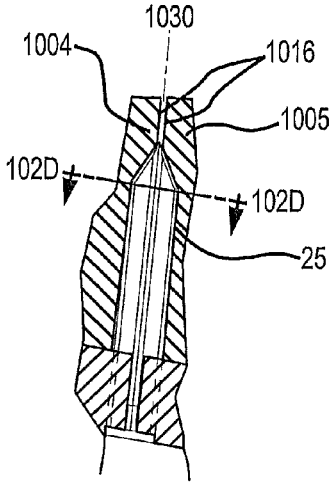


FIG.102C

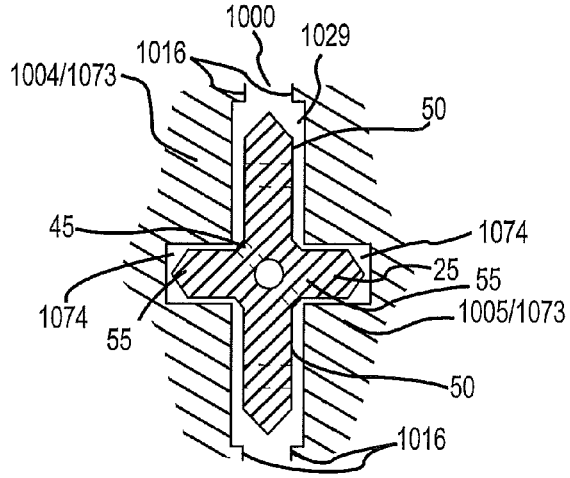


FIG.102D

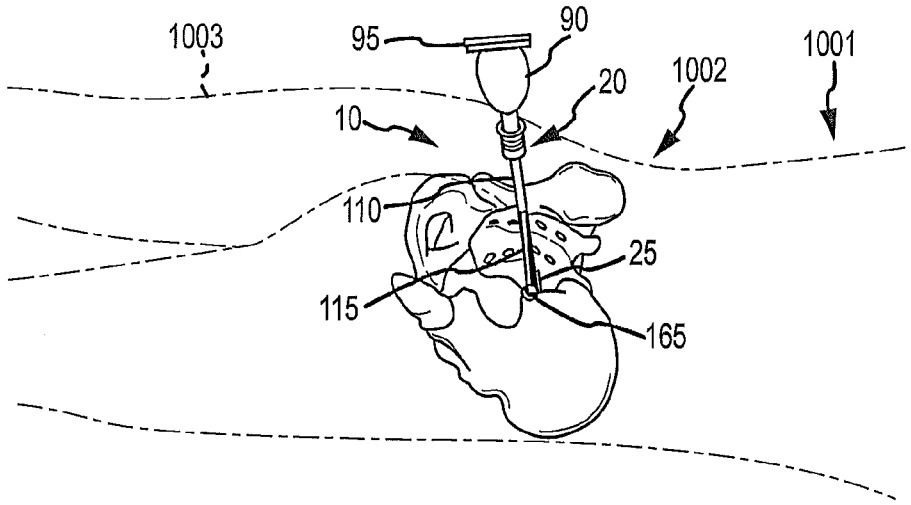


FIG.103A

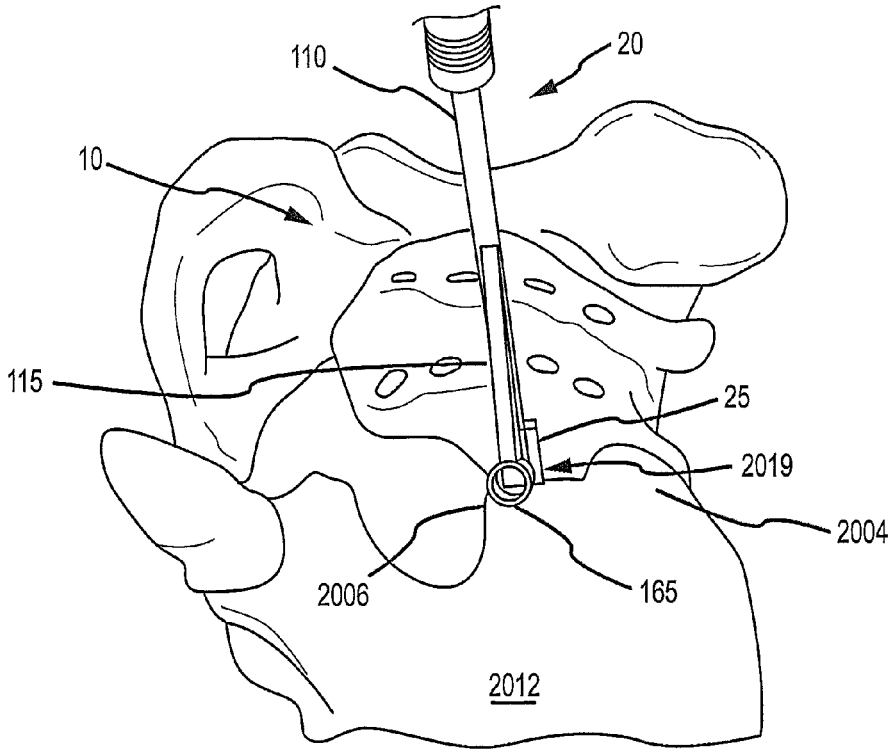


FIG.103B

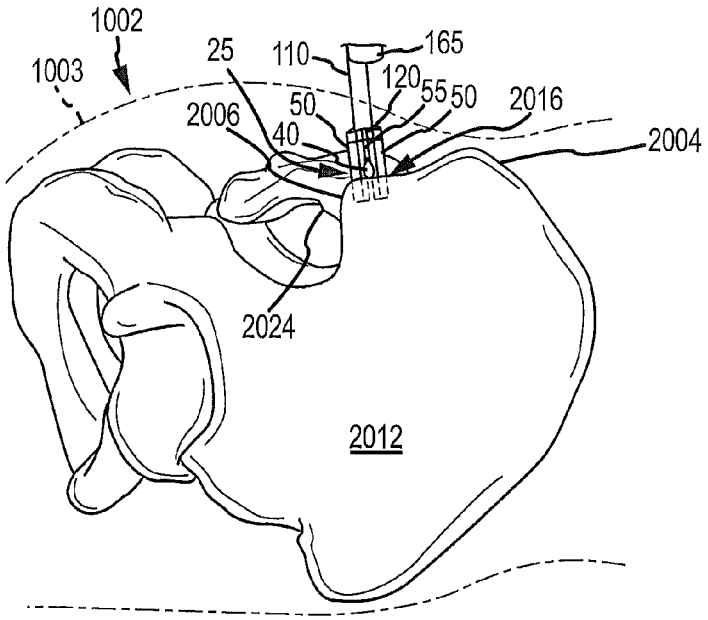


FIG.104

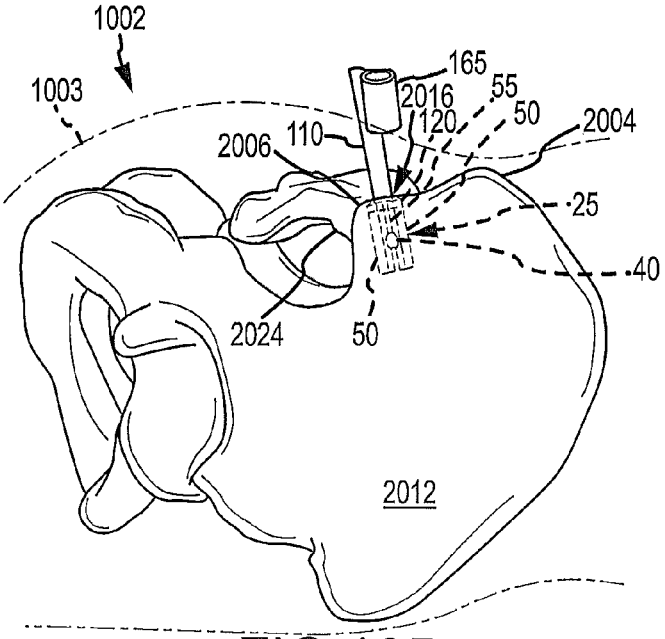


FIG.105

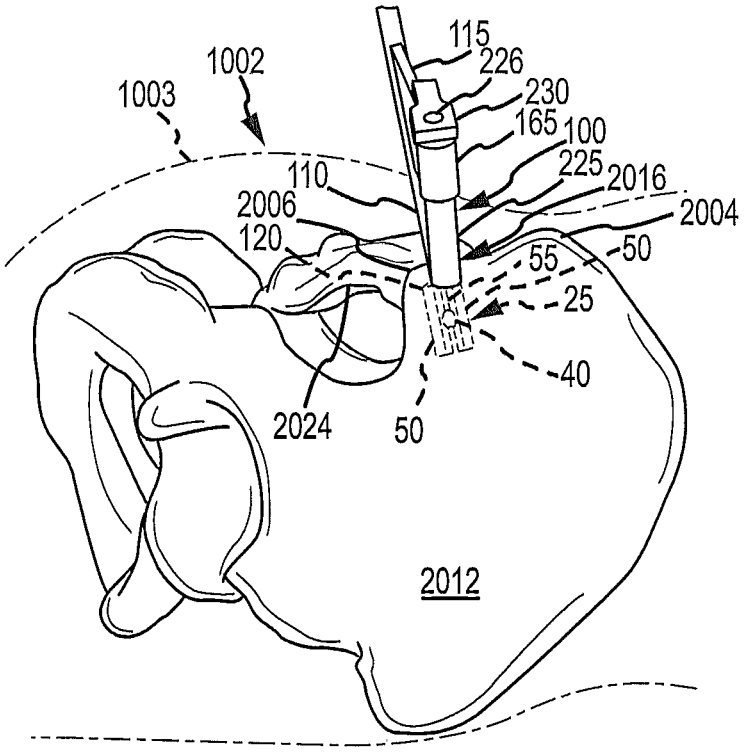
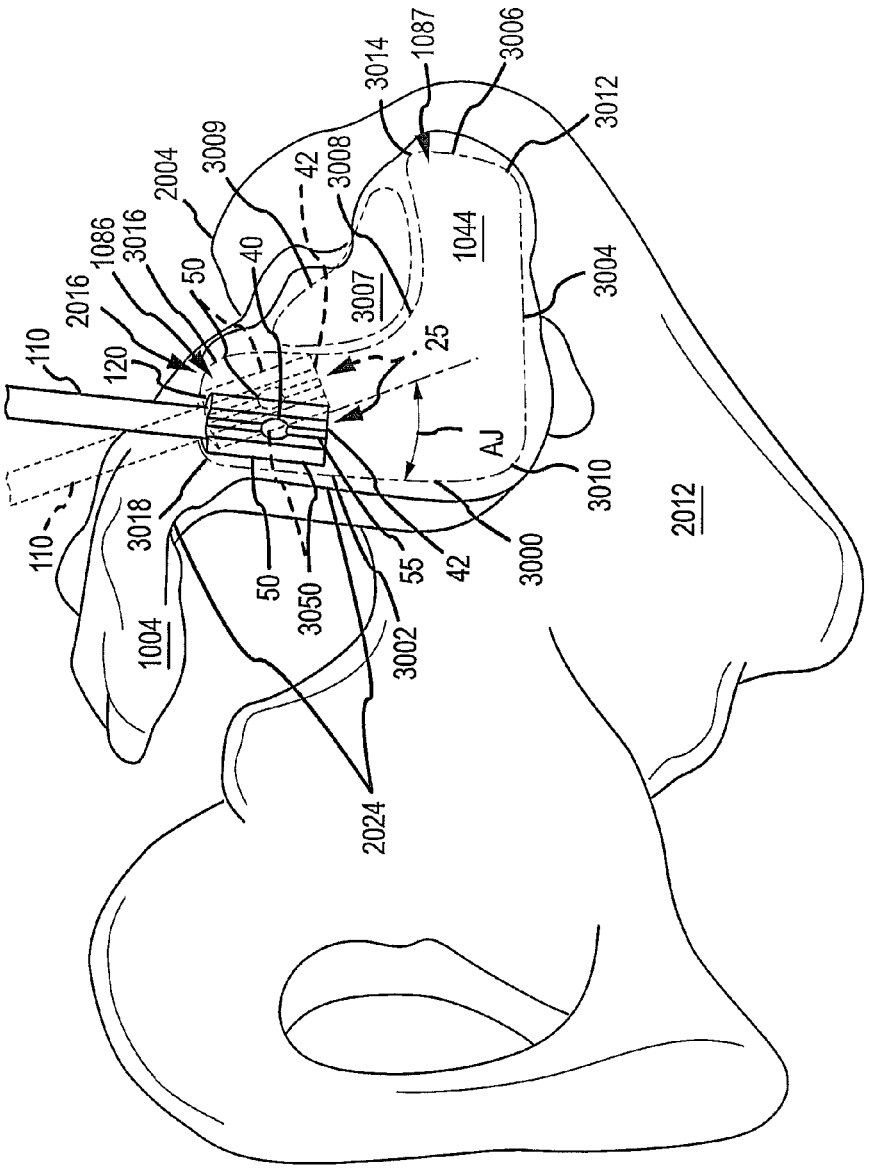

115
226
230
165
100
225
2016
2004
1002
1003
110
2006
120
55
50
25
40
2024
50
2012

FIG.106A


3014
1087
3006
3012
2004
3009
42
3008
1086
3016
2016
50
40
1044
3004
3007
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120
25
AJ
3010
110
3018
2012
50
3050
55
42
3000
1004
3002
2024

FIG.106B

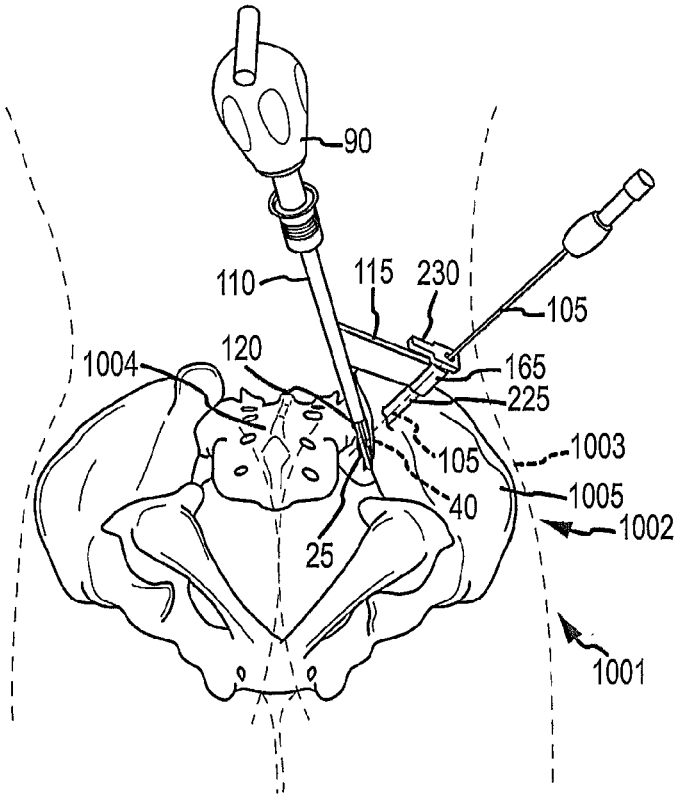

90
110
115
230
105
1004
120
165
225
105
1003
40
1005
1002
25
1001

FIG.107A

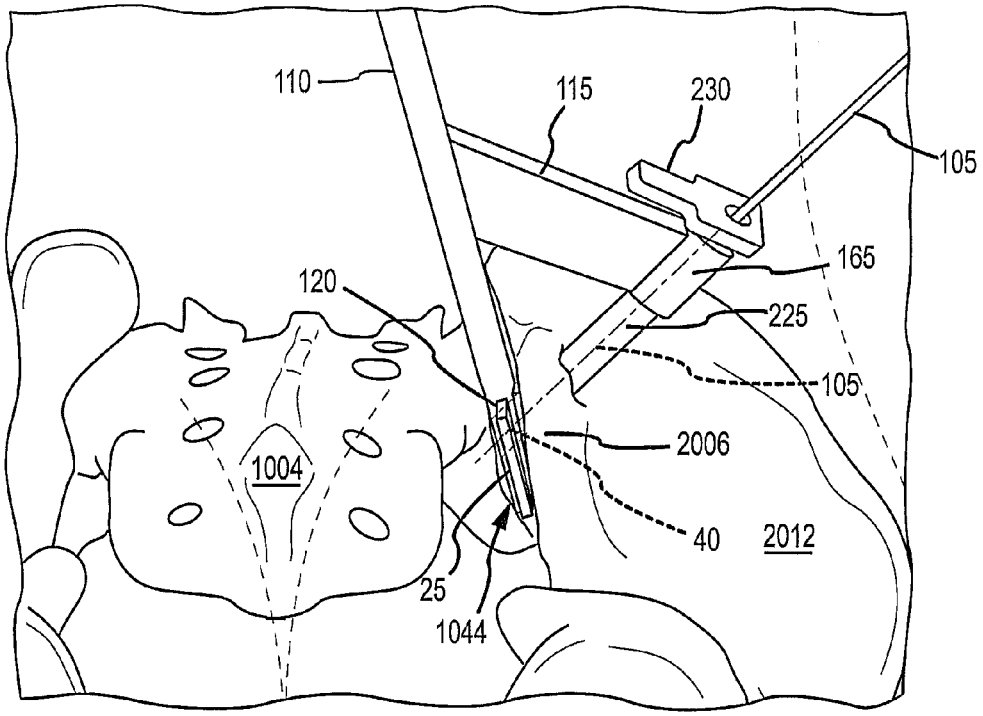


FIG.107B

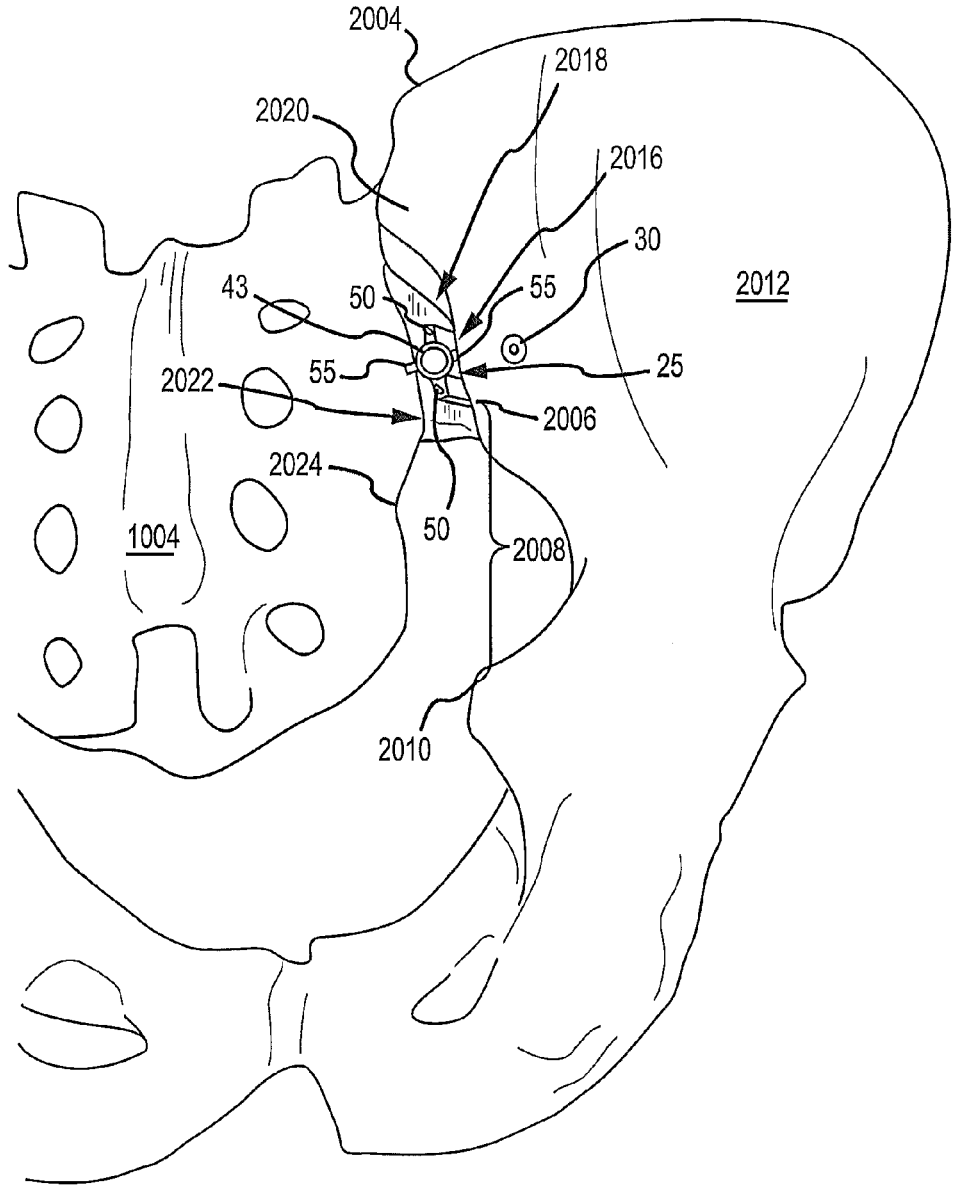

2004
2018
2020
2016
30
43
50
55
2012
55
25
2022
2006
2024
50
1004
2008
2010

FIG.108A

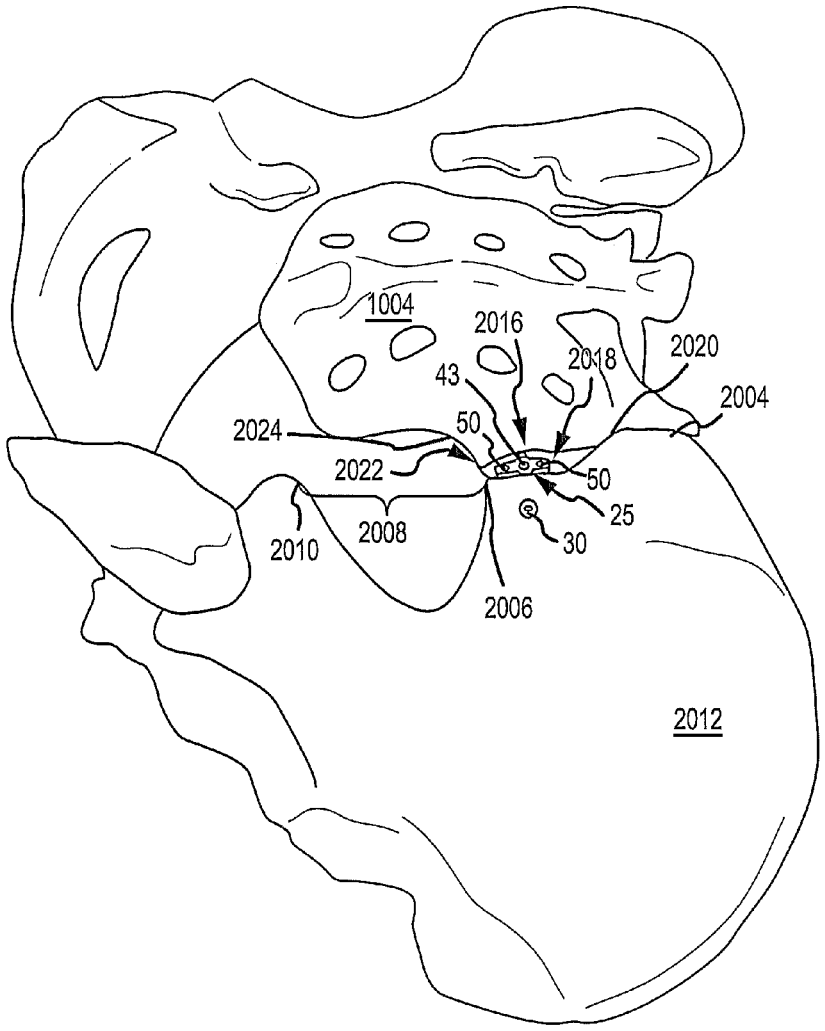

1004
2016
2018
2020
2004
43
50
2024
2022
50
25
30
2010
2008
2006
2012

FIG.108B

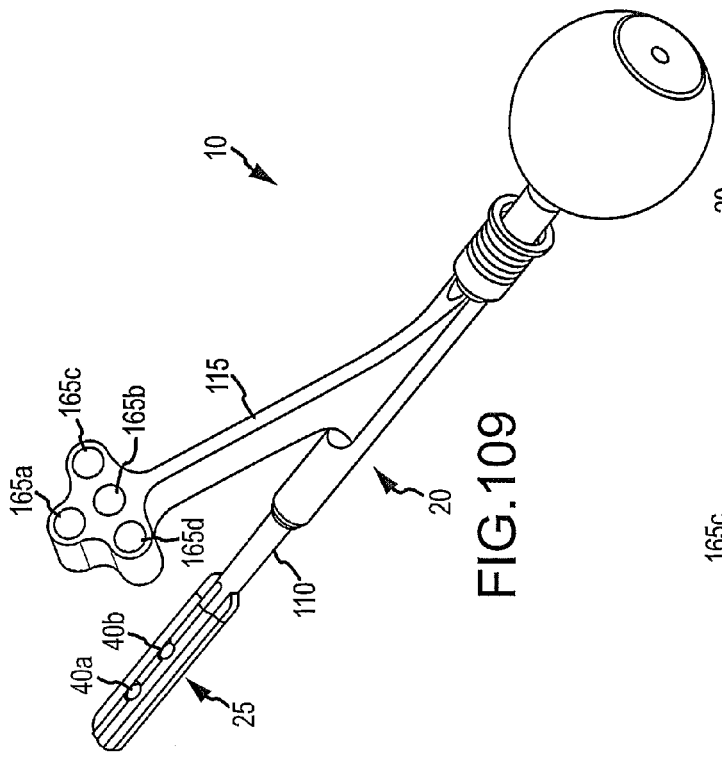


FIG.109

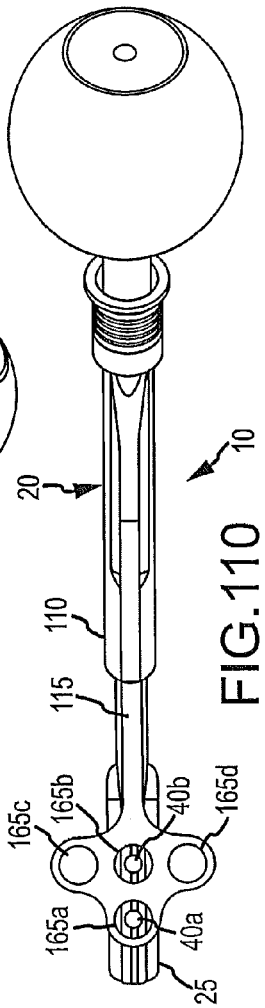


FIG.110

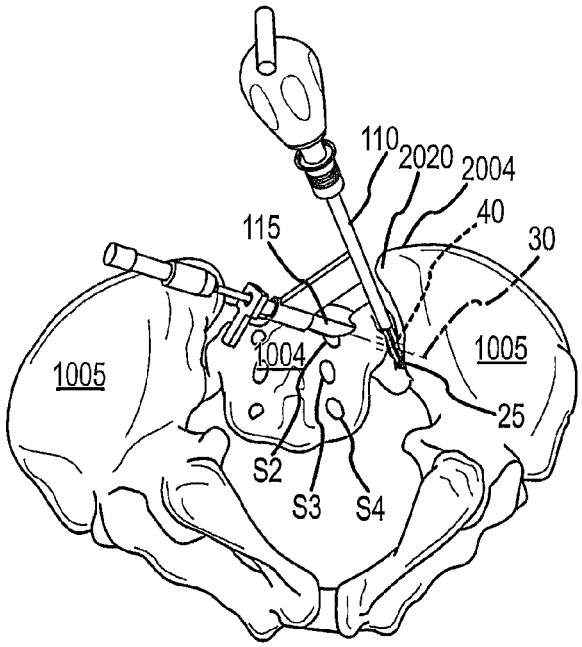


FIG.111A

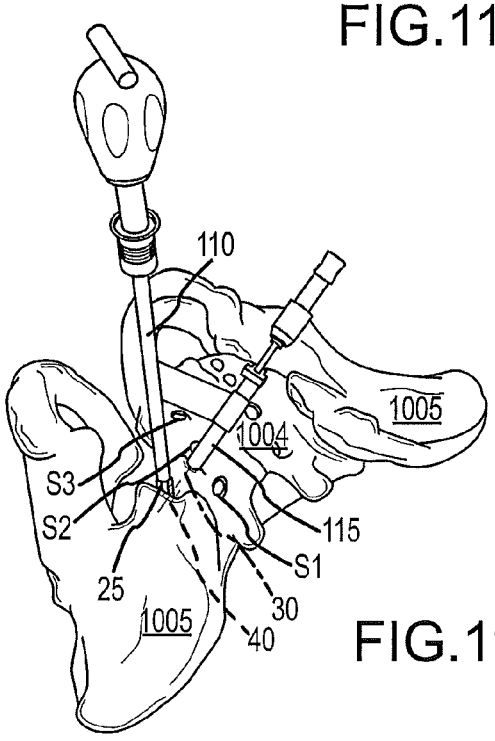


FIG.111B

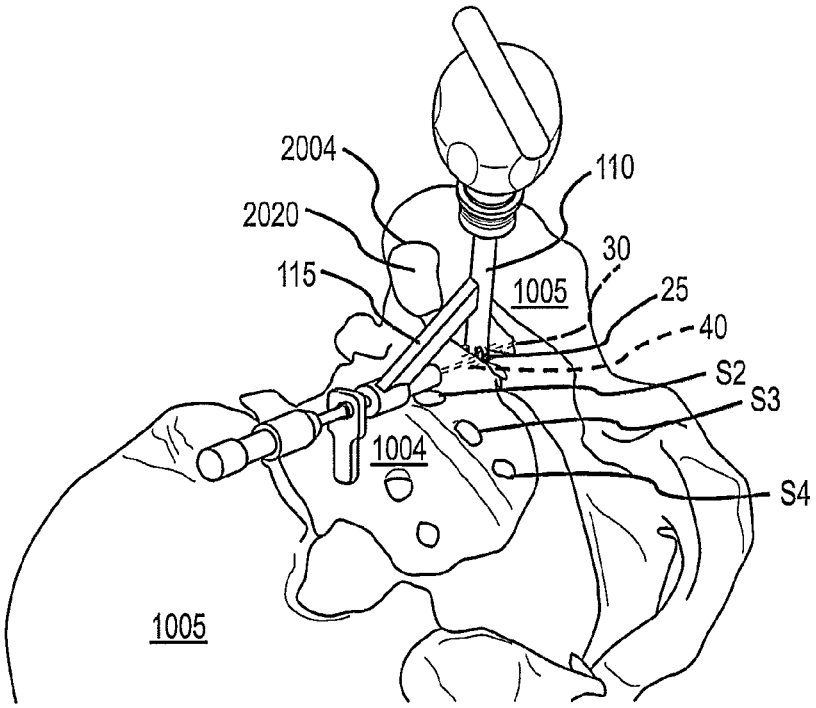


FIG.111C

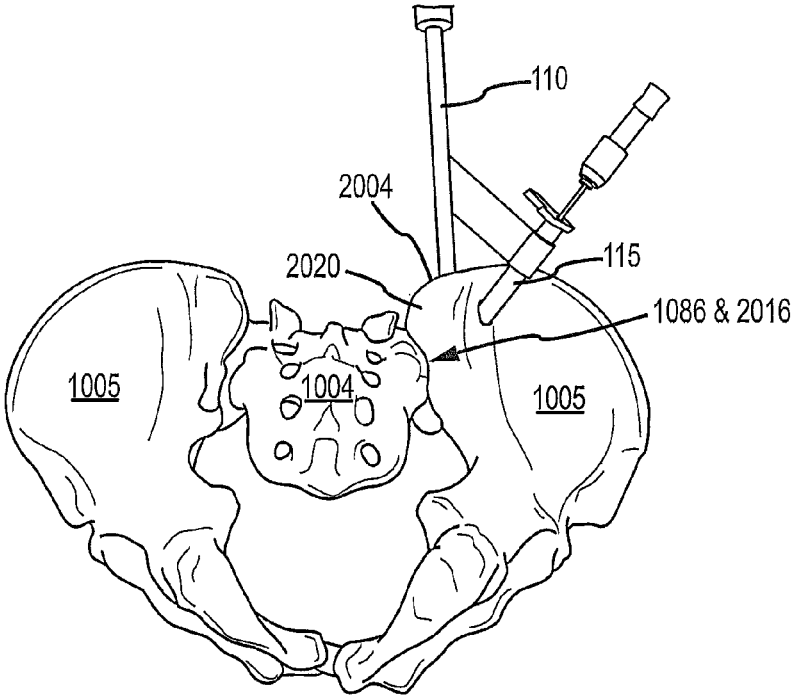


FIG.112A

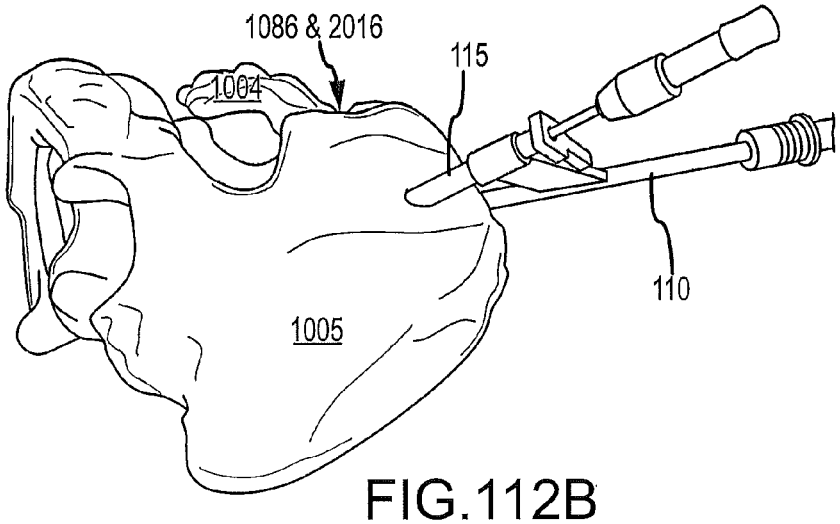


FIG.112B

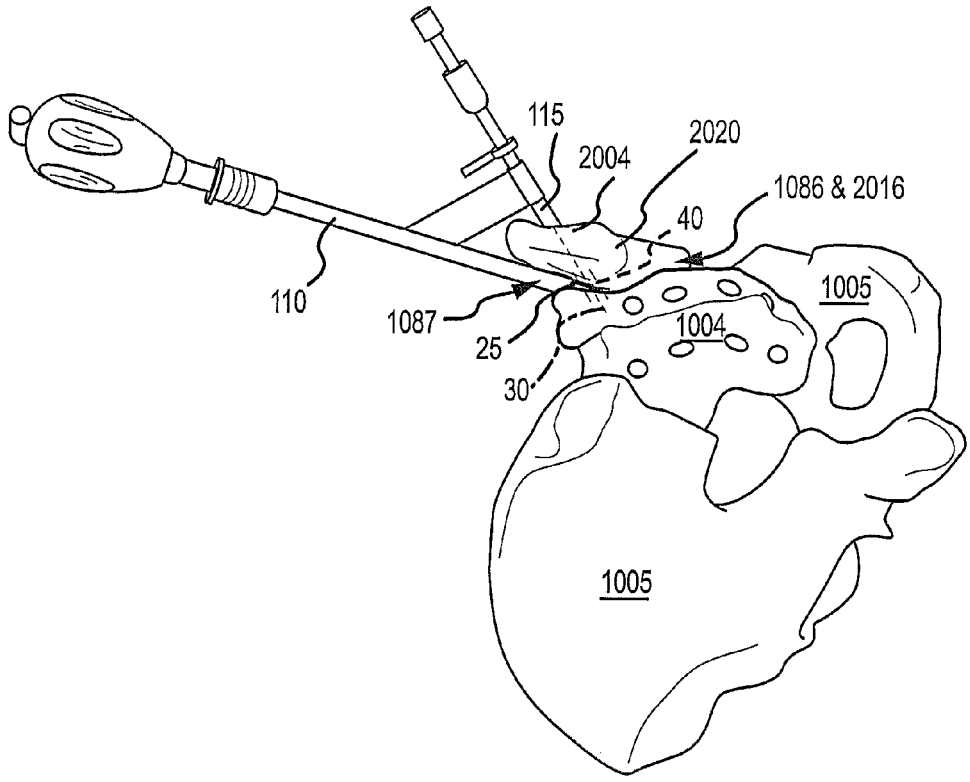


FIG.112C

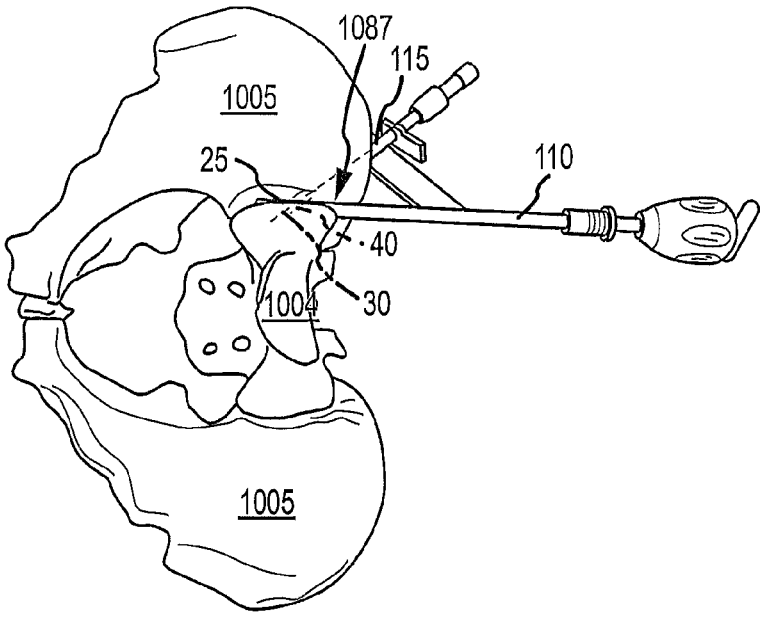


FIG.112D

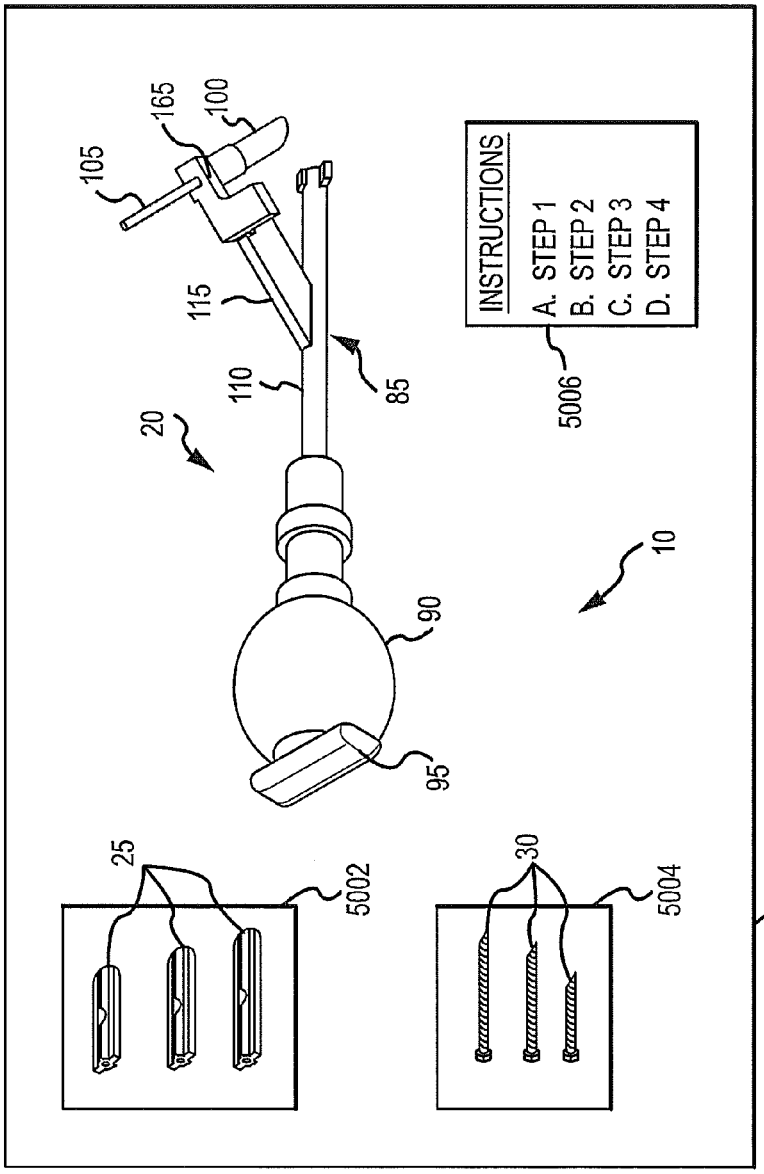

INSTRUCTIONS
A. STEP 1
B. STEP 2
C. STEP 3
D. STEP 4
5006
4999
105
165
100
115
110
85
20
10
90
95
25
5002
30
5004
5000

FIG.113

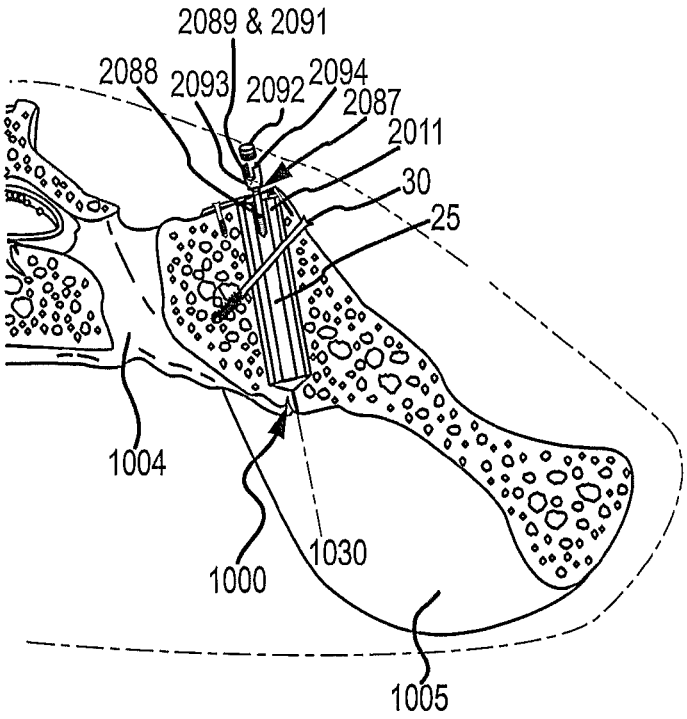

2089 & 2091
2088
2093
2092
2094
2087
2011
30
25
1004
1000
1030
1005

FIG.114

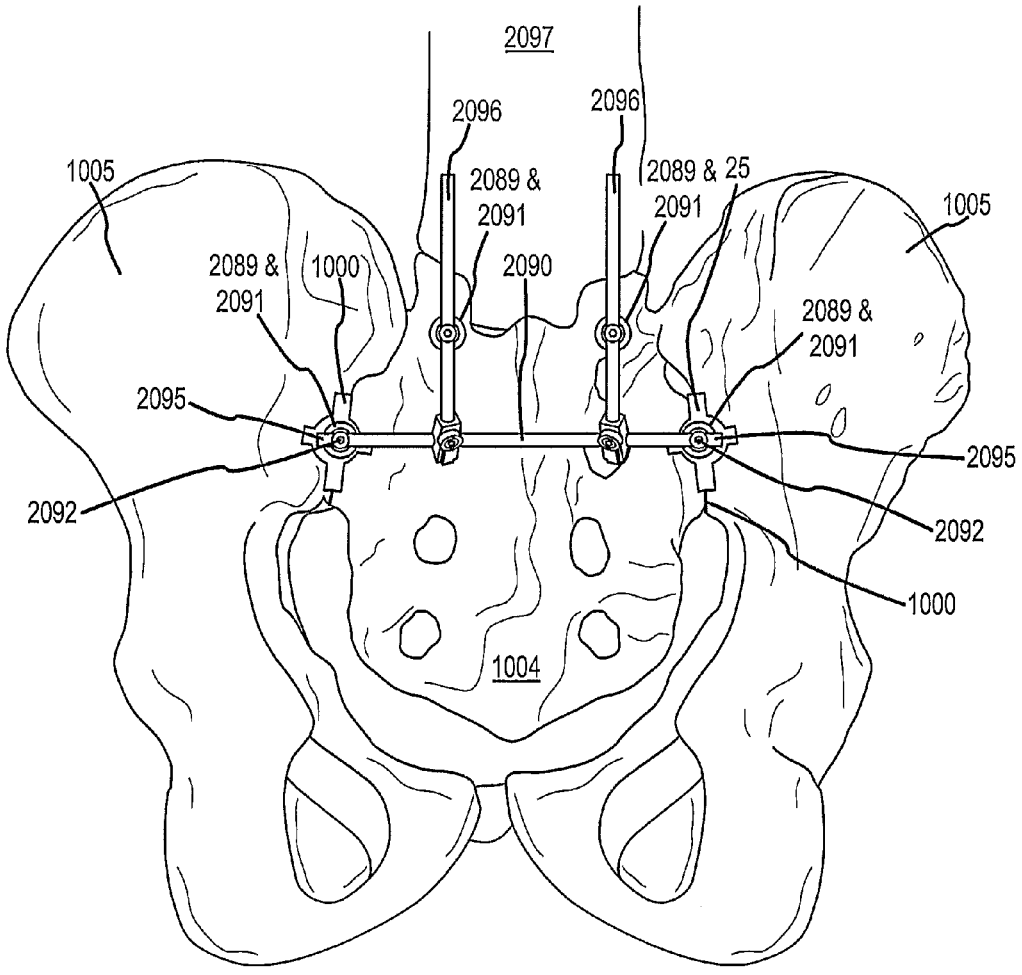

2097
2096
2096
1005
2089 &
2091
2089 & 25
2091
1005
2089 &
2091
1000
2090
2089 &
2091
2095
2095
2092
2092
1000
1004

FIG.115

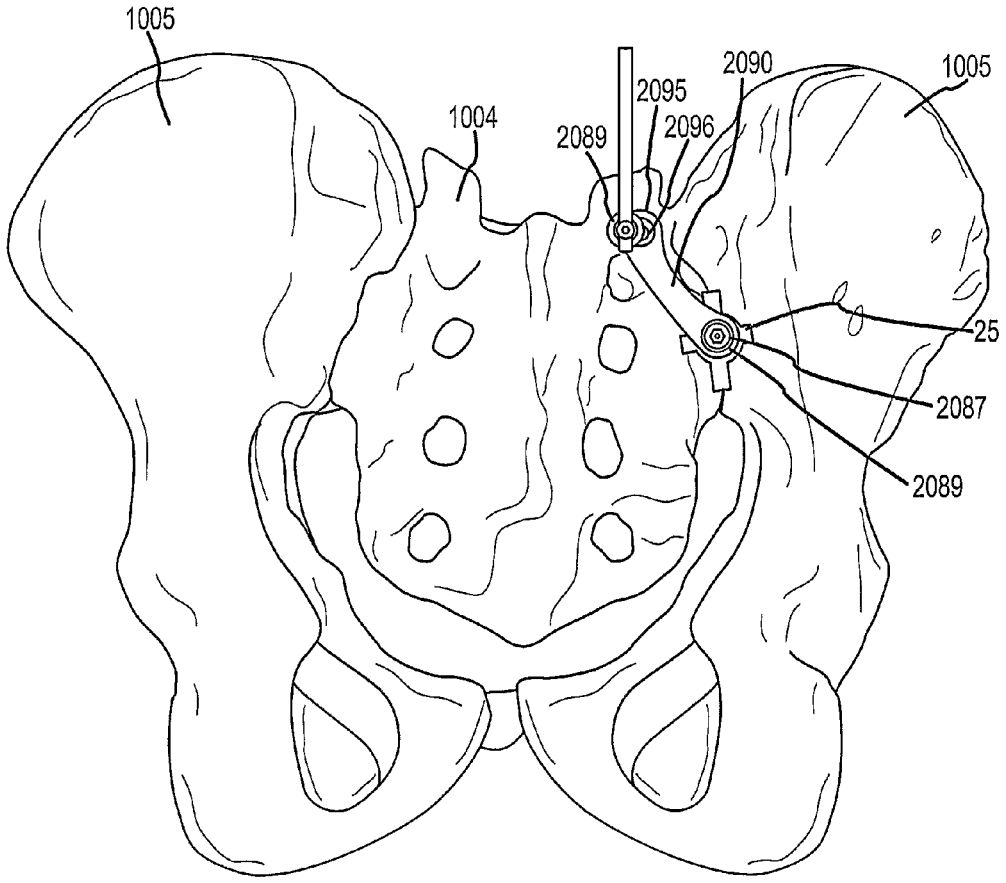


FIG.116

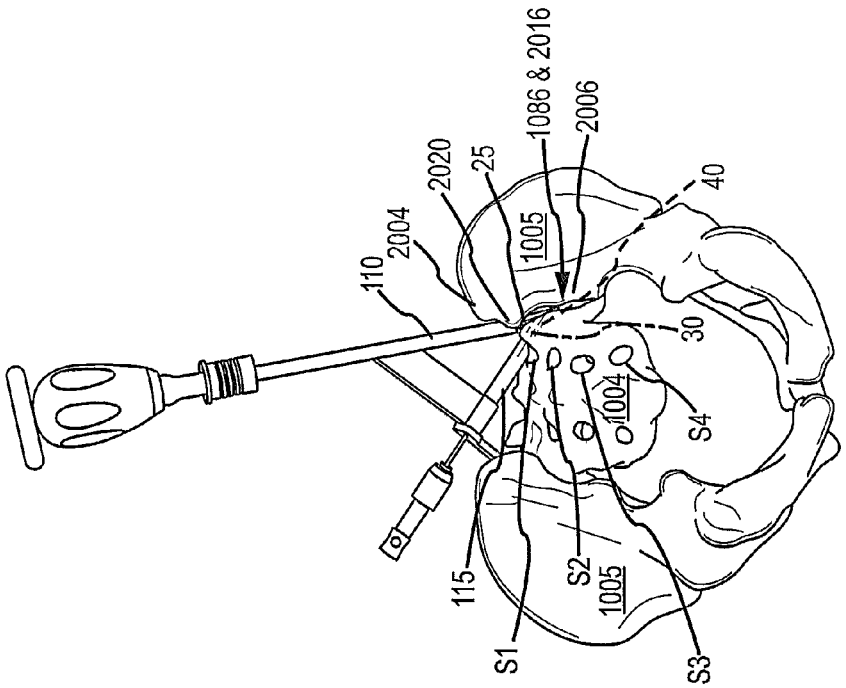


FIG.117B

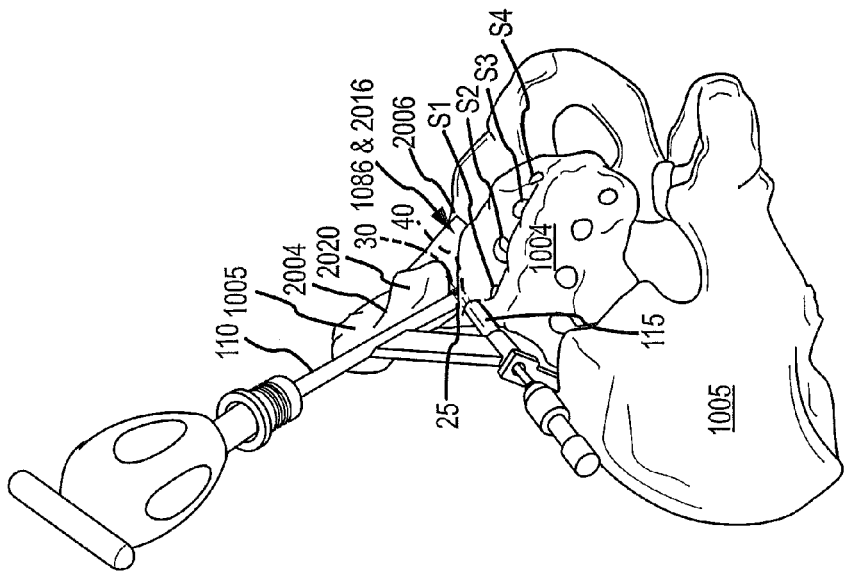
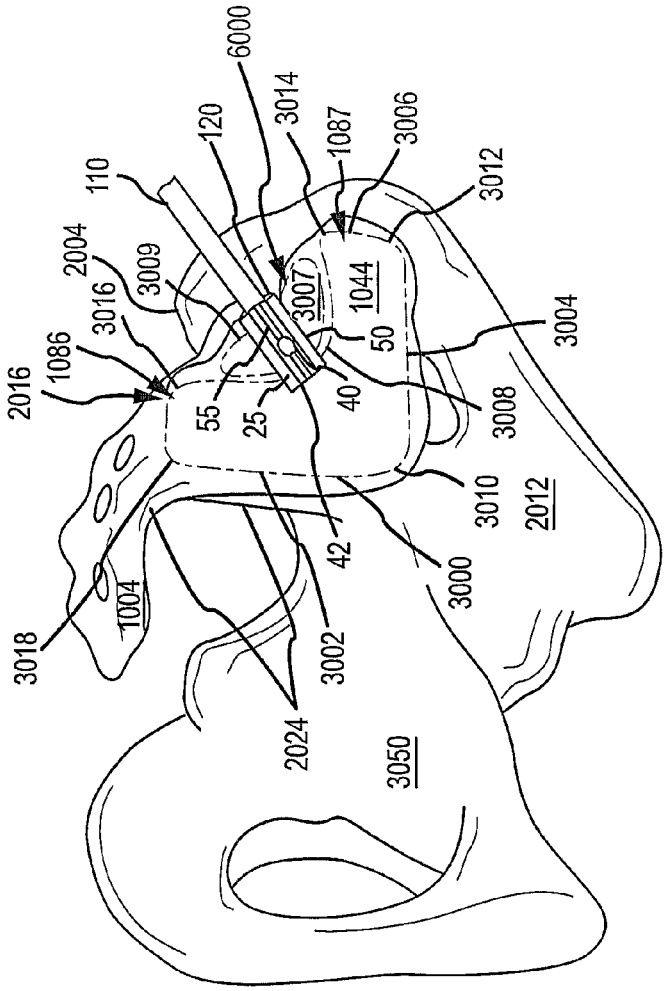


FIG.117A


6000
3014
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110
3012
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3007
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3016
50
3004
1086
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25
40
3008
3010
2012
42
3000
1004
3018
3002
2024
3050

FIG.117C

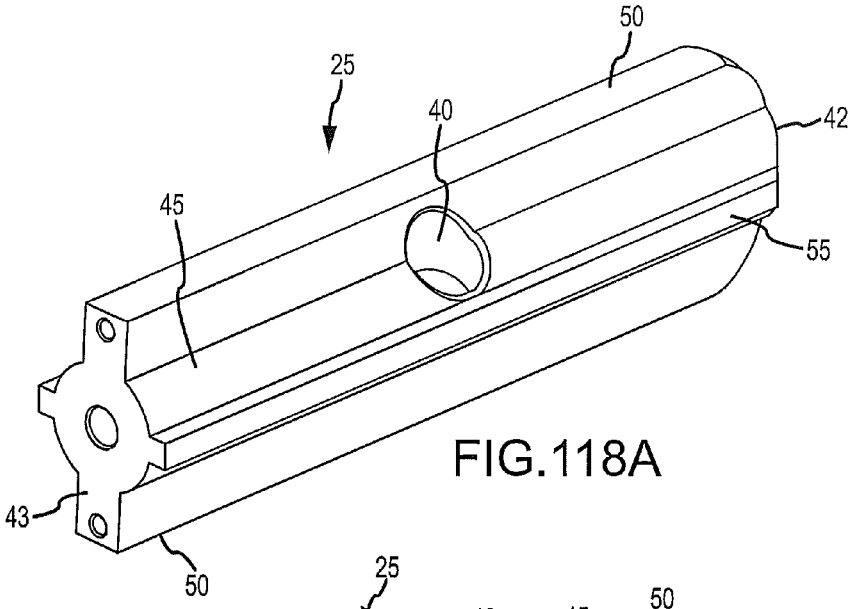


FIG.118A

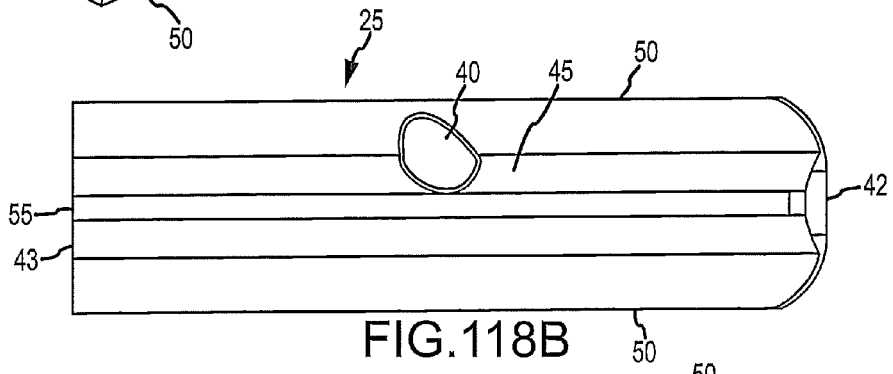


FIG.118B

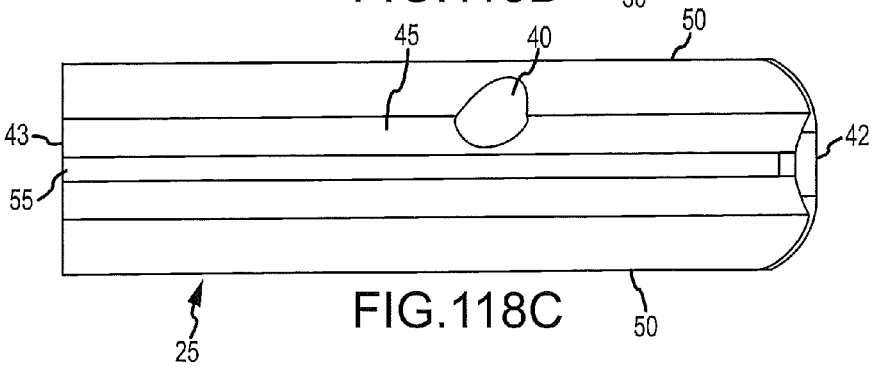


FIG.118C

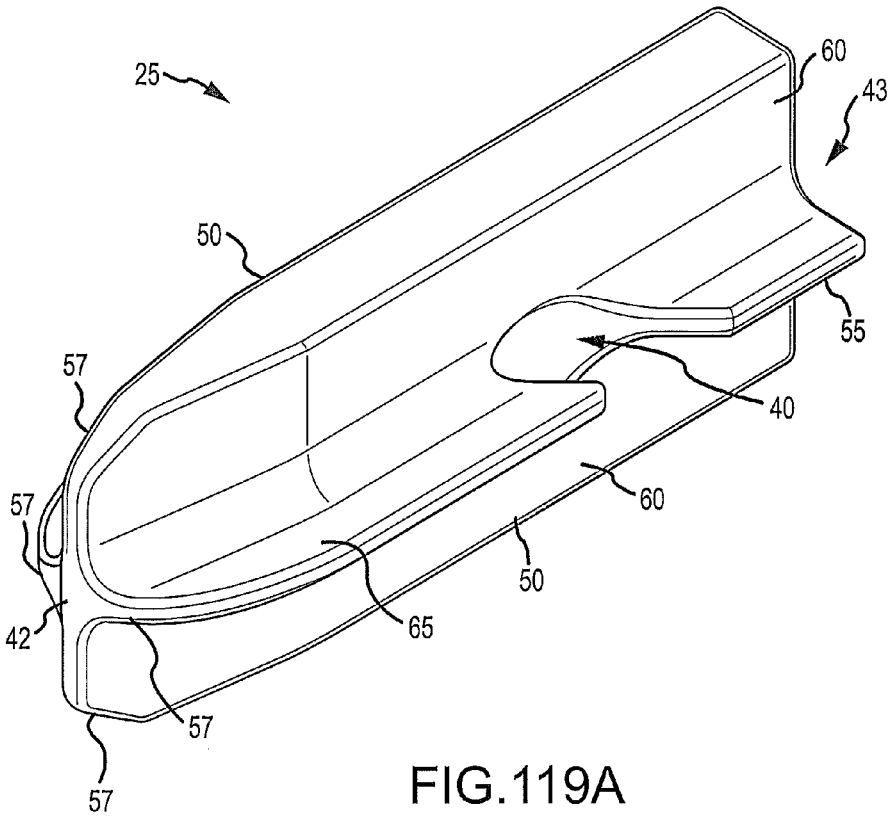


FIG.119A

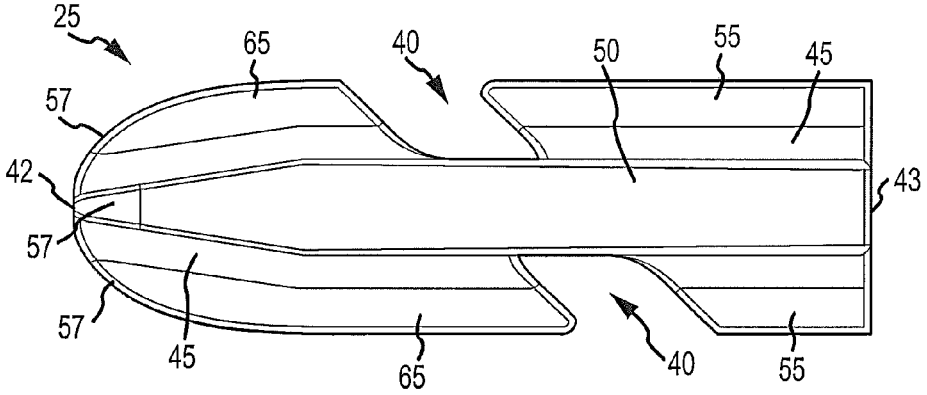


FIG.119B

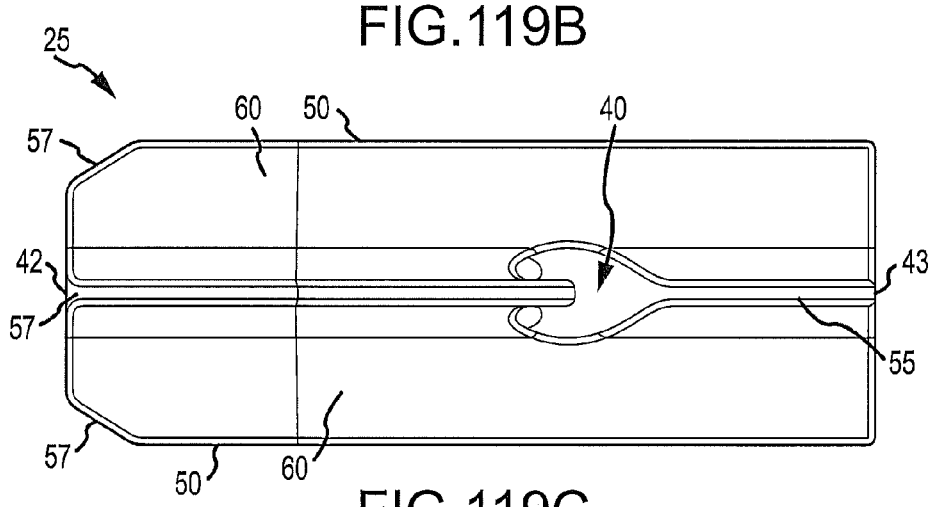


FIG.119C

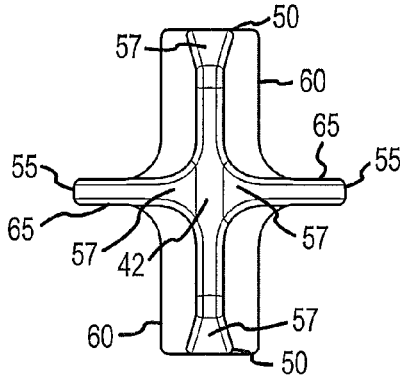


FIG.119D

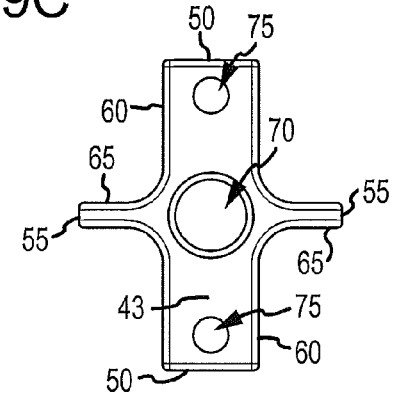


FIG.119E

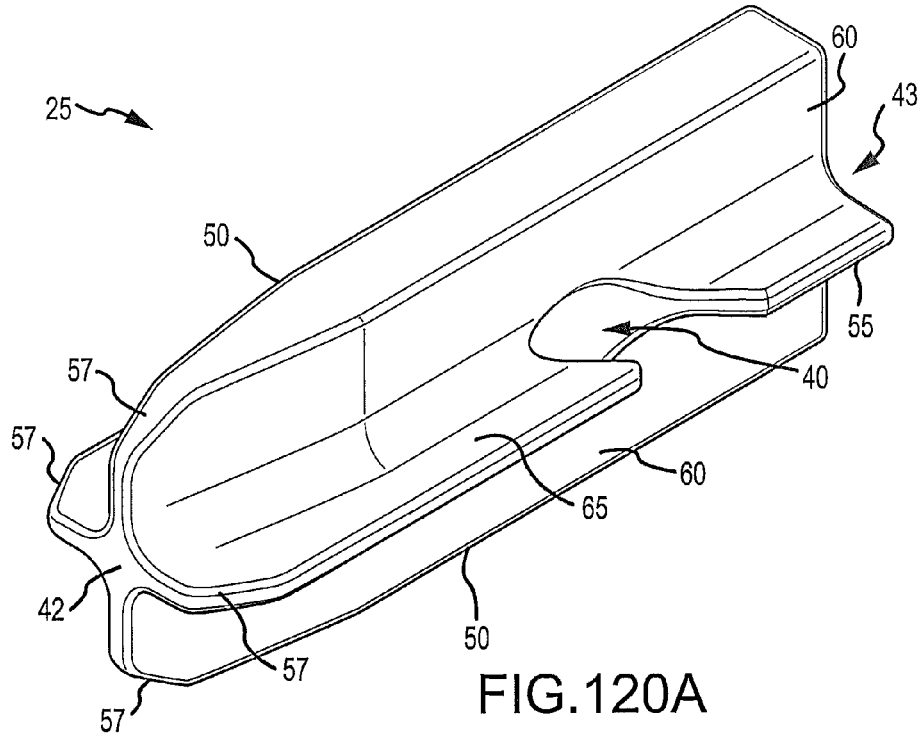


FIG.120A

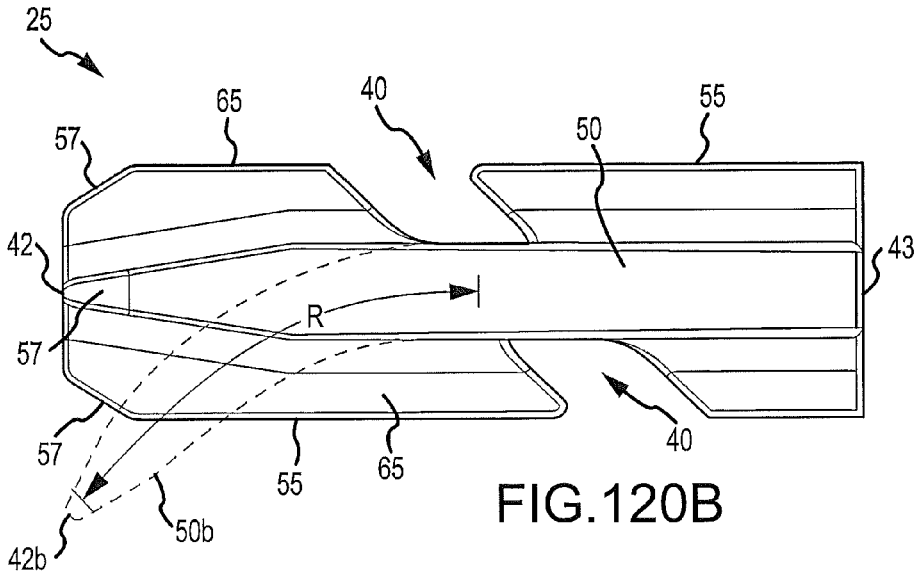


FIG.120B

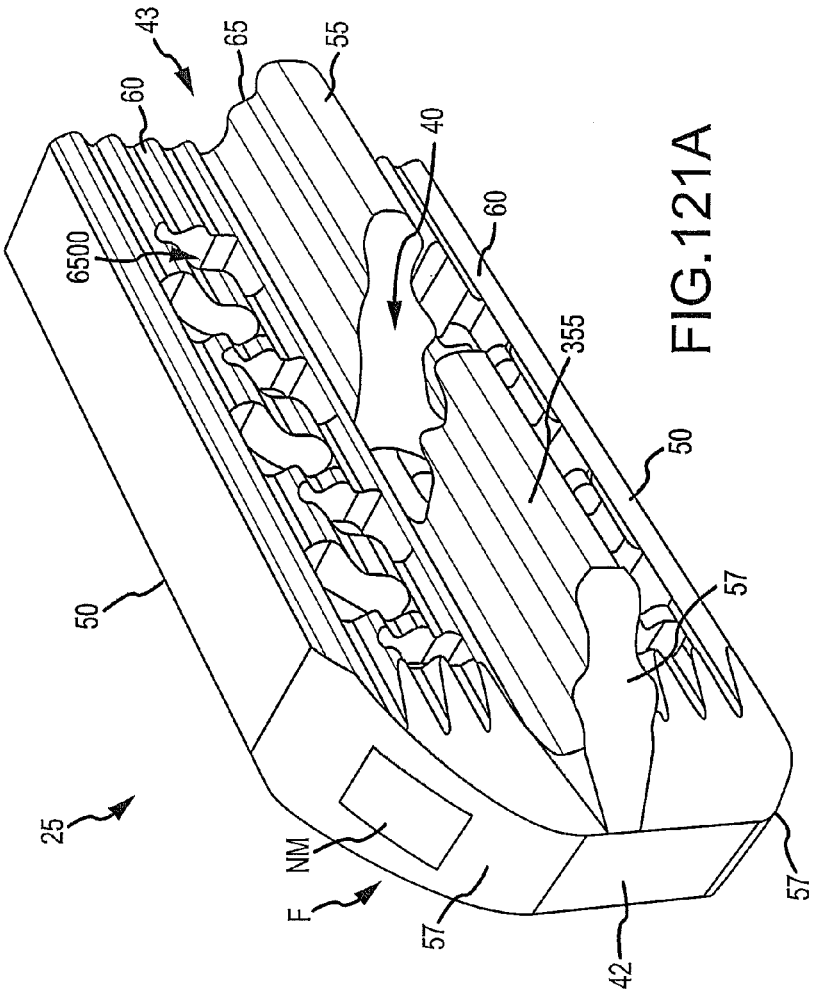


FIG.121A

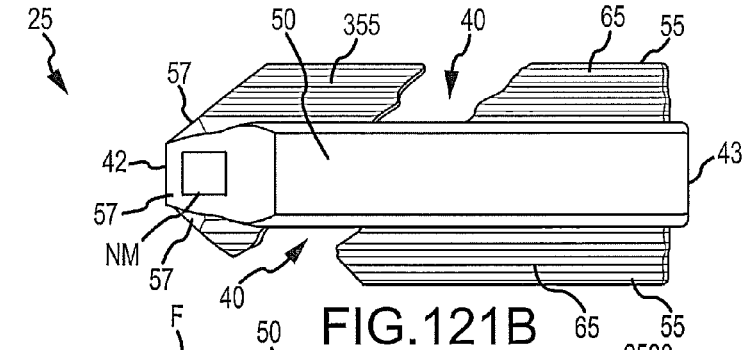


FIG.121B

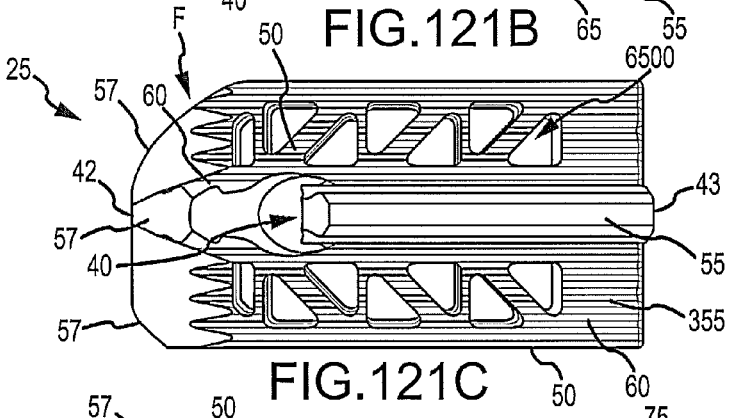


FIG.121C

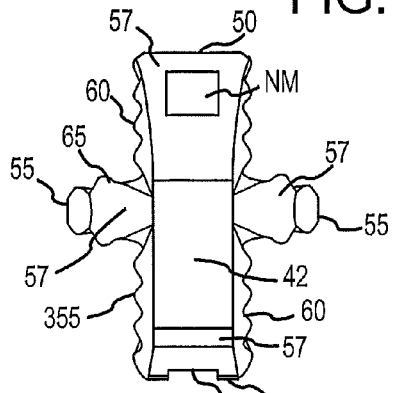


FIG.121D

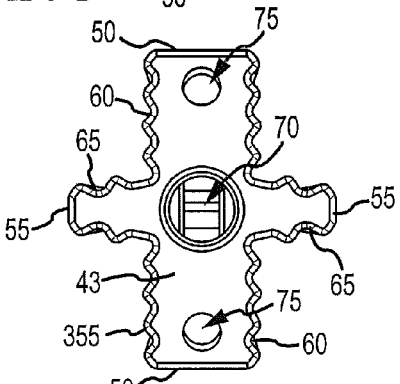


FIG.121E

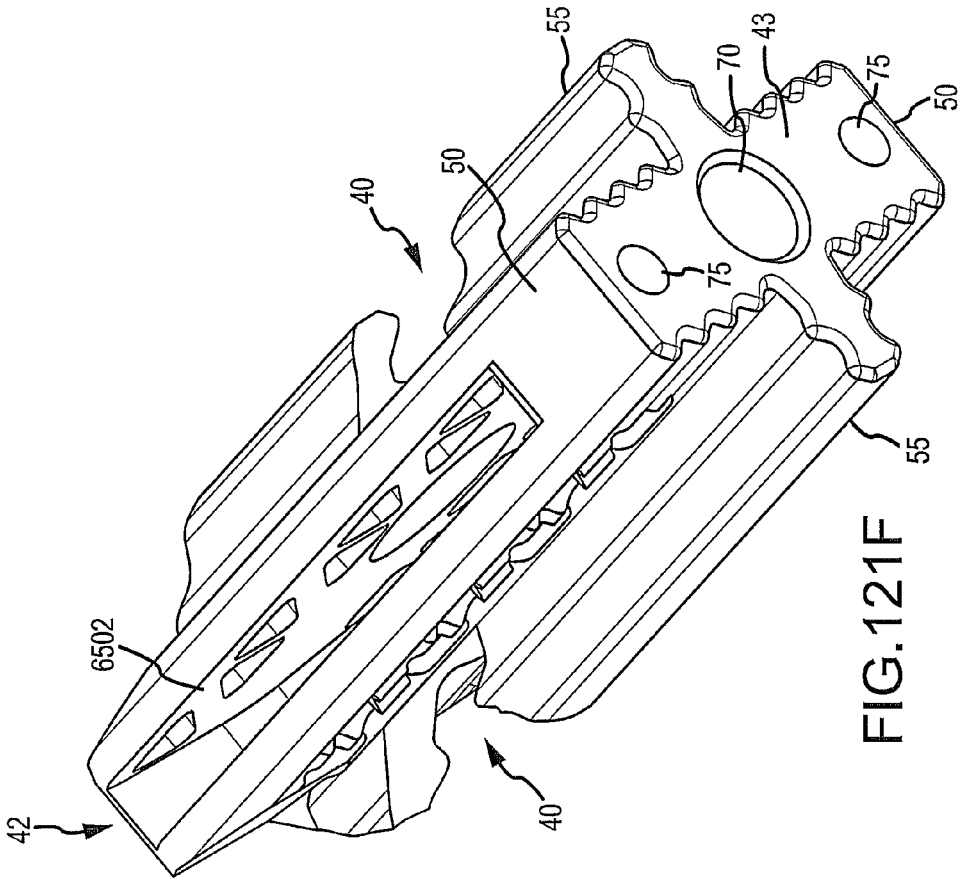


FIG.121F

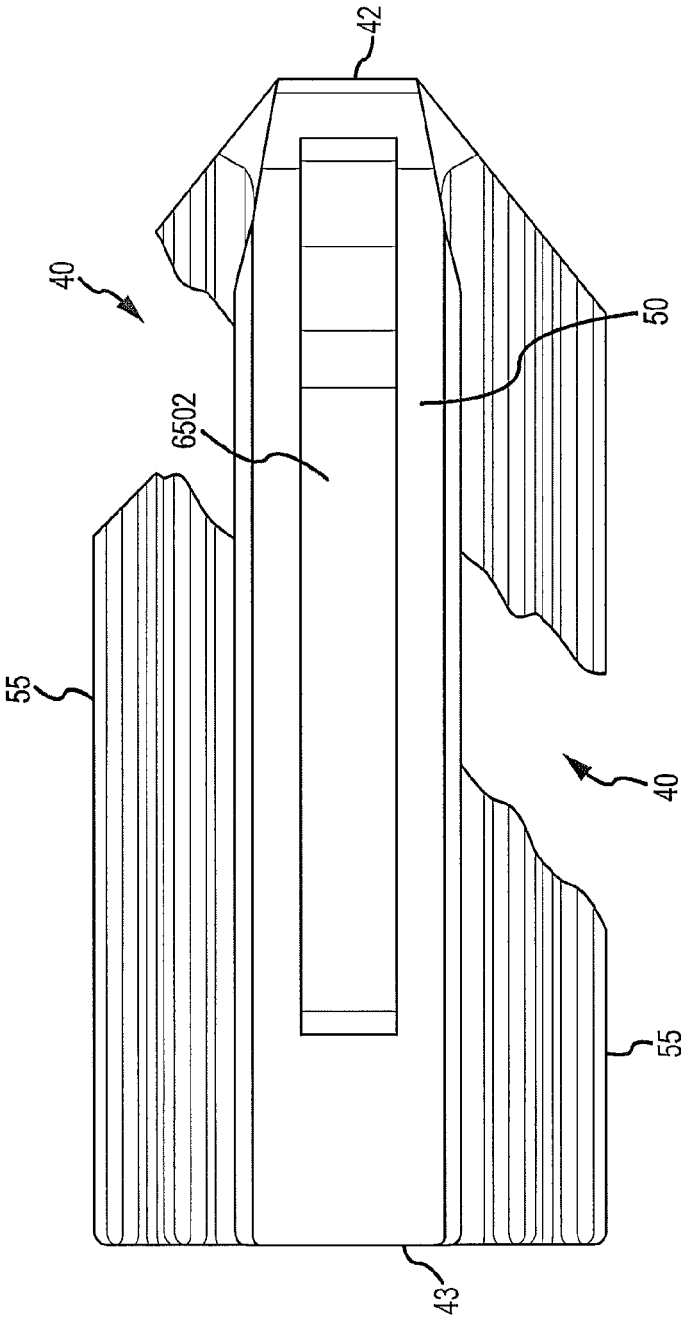


FIG.121G

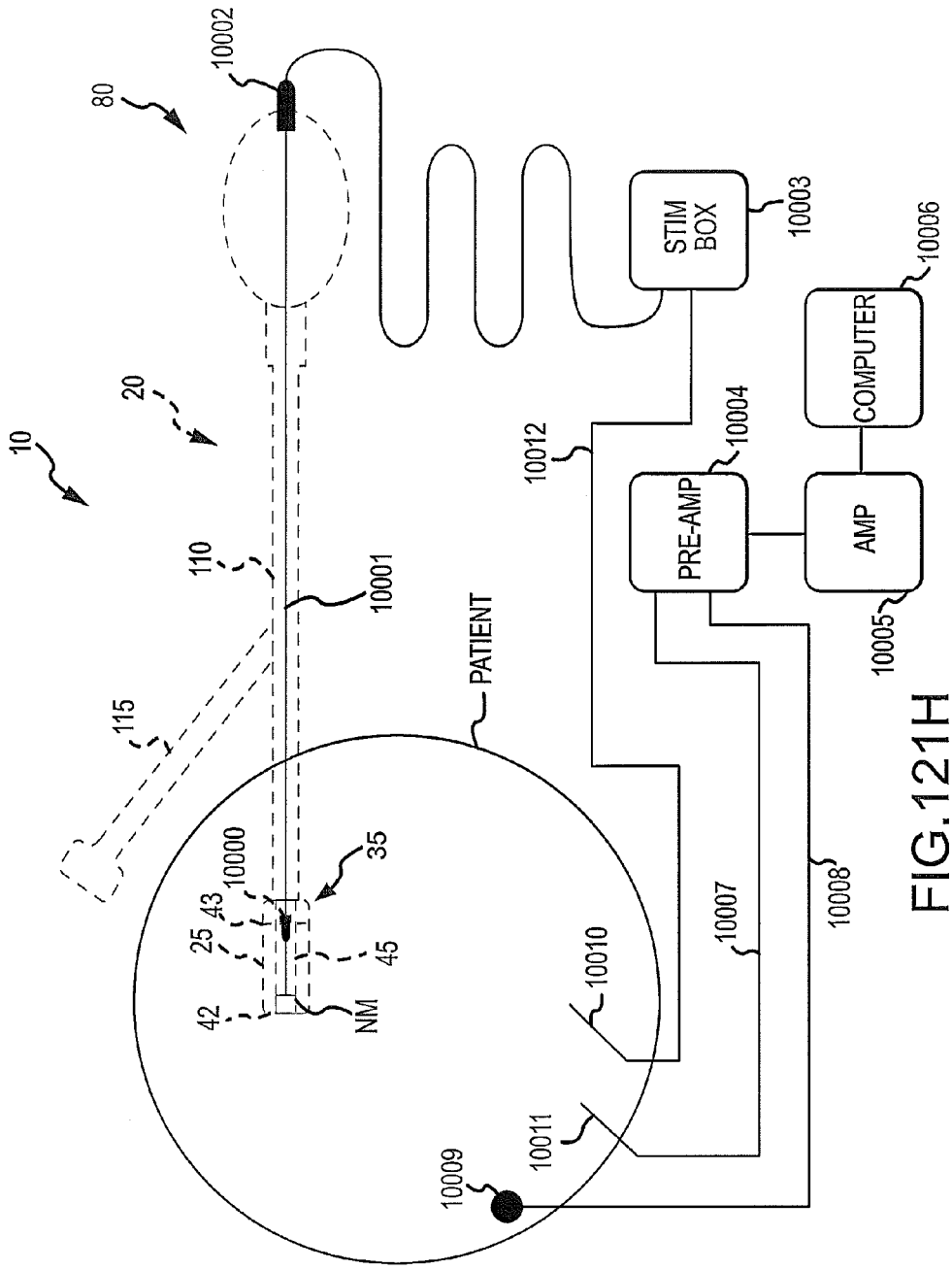
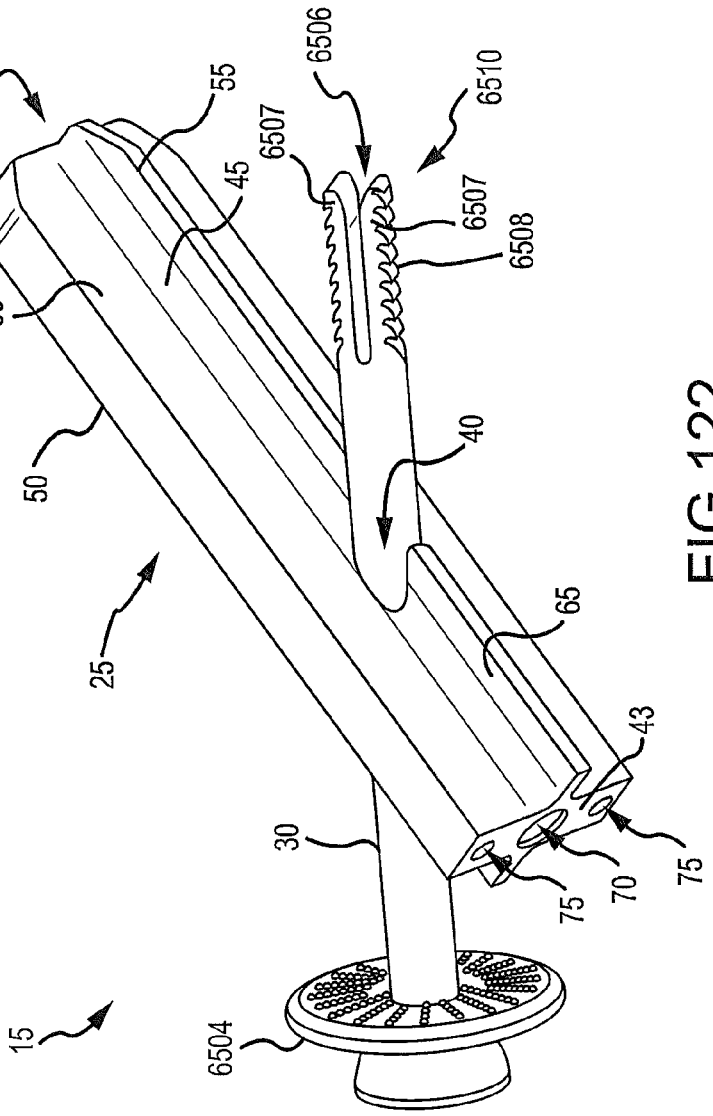

10002
80
20
10
110
10001
115
PATIENT
10000
35
43
25
45
42
NM
10010
10011
10009
10012
10004
PRE-AMP
STIM BOX
10003
COMPUTER
10006
AMP
10005
10007
10008

FIG.121H


42
55
6506
6510
6507
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6507
6508
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50
40
25
65
43
30
75
70
75
15
6504

FIG.122

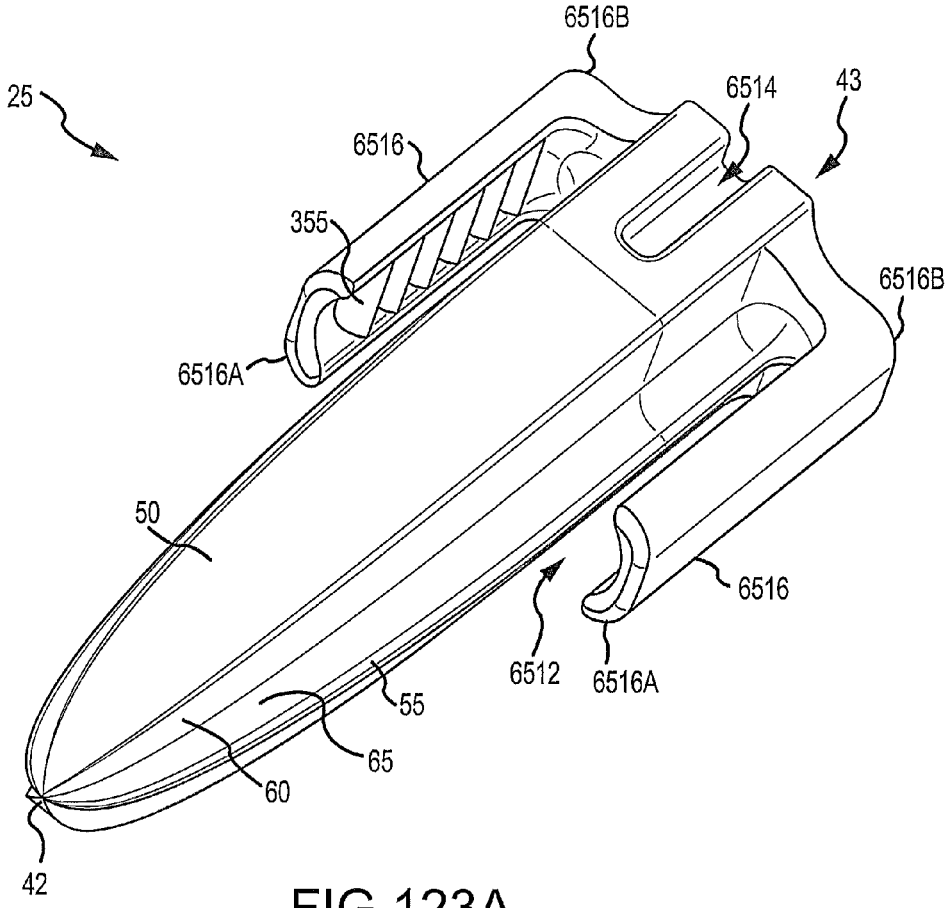

6516B
25
6514
43
6516
355
6516B
6516A
50
6516
6512
6516A
55
65
60
42

FIG.123A

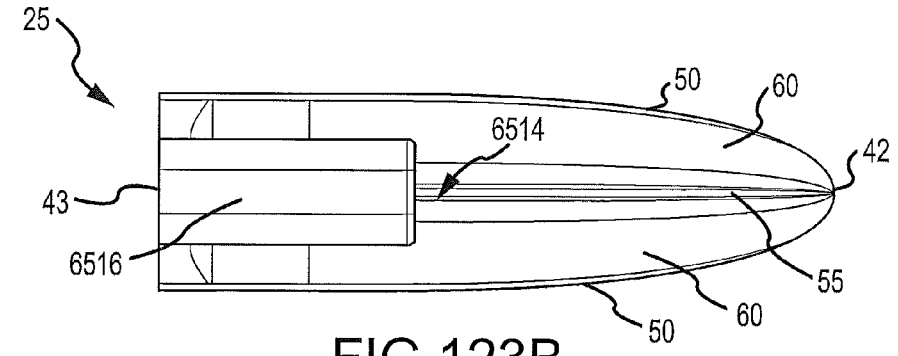


FIG.123B

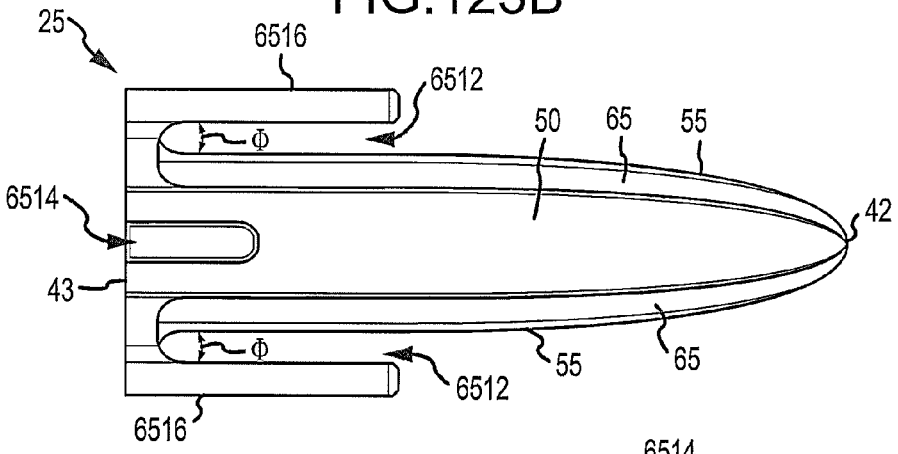


FIG.123C

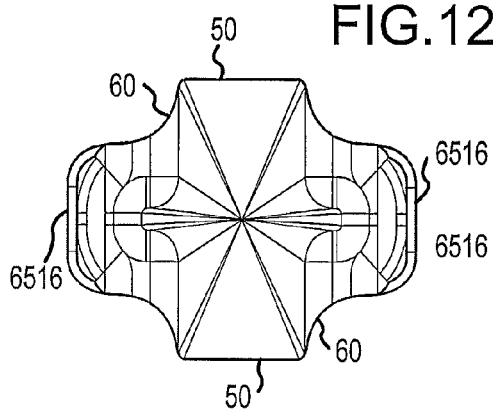


FIG.123D

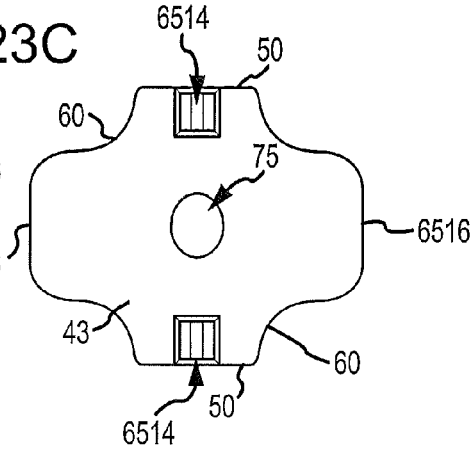


FIG.123E

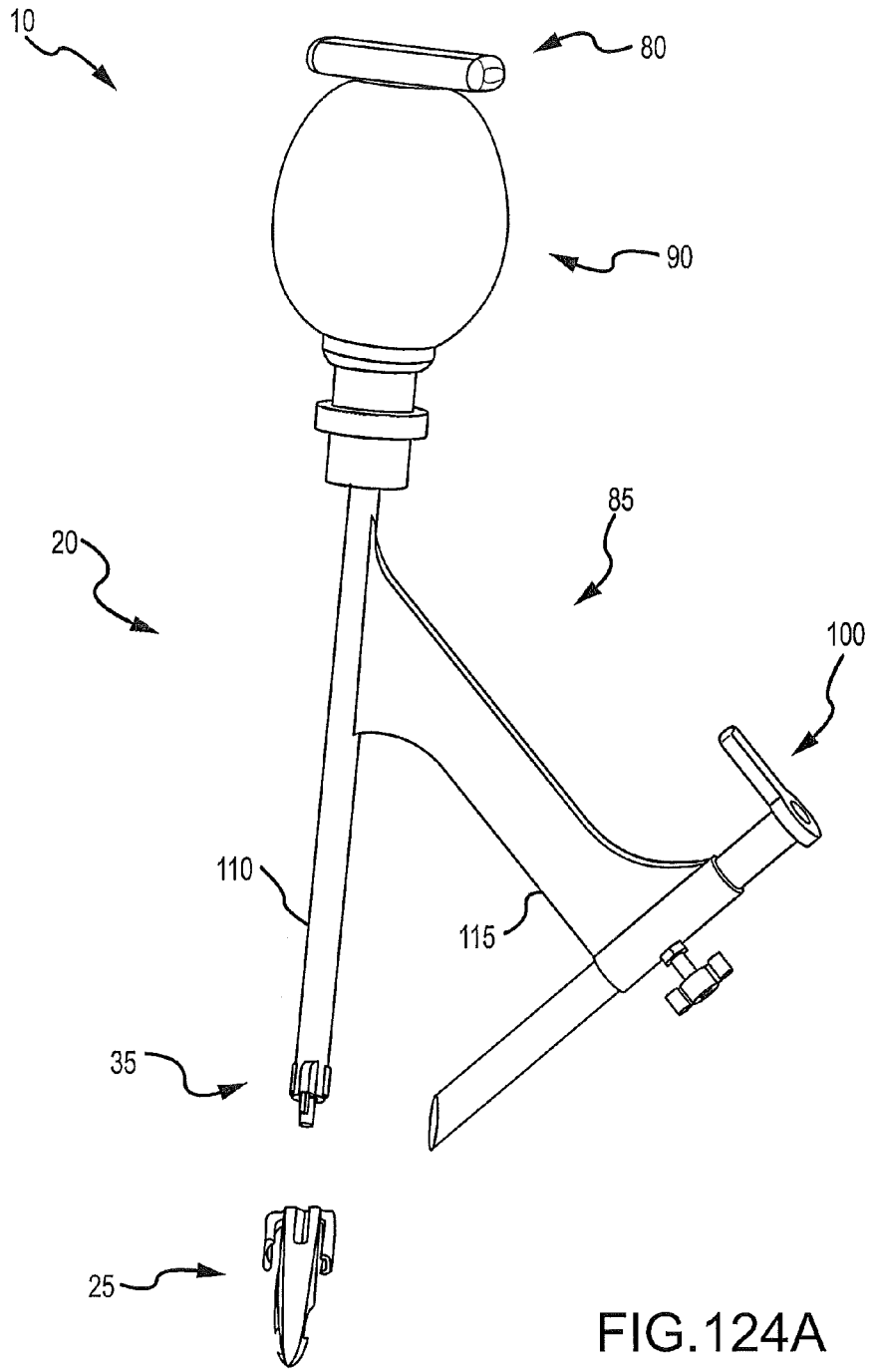


FIG.124A

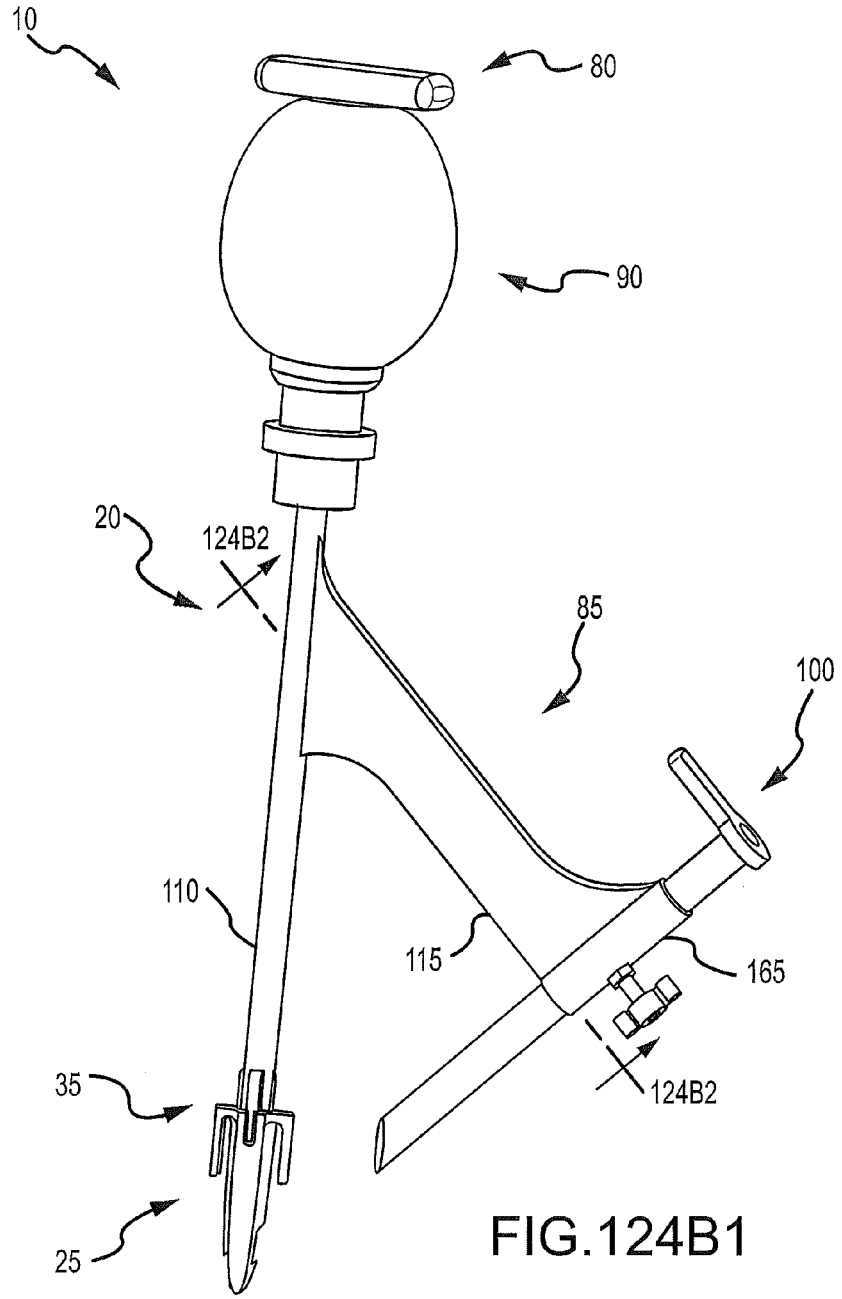


FIG.124B1

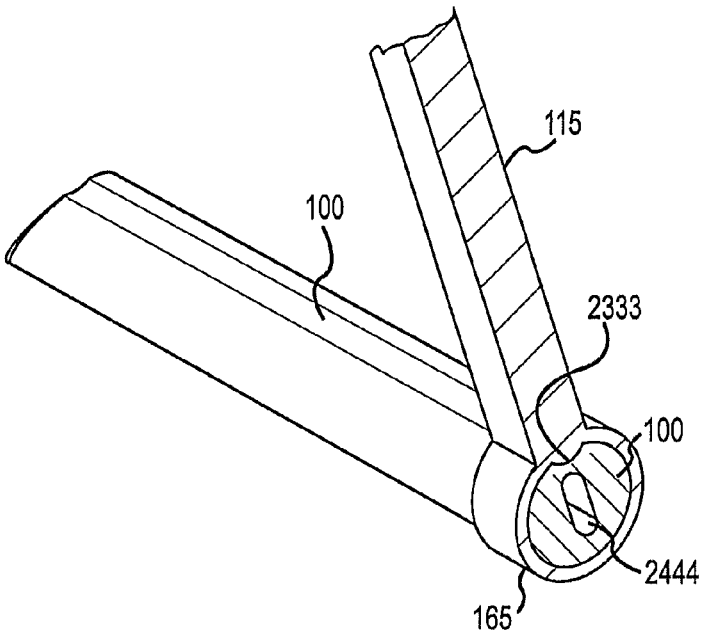


FIG.124B2

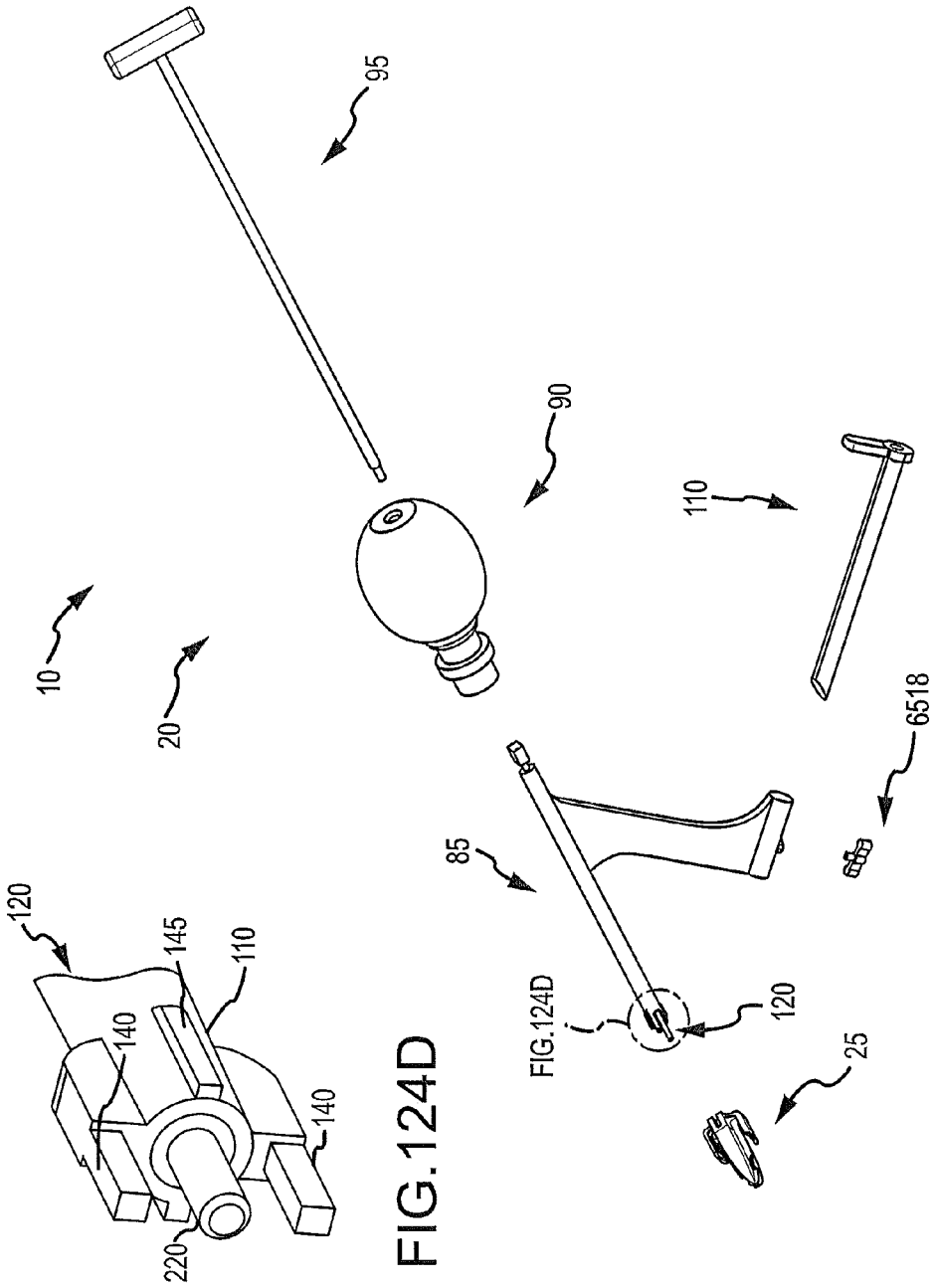


FIG.124C

FIG.124D

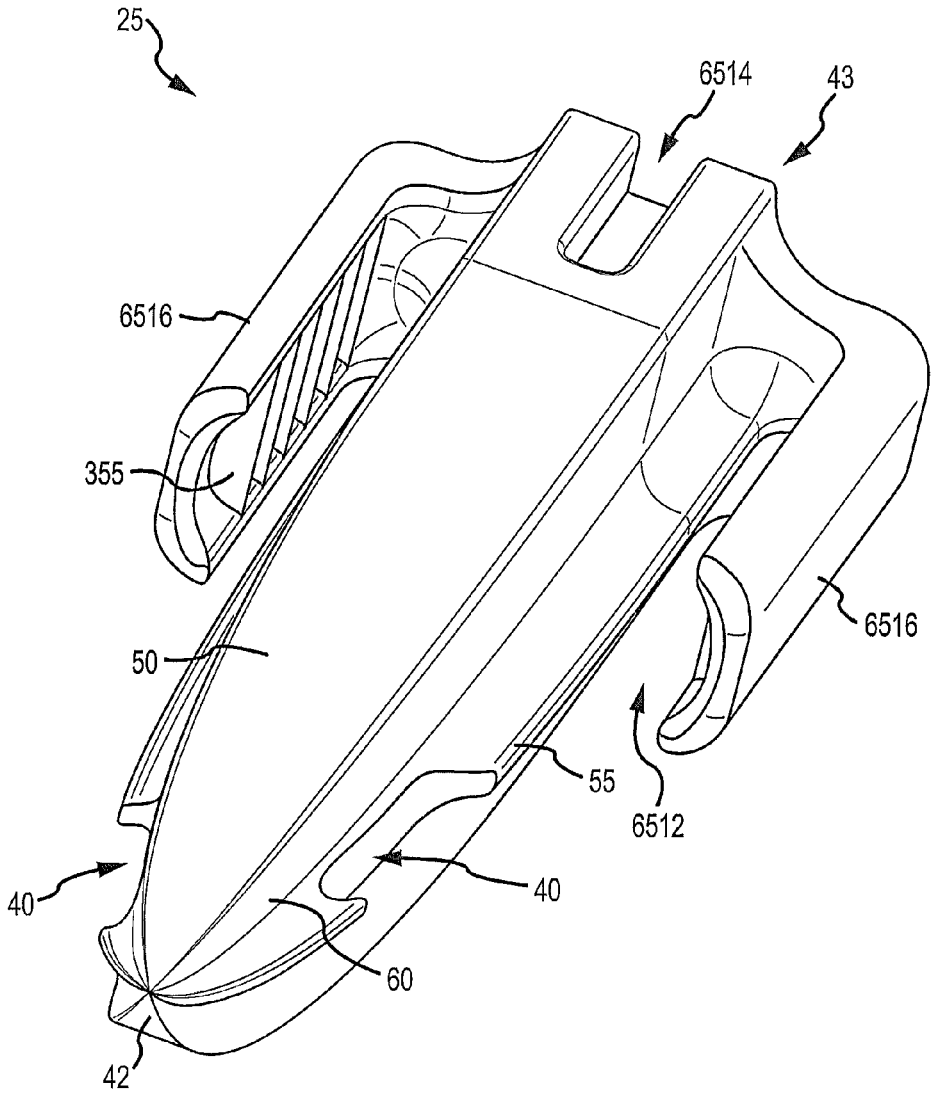


FIG.124E

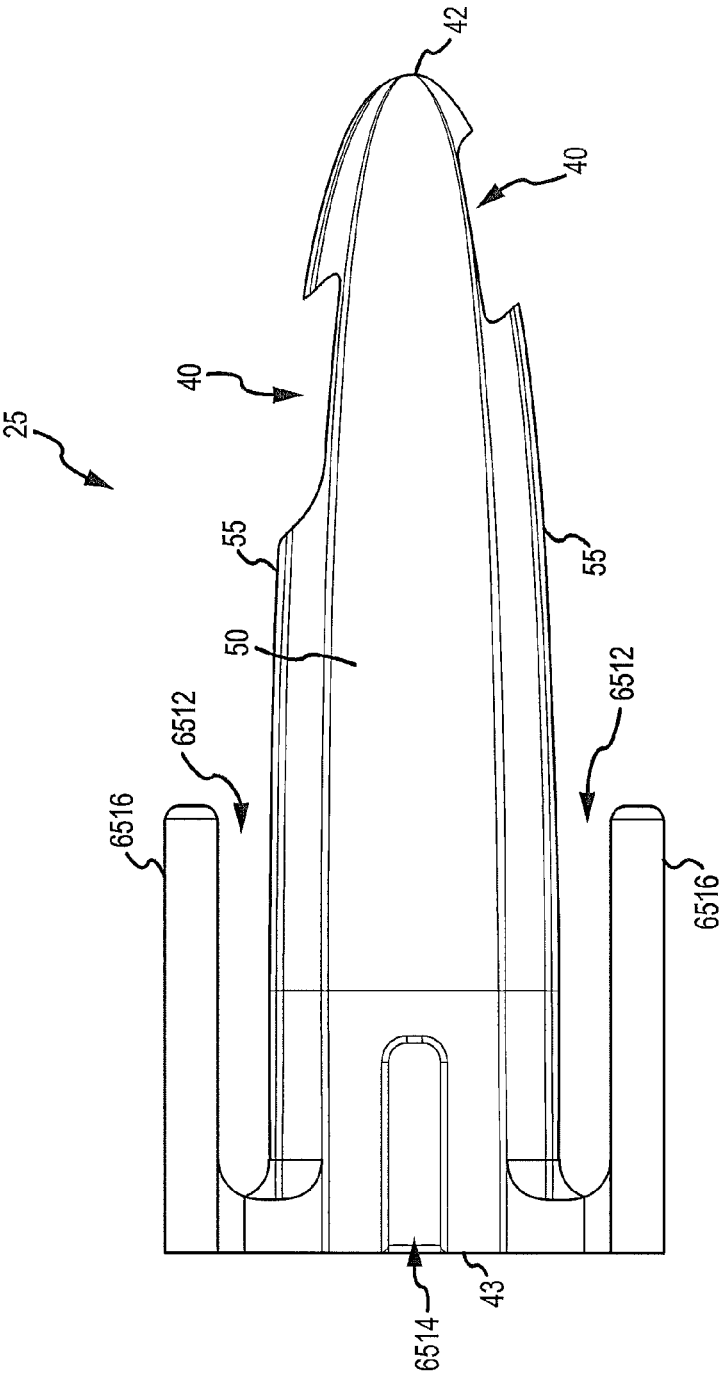


FIG.124F

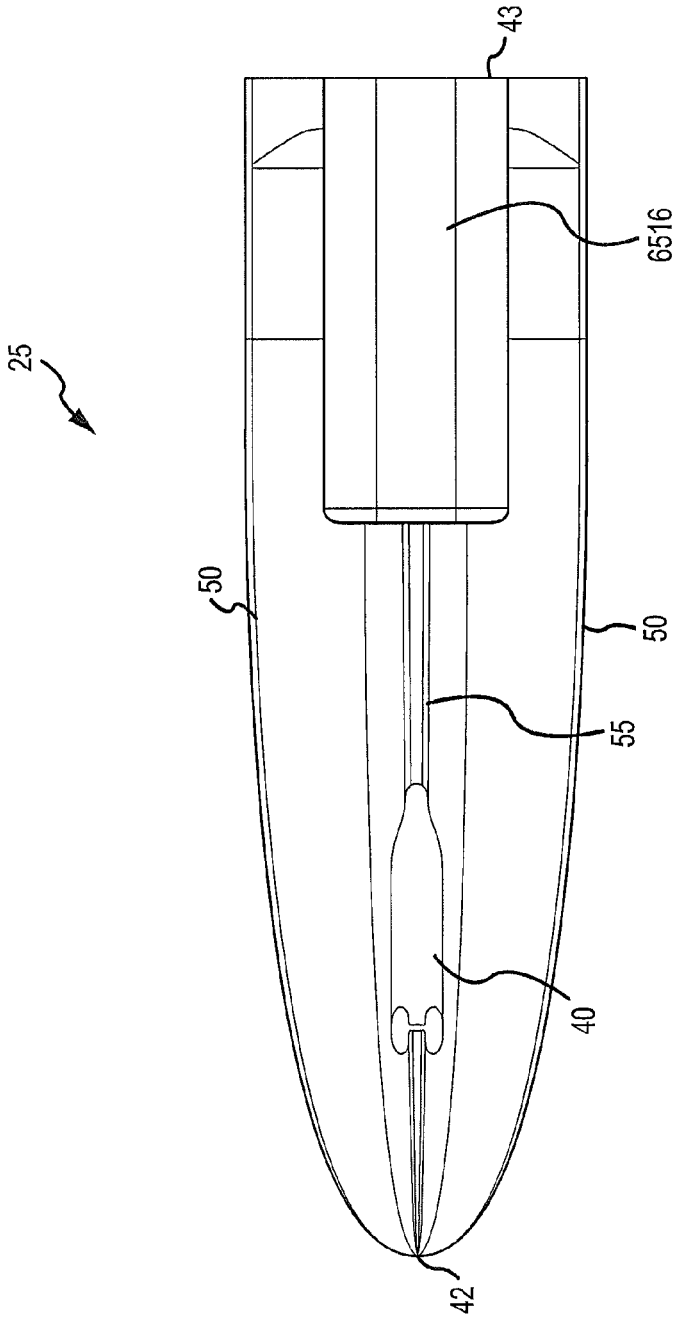


FIG.124G

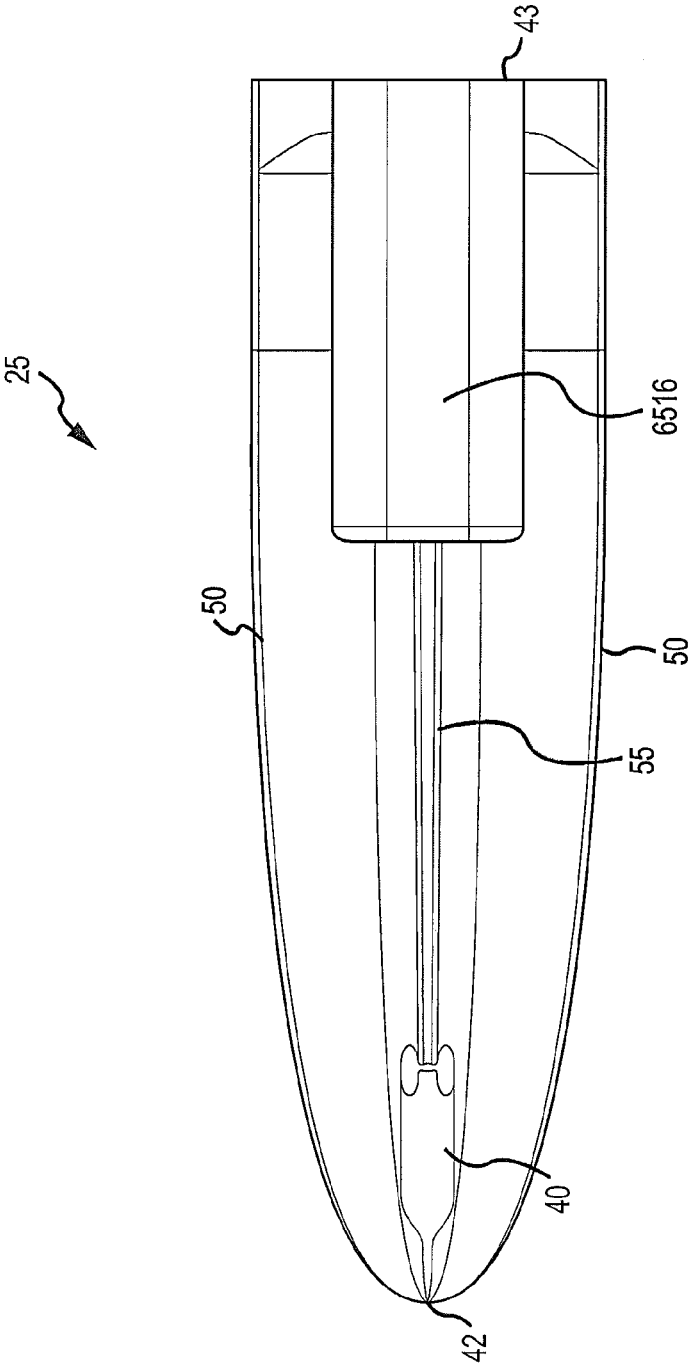


FIG.124H

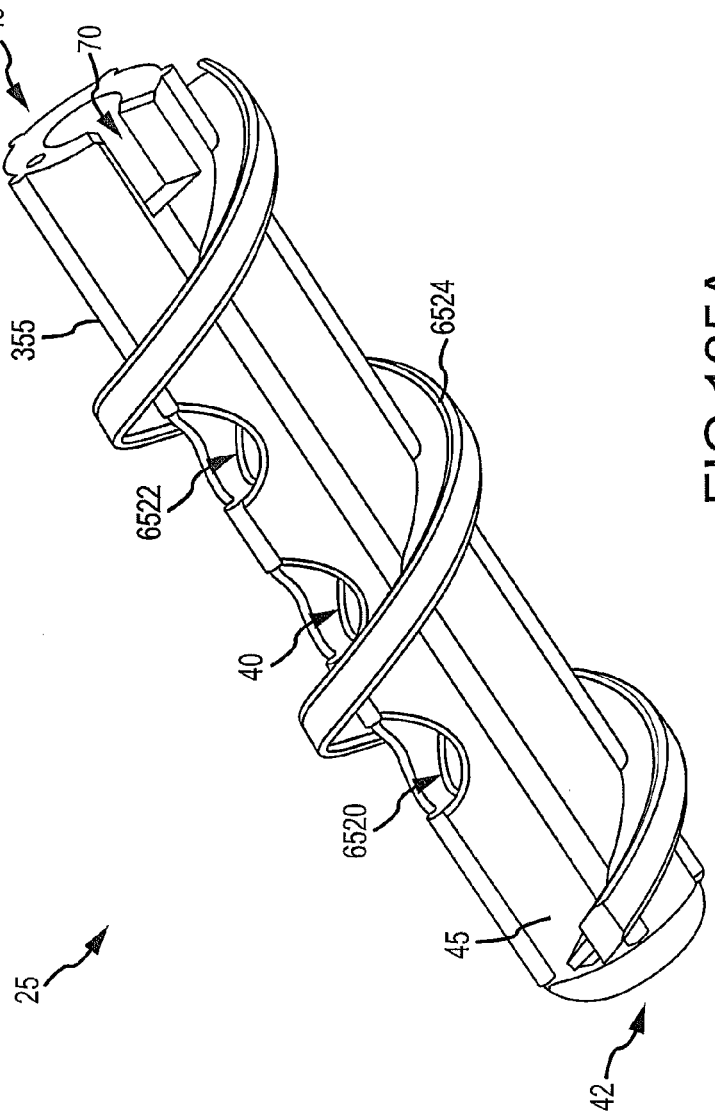


FIG.125A

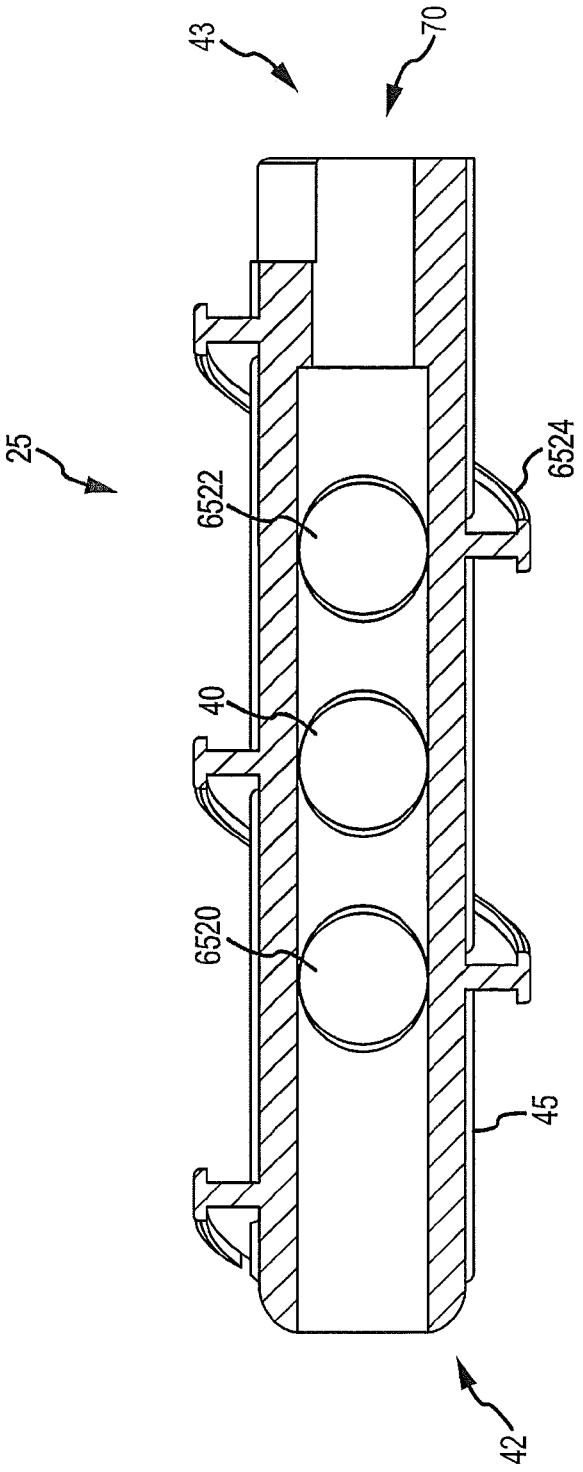


FIG.125B

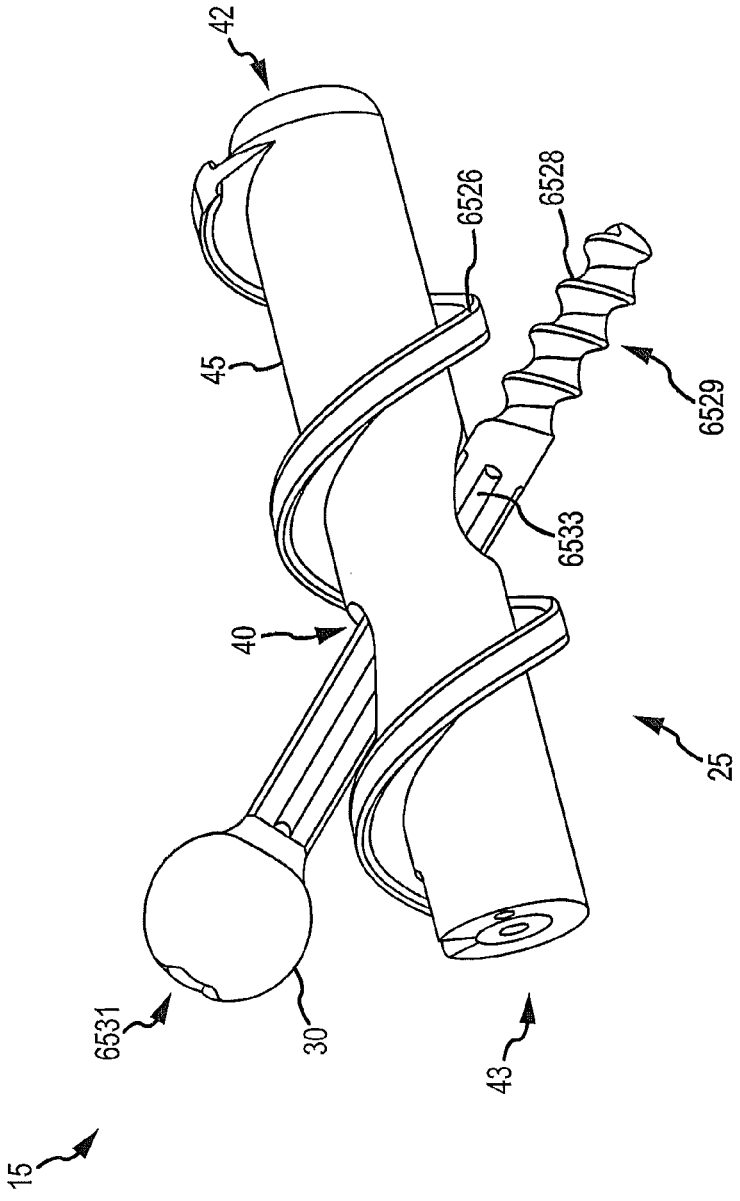


FIG.126A

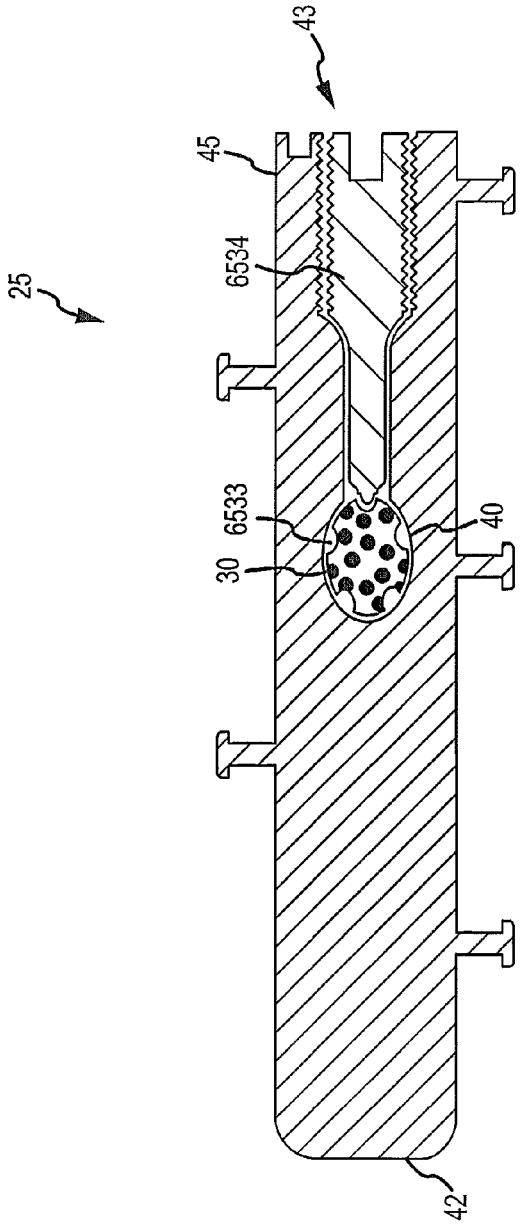


FIG.126B

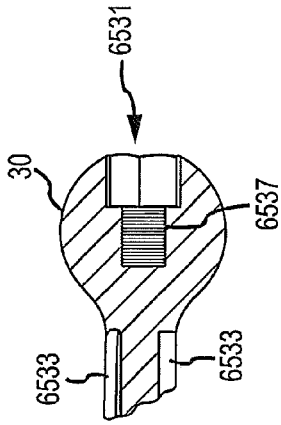


FIG.126C

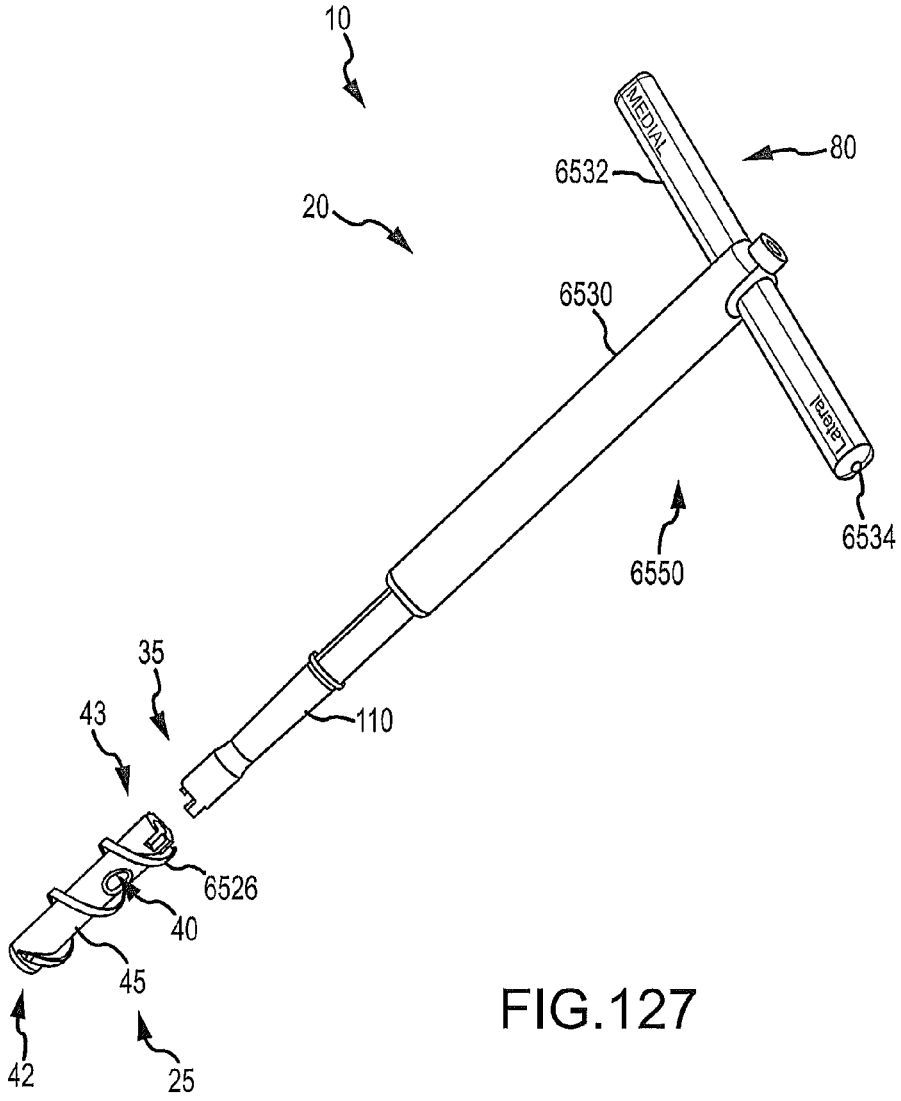

10
20
MEDIAL
80
6532
6530
LATERAL
6534
6550
35
43
110
6526
40
45
42
25

FIG.127

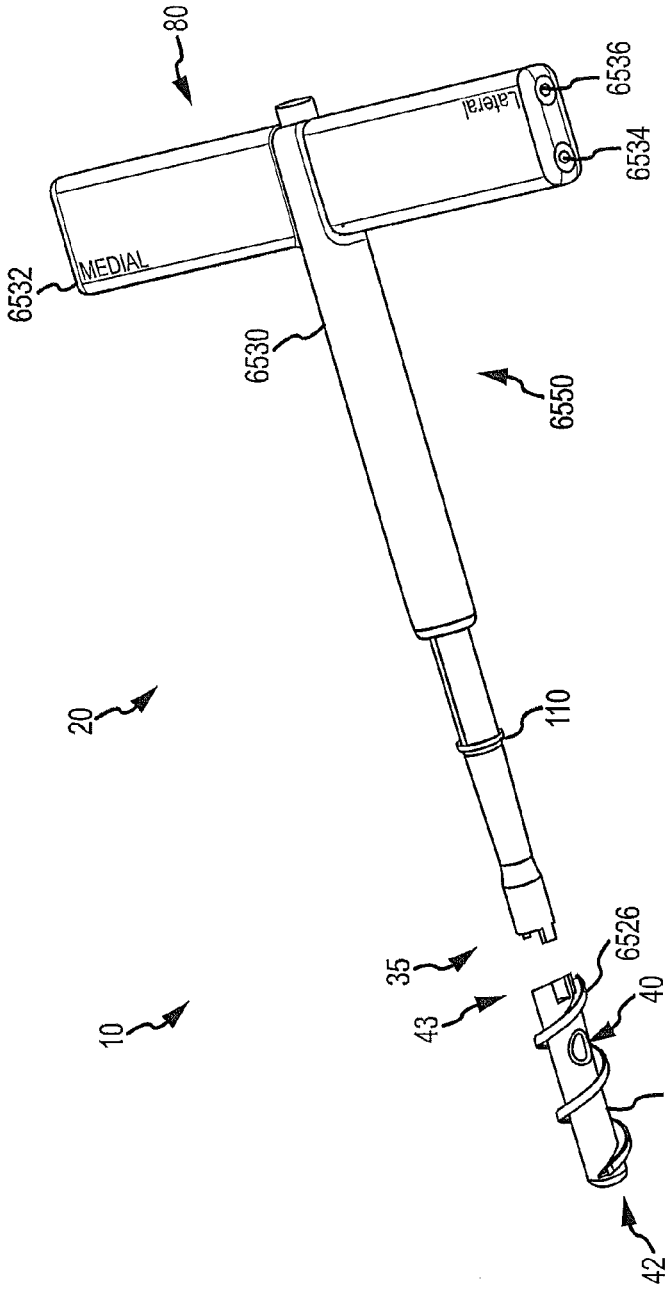

80
6536
6534
Lateral
MEDIAL
6532
6530
6550
20
110
35
6526
40
43
10
45
25
42

FIG.128A

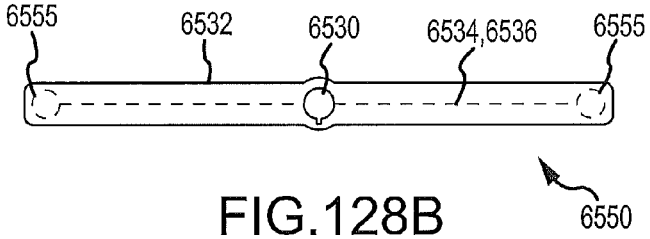


FIG.128B

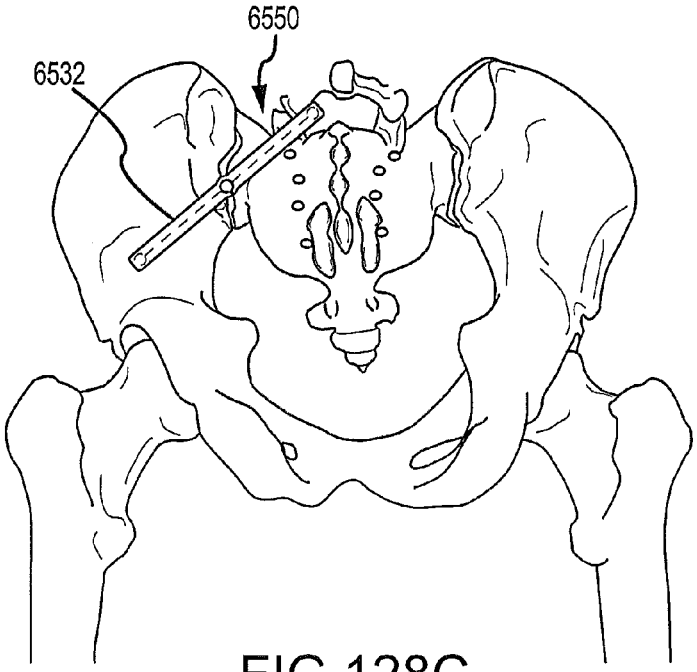


FIG.128C

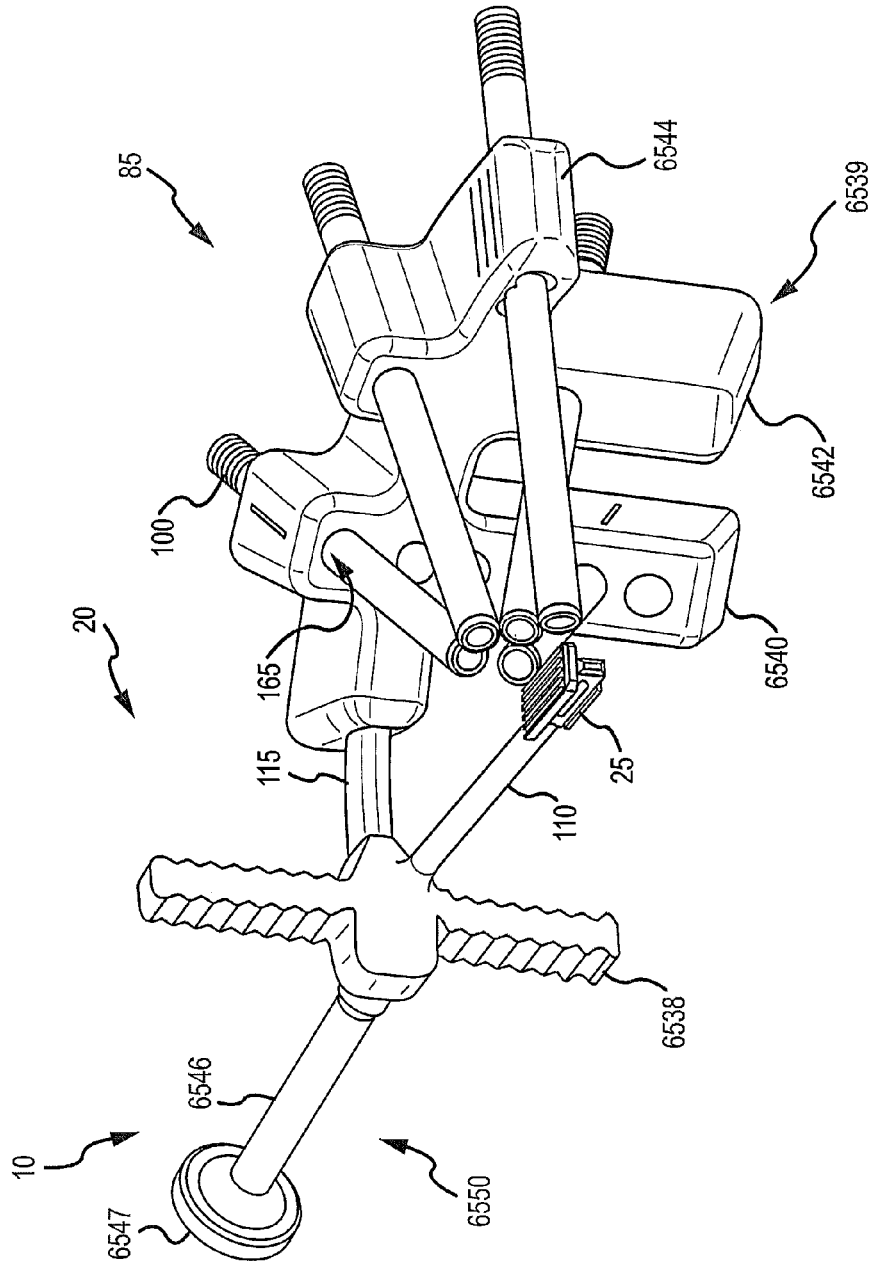

85
6544
6539
6542
100
20
165
6540
115
25
110
6538
6546
10
6547
6550

FIG.129A

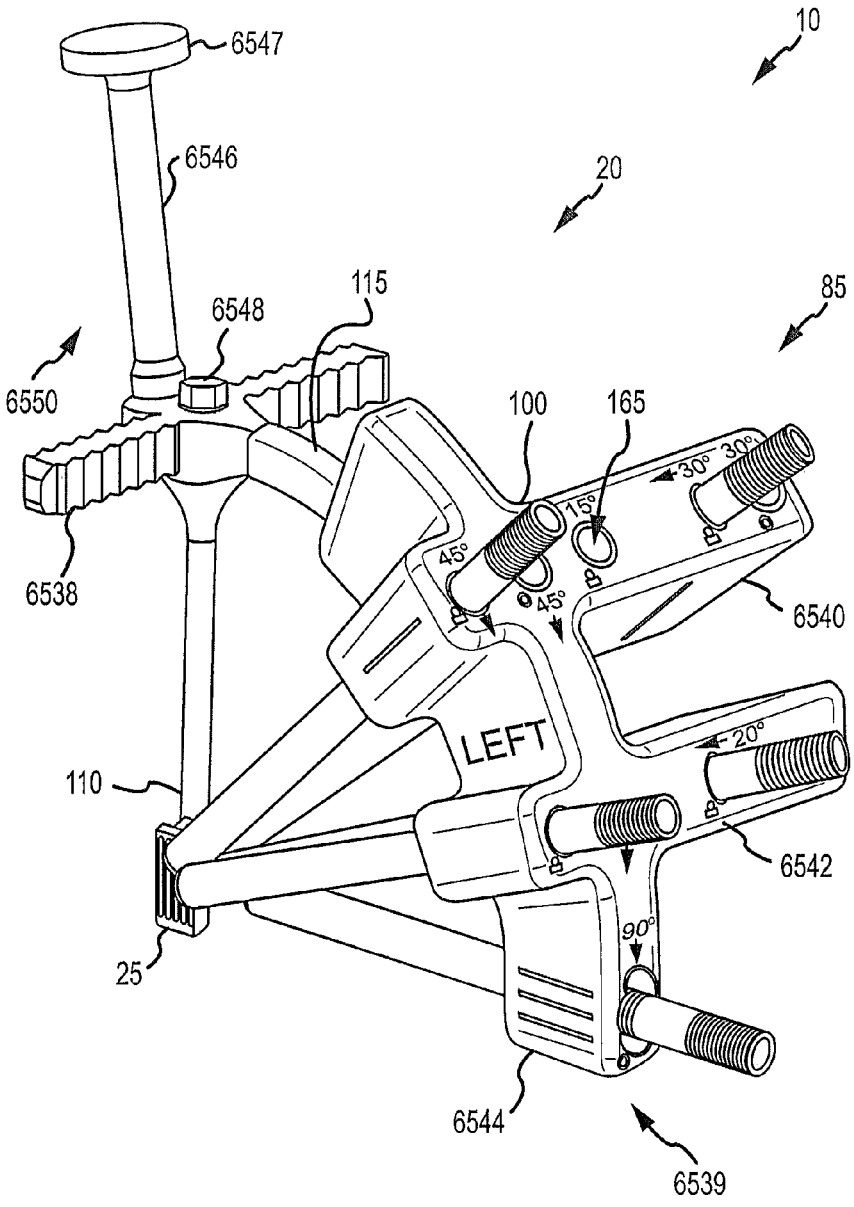

10
6547
6546
20
115
85
6548
6550
100
165
30°
30°
15°
45°
45°
6538
6540
LEFT
20°
110
6542
90°
25
6544
6539

FIG.129B

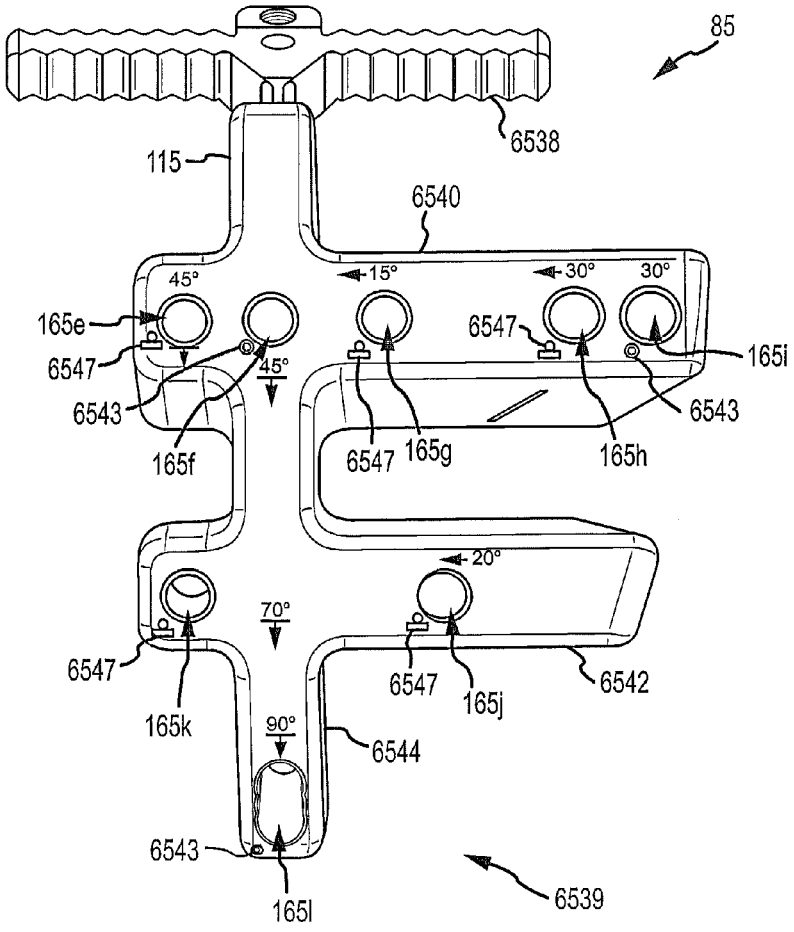

85
6538
115
6540
45°
15°
30°
30°
165e
6547
6543
45°
165f
6547
165g
6547
165h
165i
6543
20°
70°
6547
165k
90°
6544
6547
165j
6542
6543
165l
6539

FIG.129C

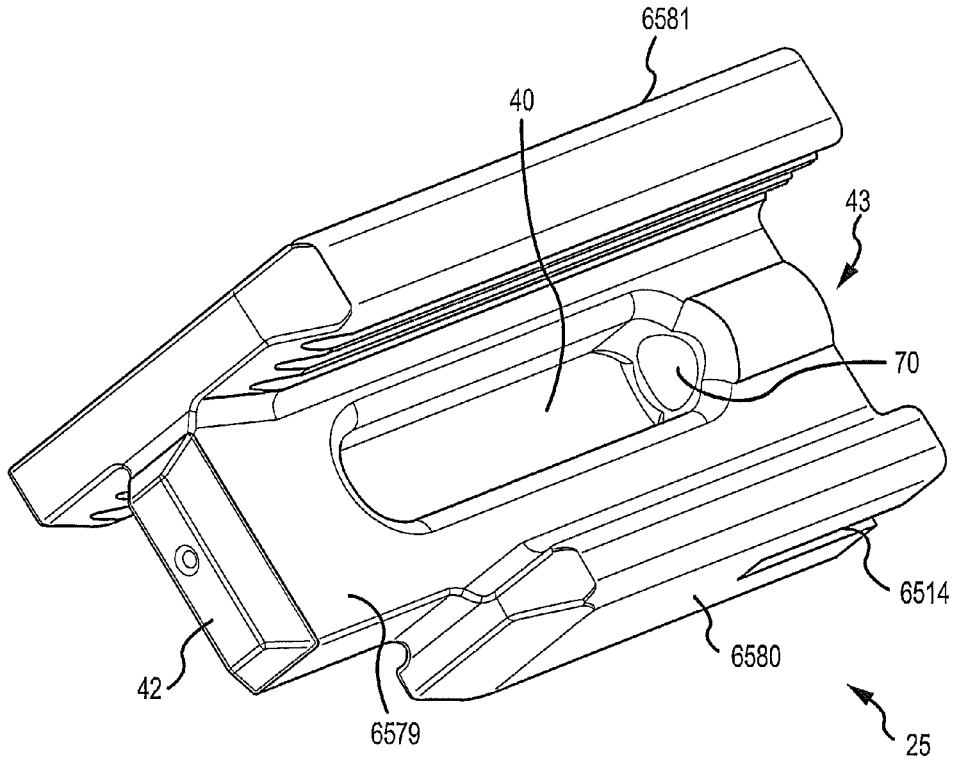


FIG.129D

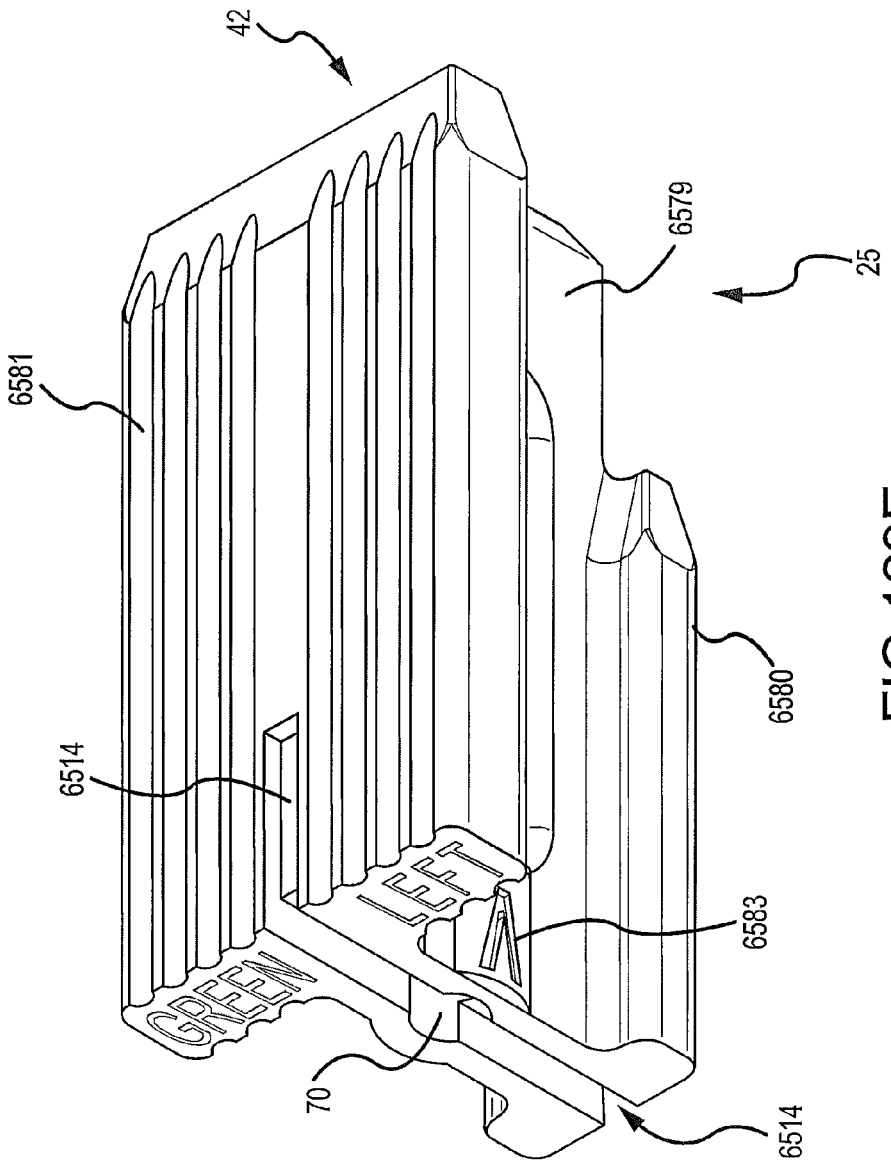


FIG.129E

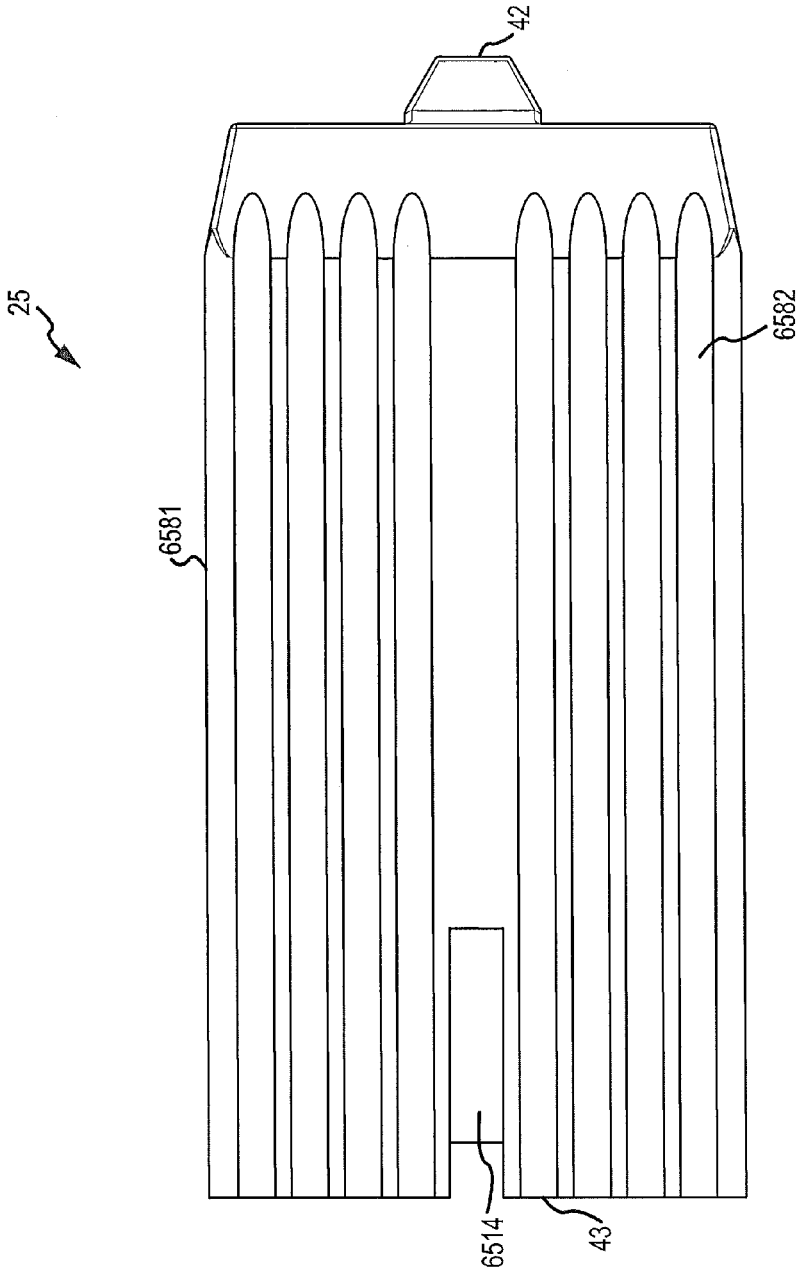


FIG.129F

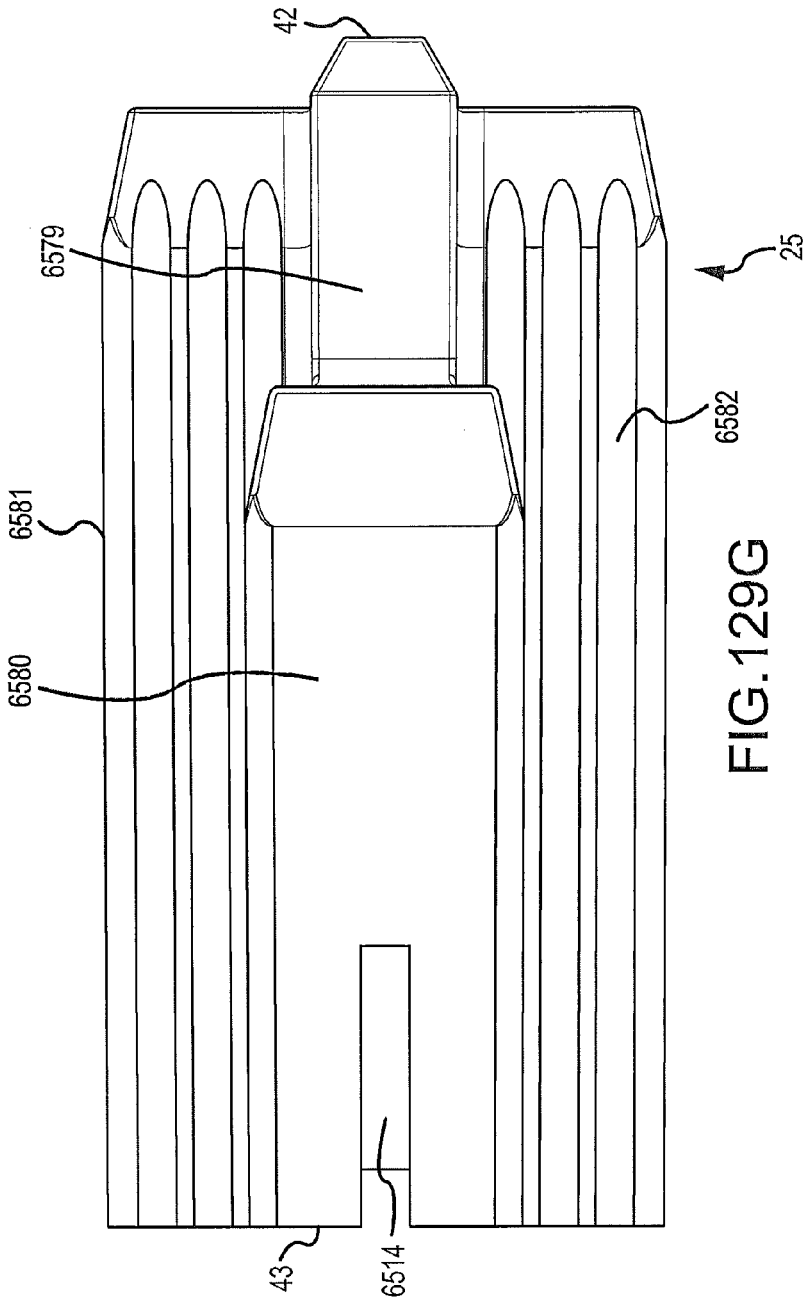


FIG.129G

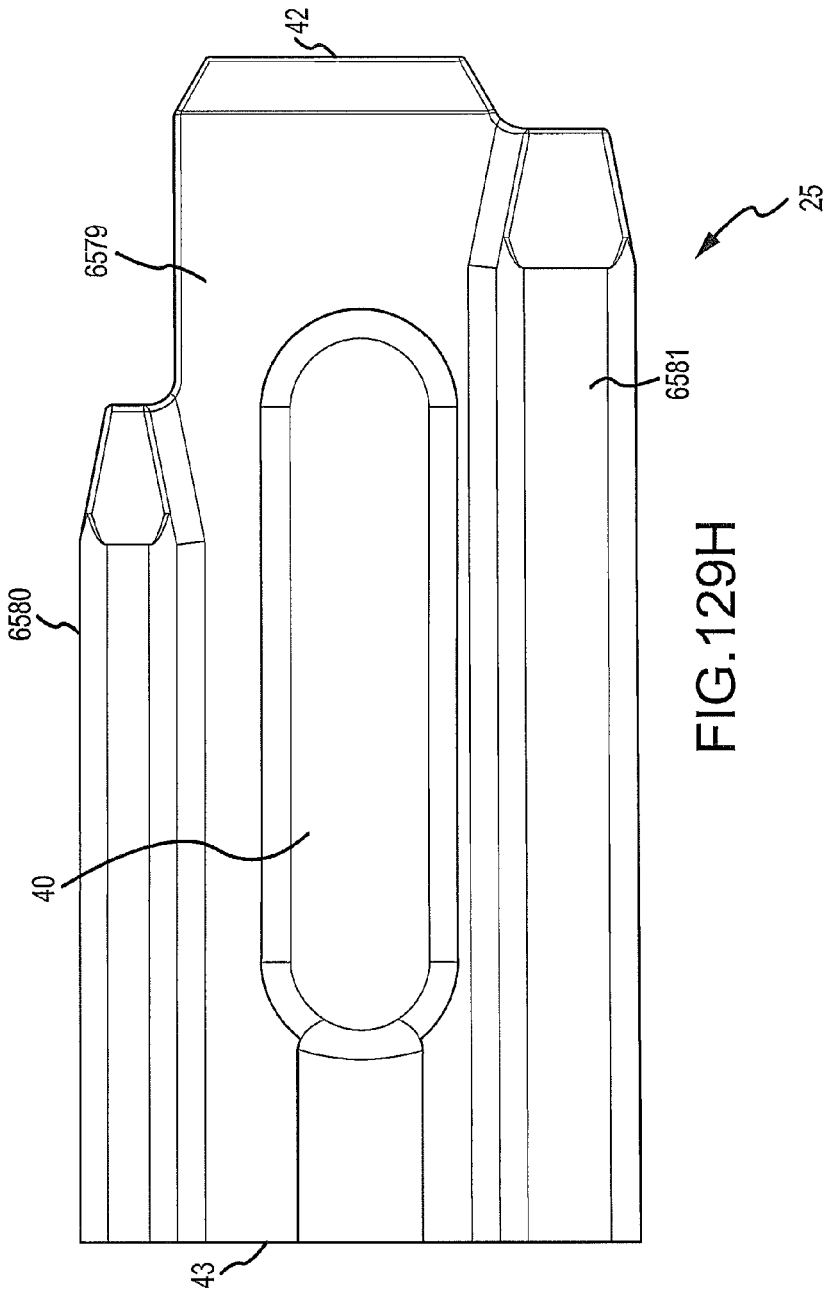


FIG.129H

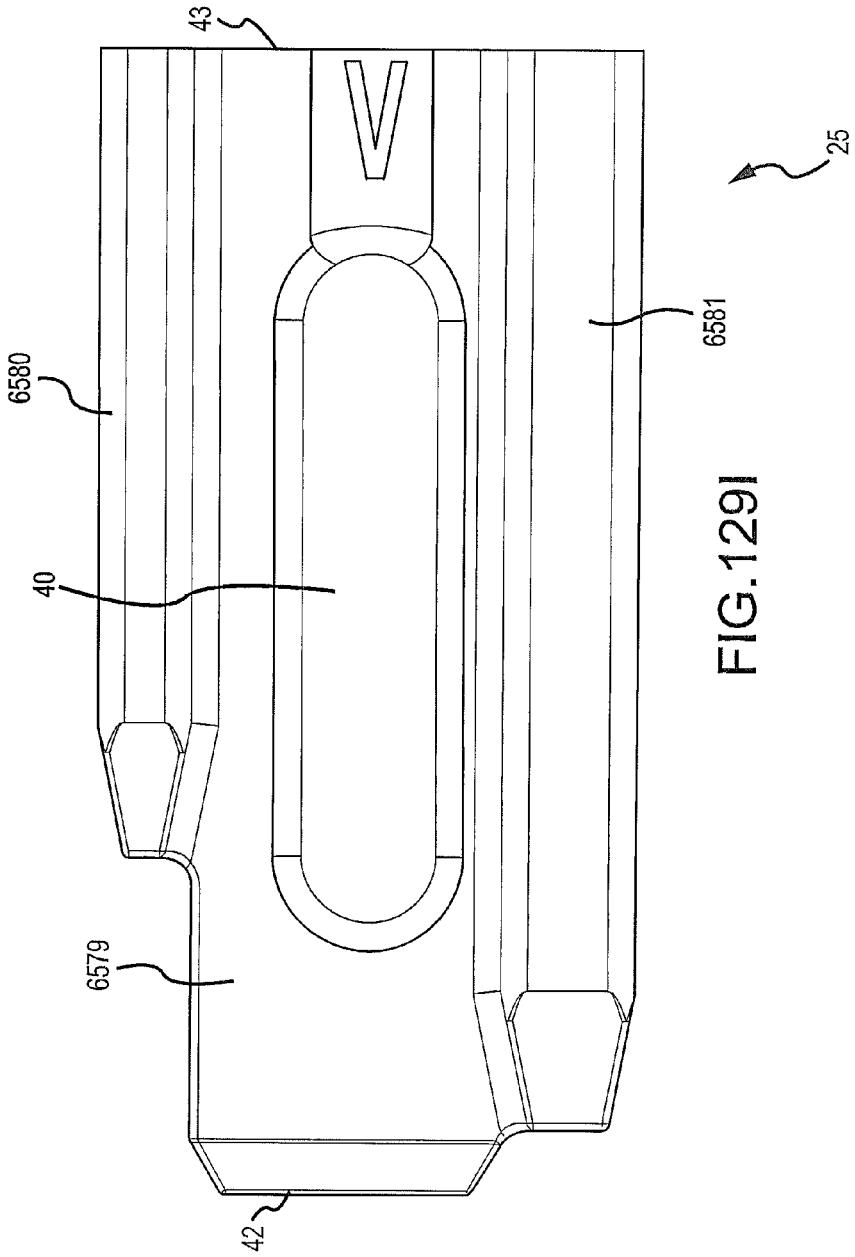


FIG.129I

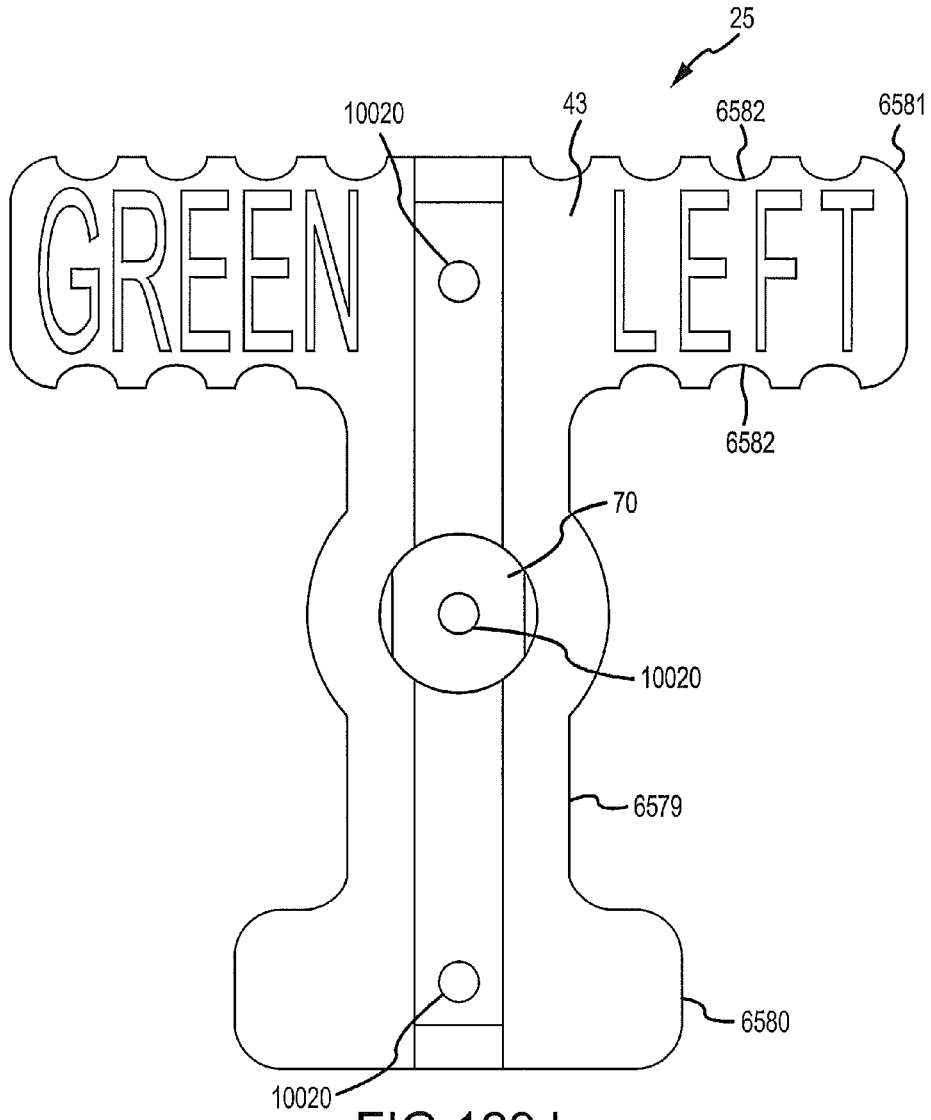

25
10020
43
6582
6581
GREEN
LEFT
6582
70
10020
6579
6580
10020

FIG.129J

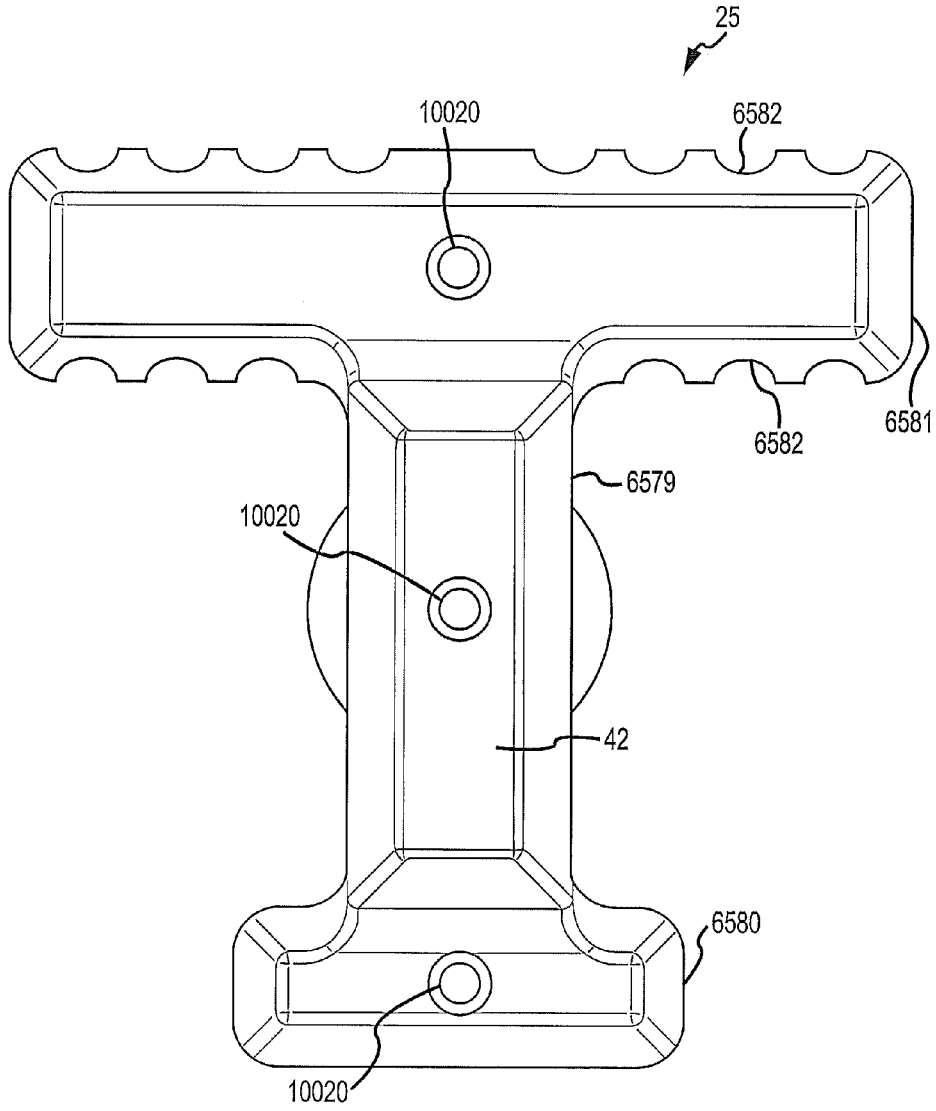


FIG.129K

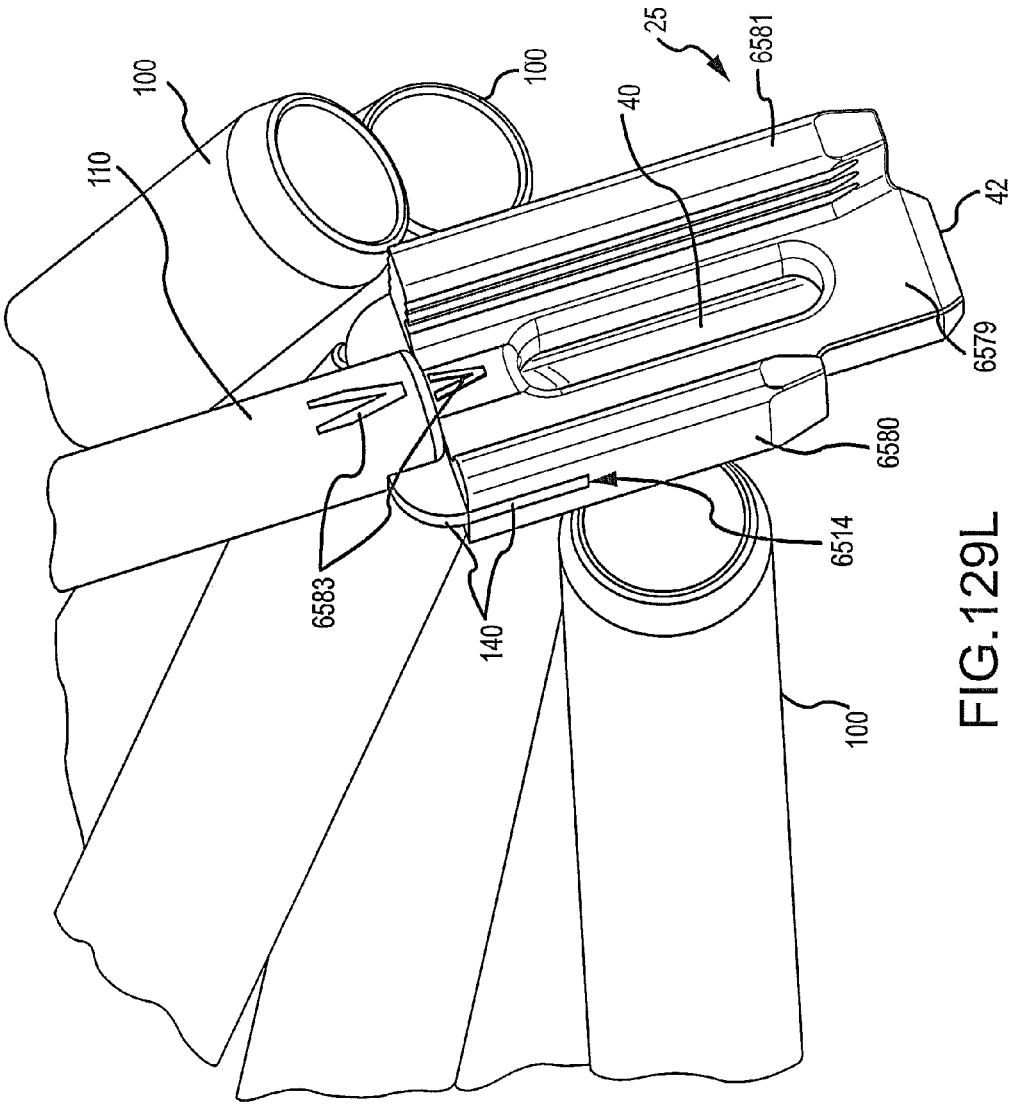


FIG.129L

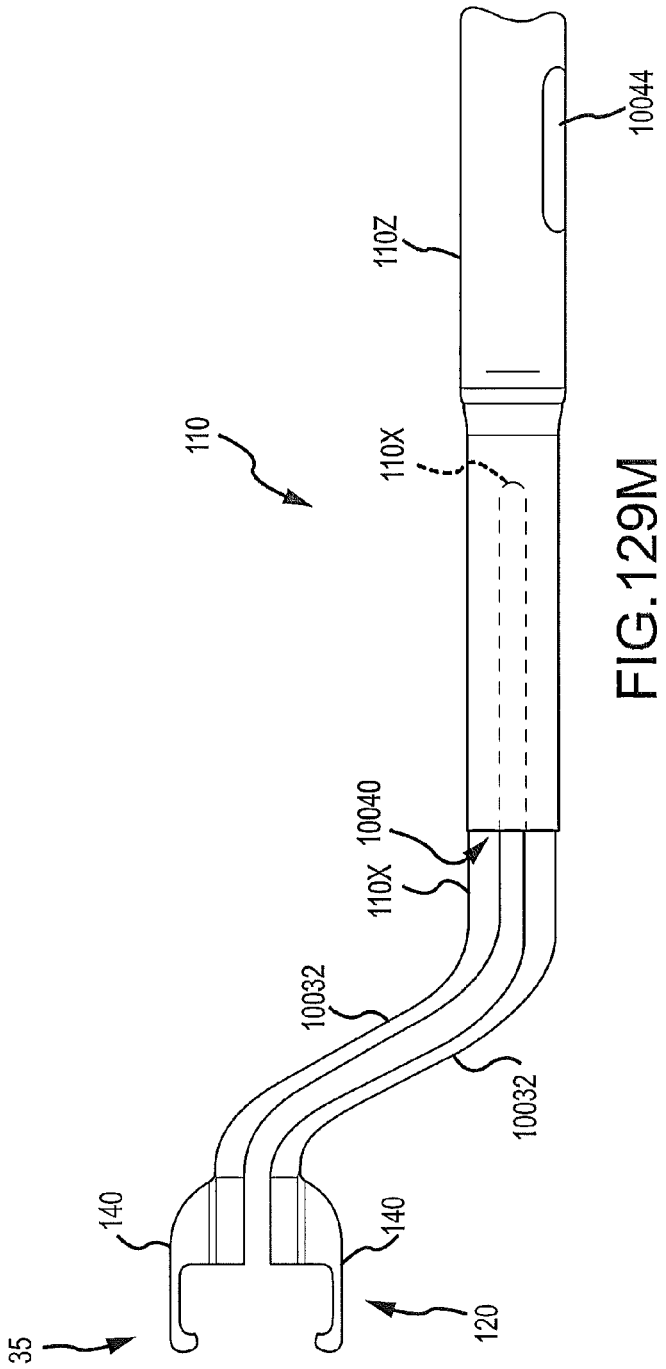


FIG.129M

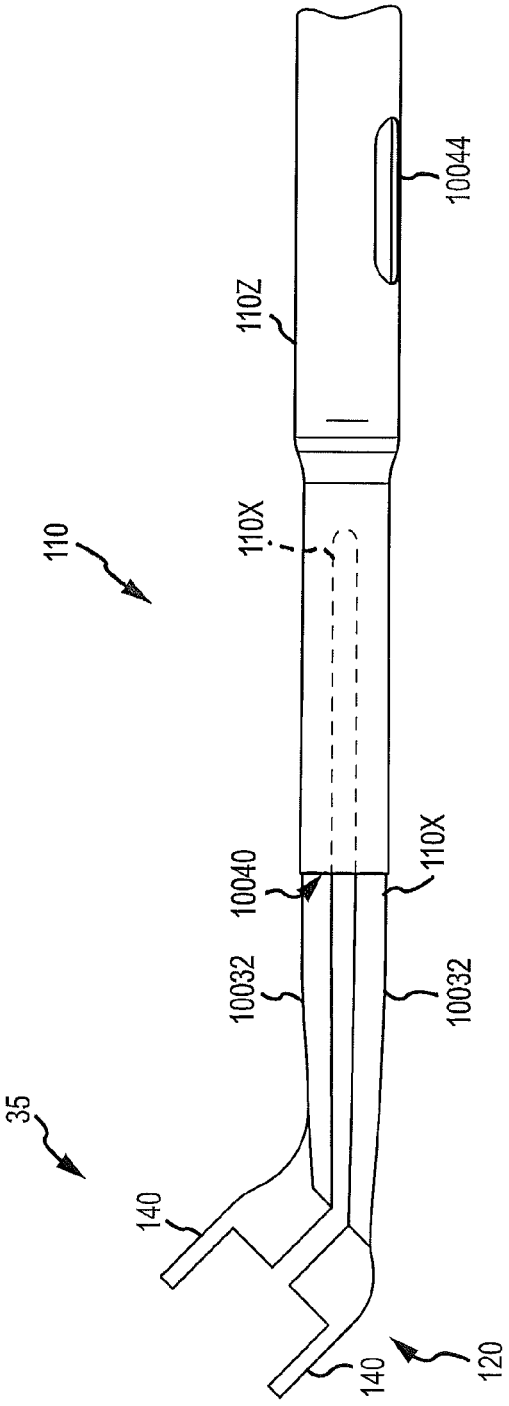


FIG.129N

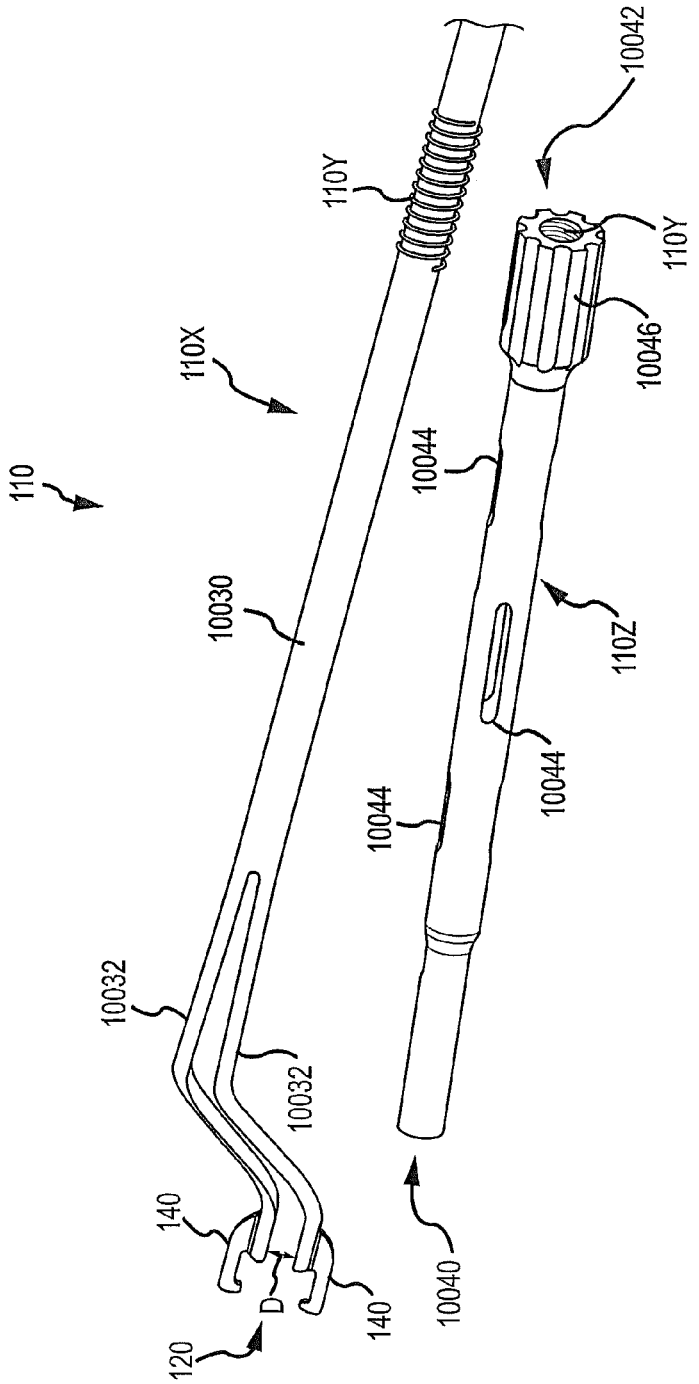

110
110X
110Y
10042
110Y
10046
10044
10030
110Z
10044
10044
10032
10032
140
140
D
120
10040

FIG.129P

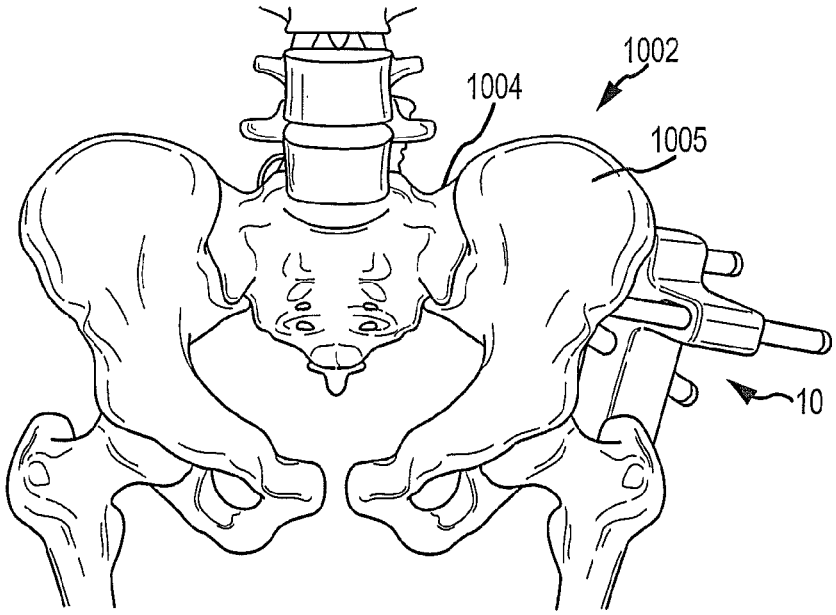


FIG.130A

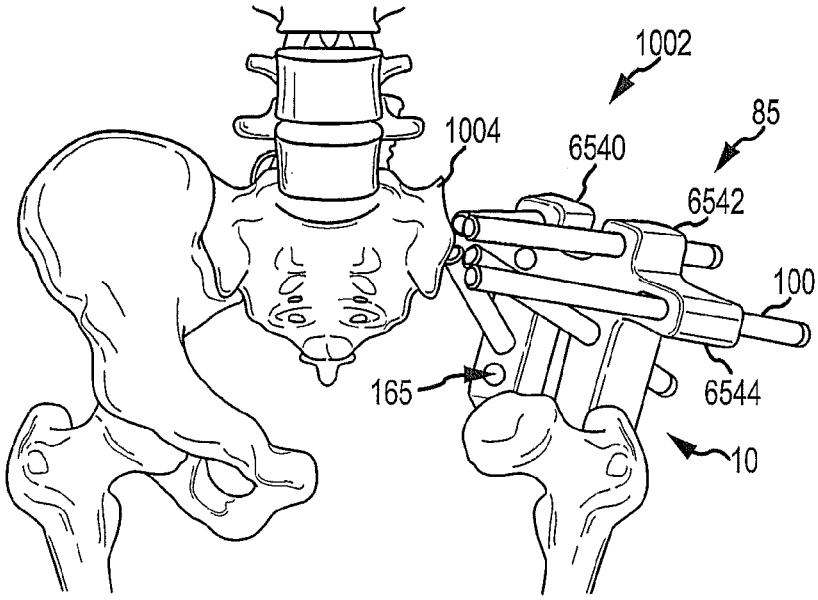


FIG.130B

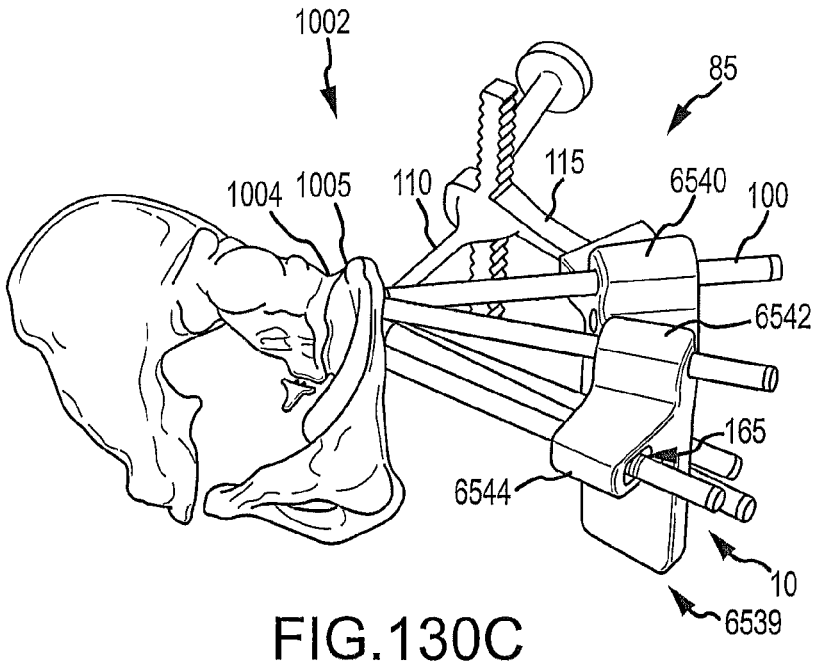


FIG.130C

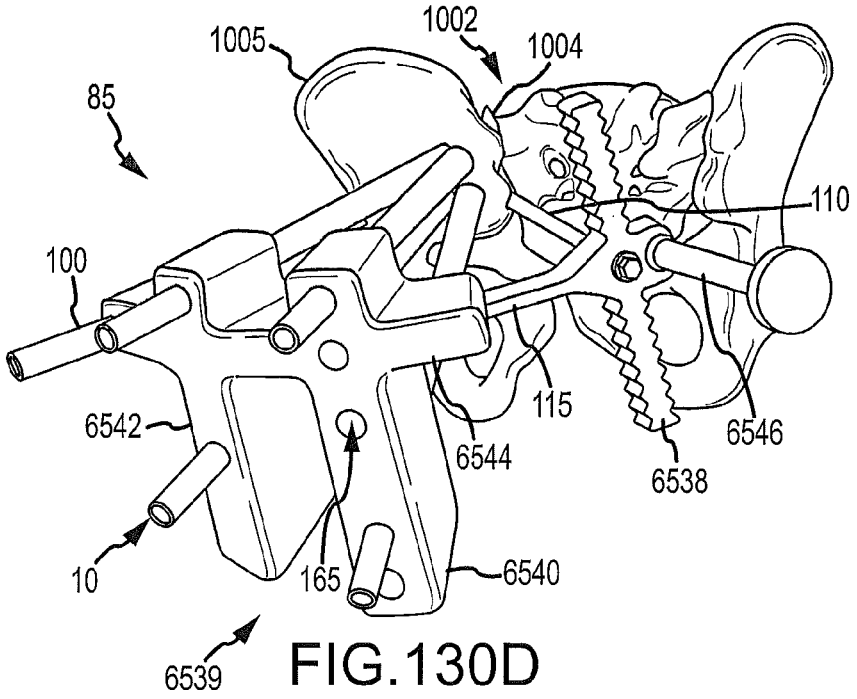


FIG.130D

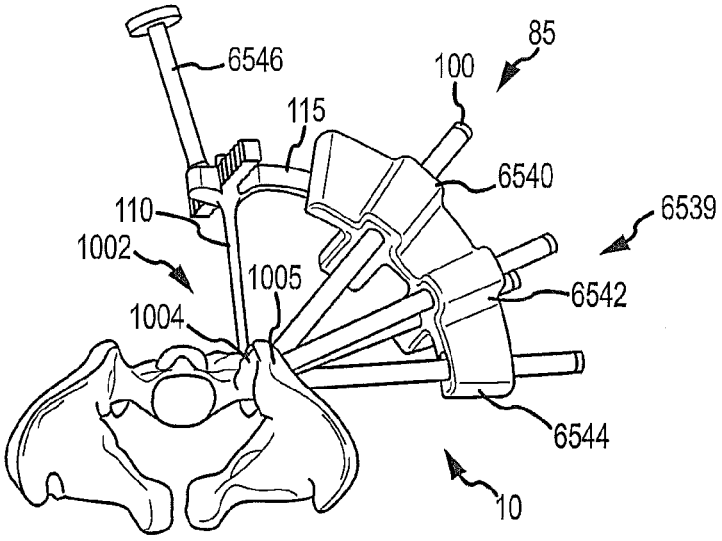


FIG.130E

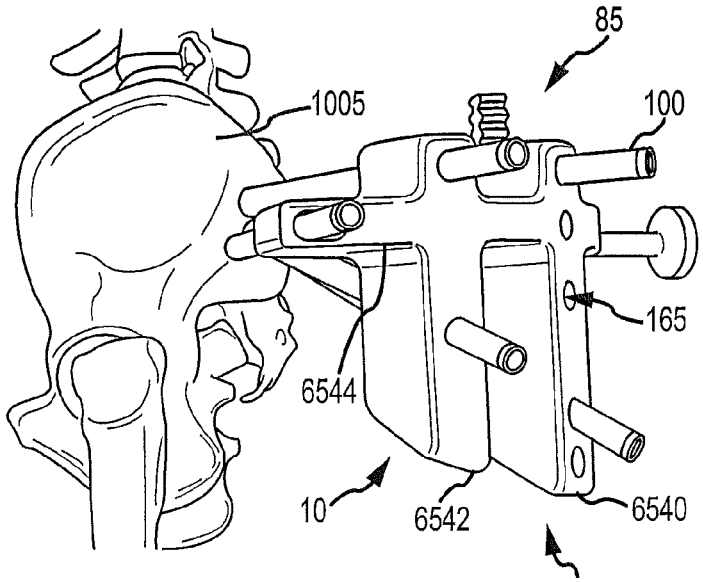


FIG.130F

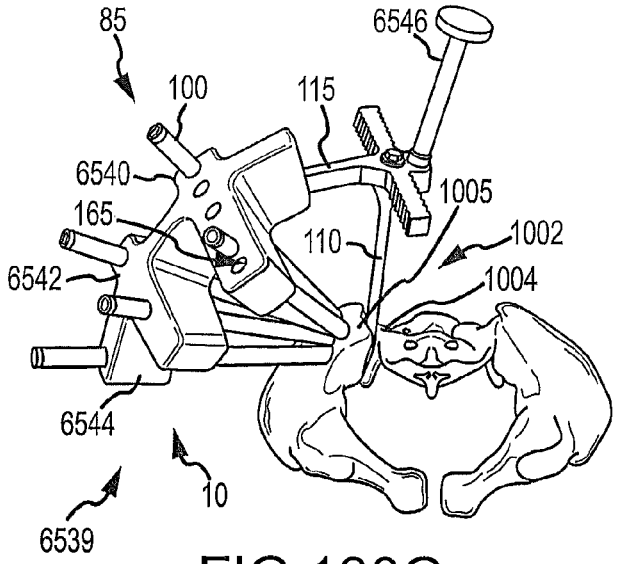


FIG.130G

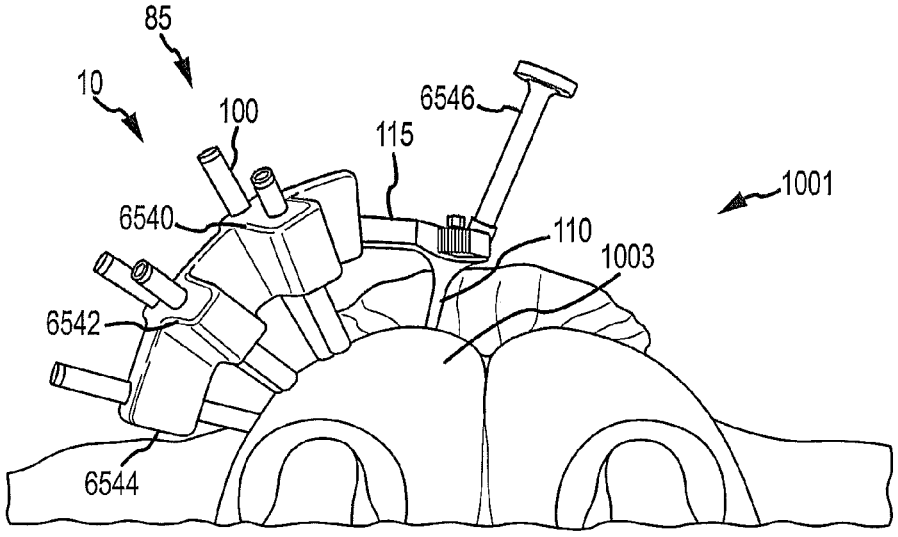


FIG.130H

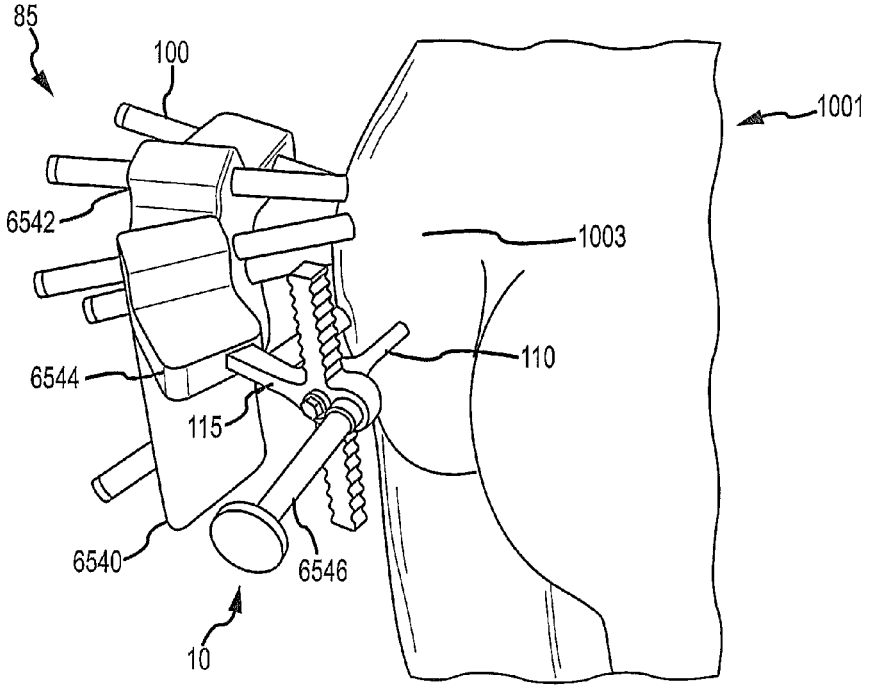


FIG.130I

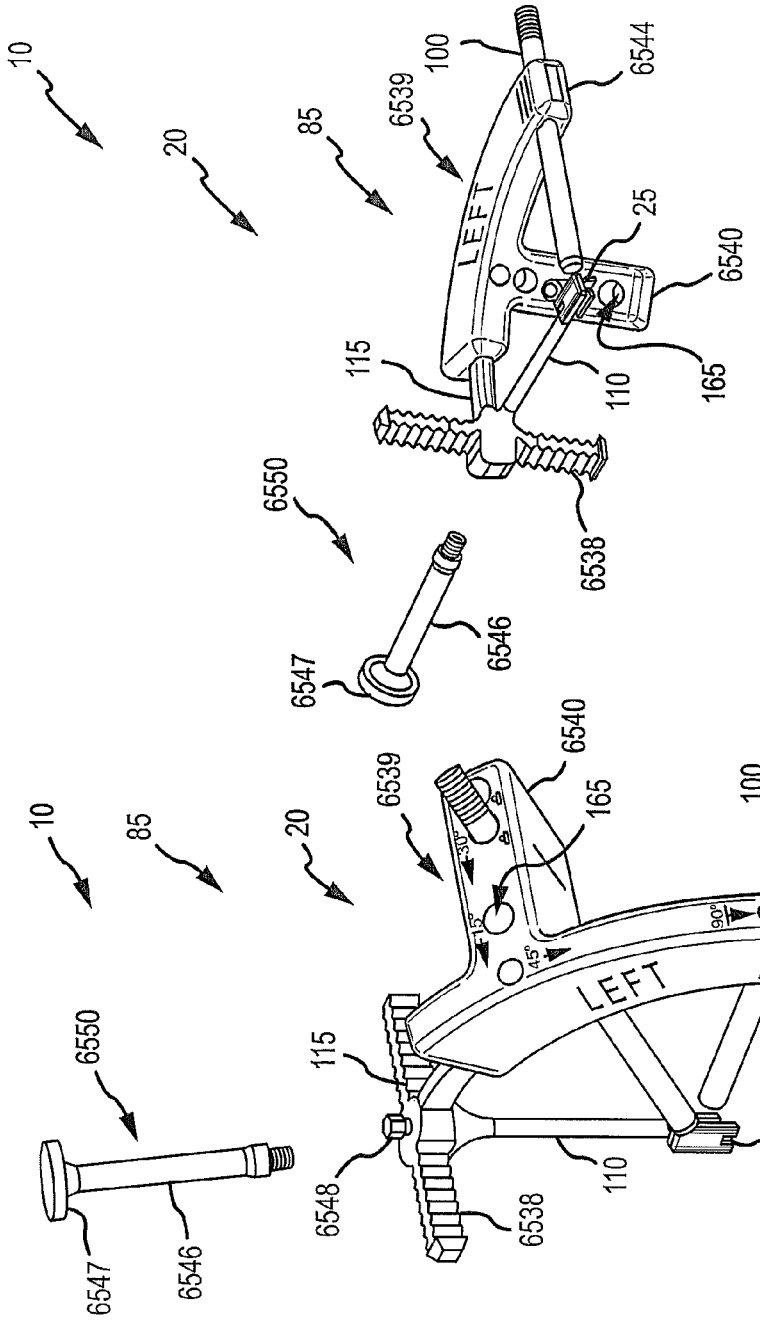


FIG.131B

FIG.131A

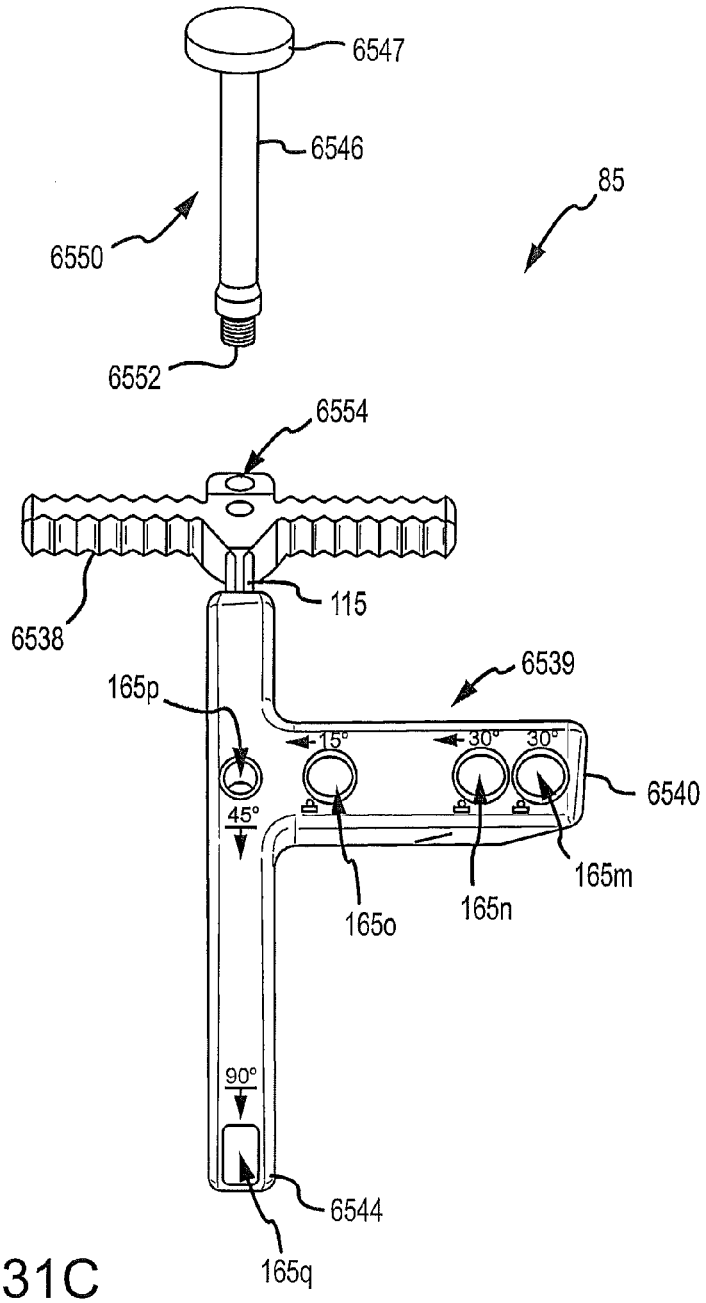

6547
6546
85
6550
6552
6554
115
6538
6539
165p
15°
30°
30°
6540
45°
165m
165o
165n
90°
6544
165q

FIG.131C

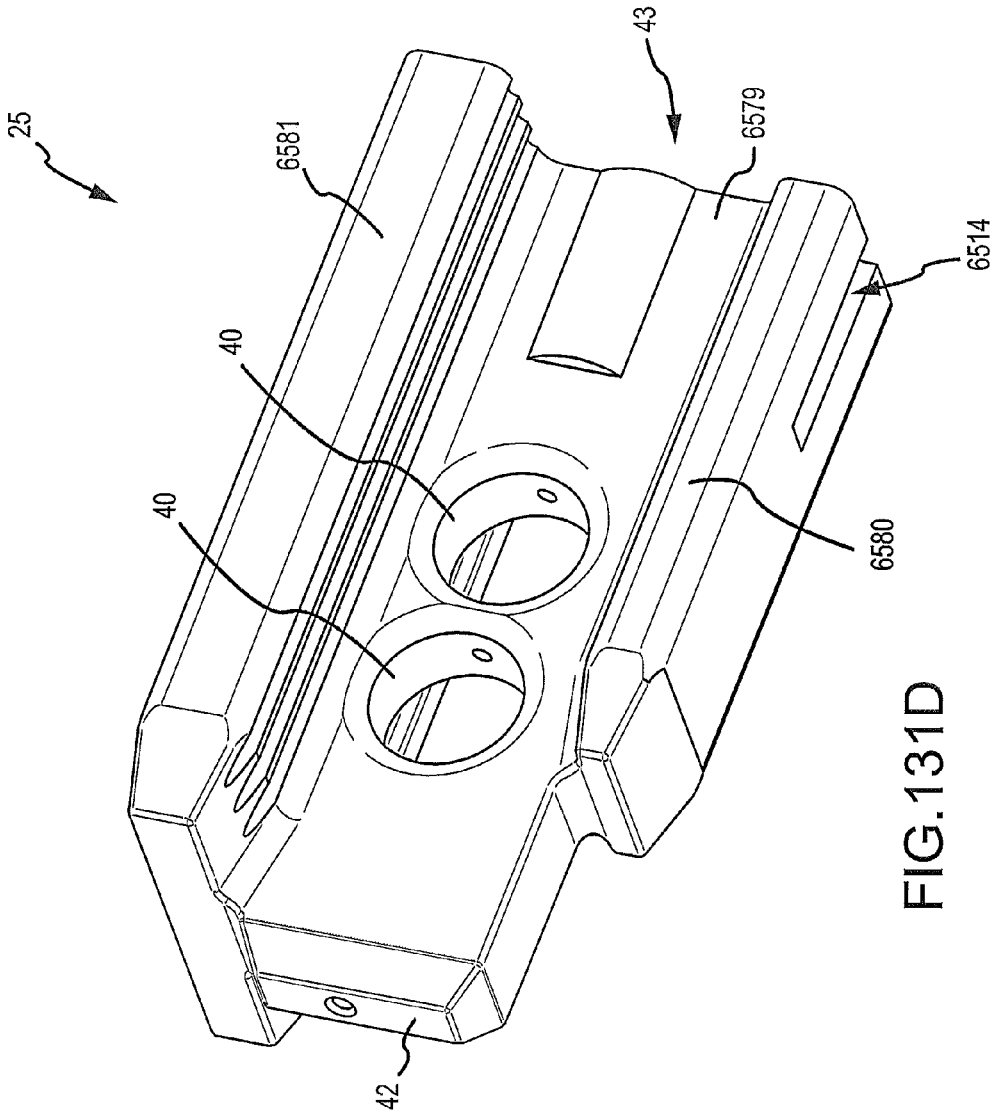


FIG.131D

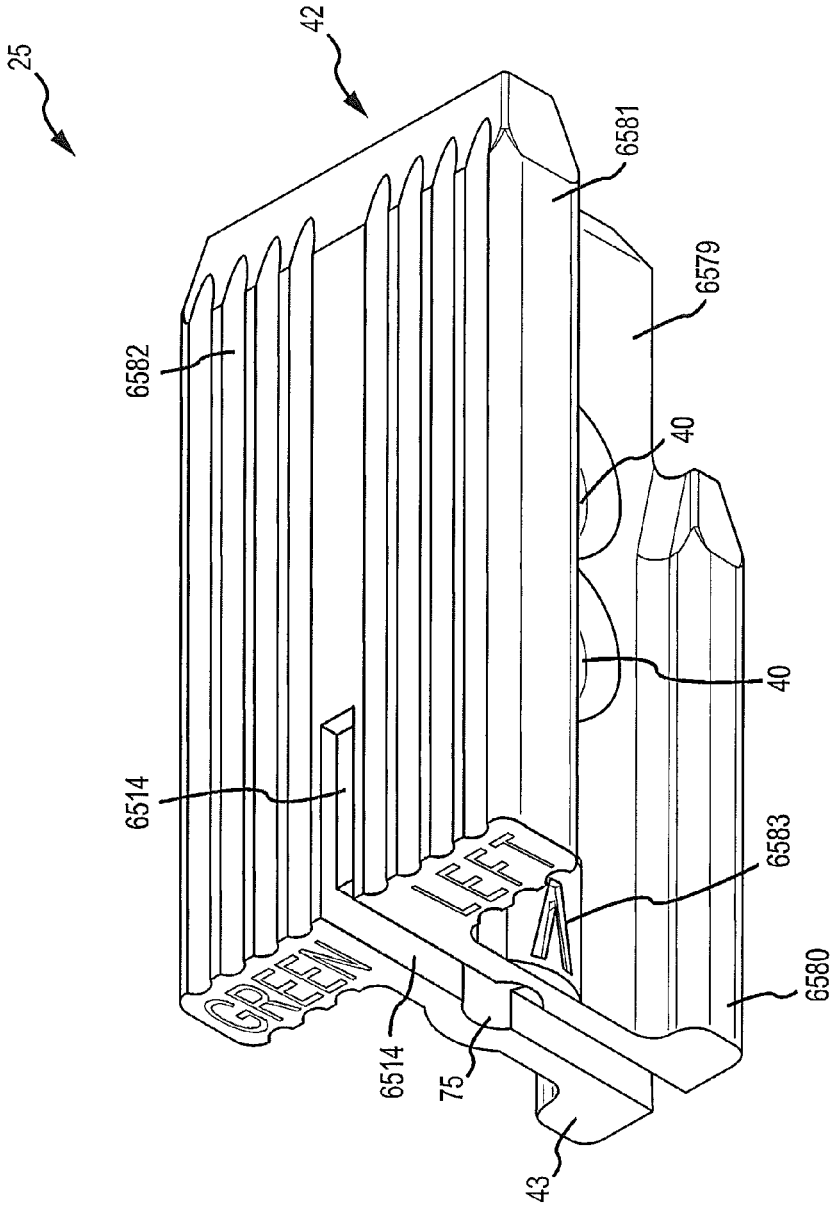


FIG.131E

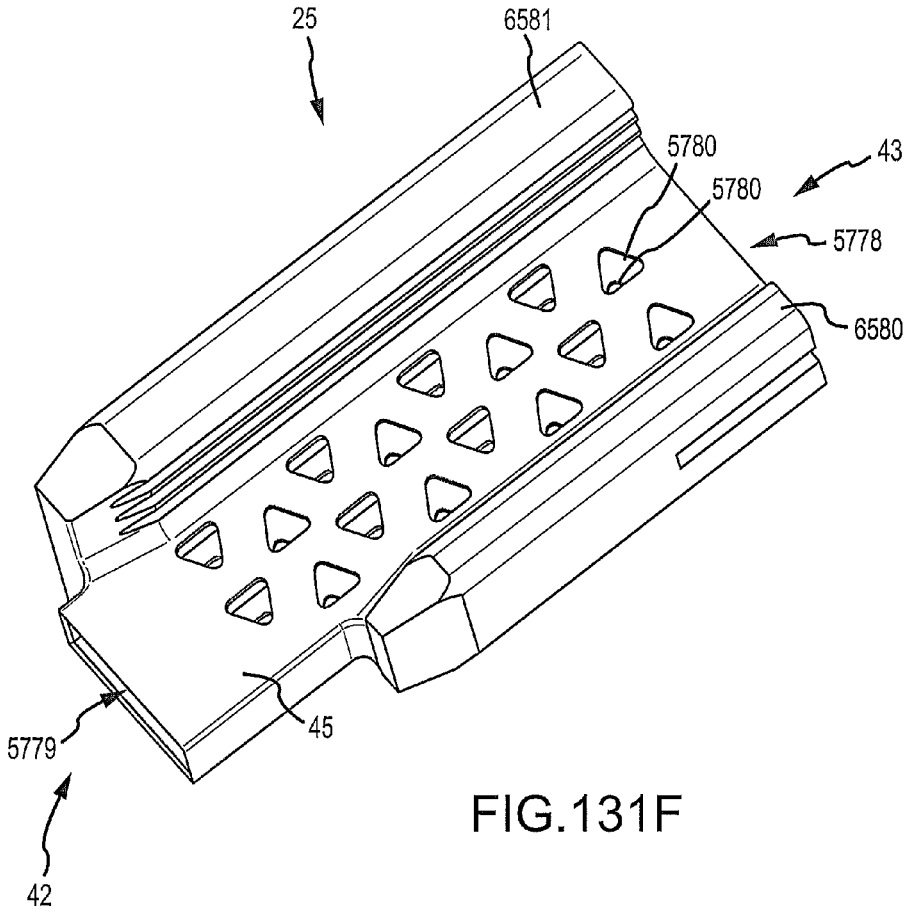


FIG.131F

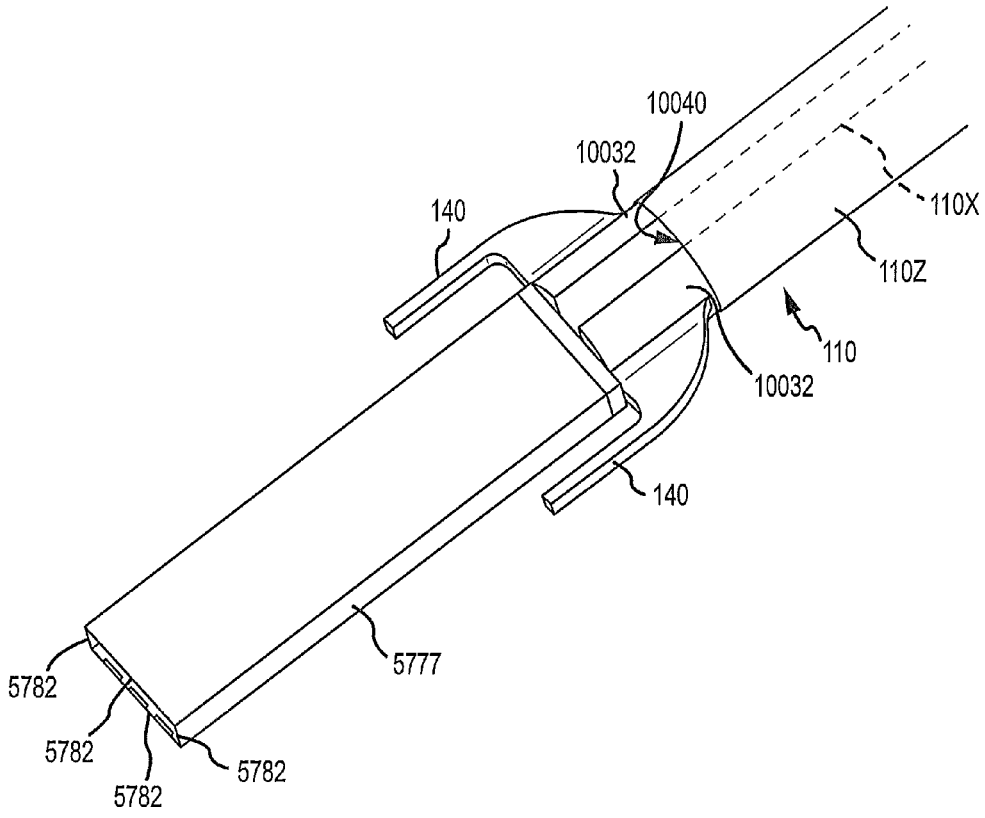

10040
10032
140
110X
110Z
110
10032
140
5777
5782
5782
5782
5782

FIG.131G

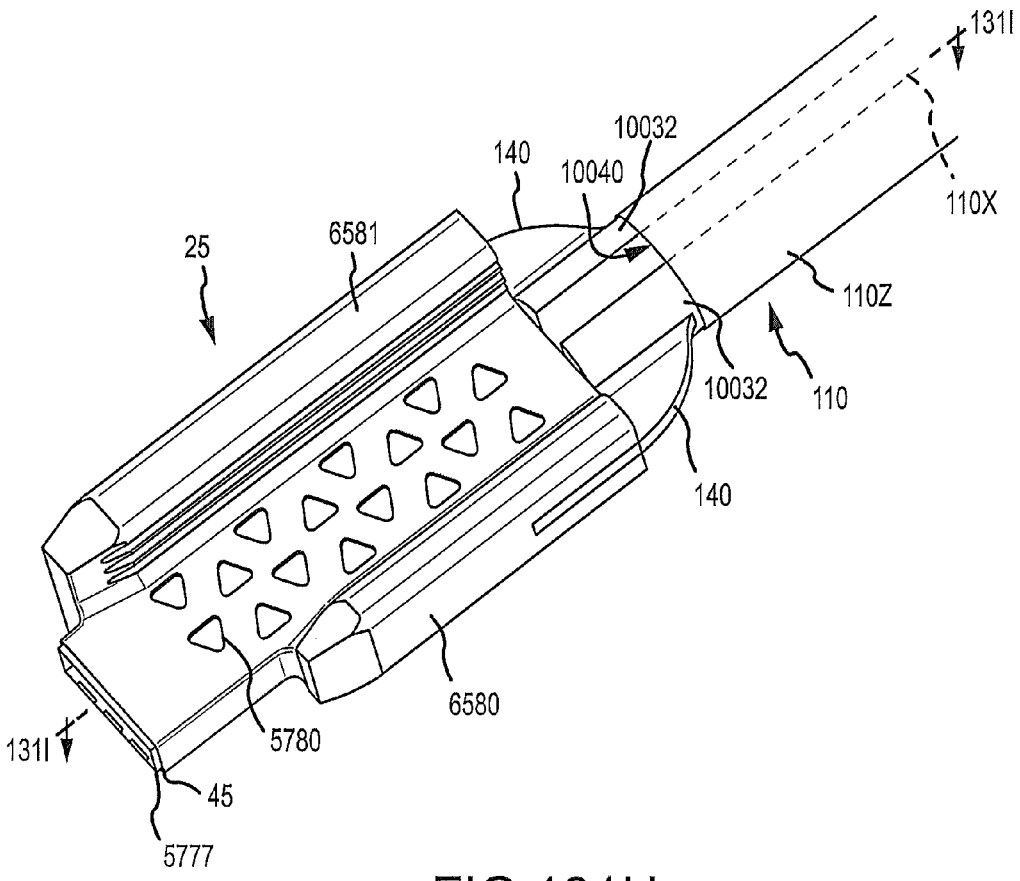

131I
10032
140
10040
110X
25
6581
110Z
10032
110
140
6580
5780
131I
45
5777

FIG.131H

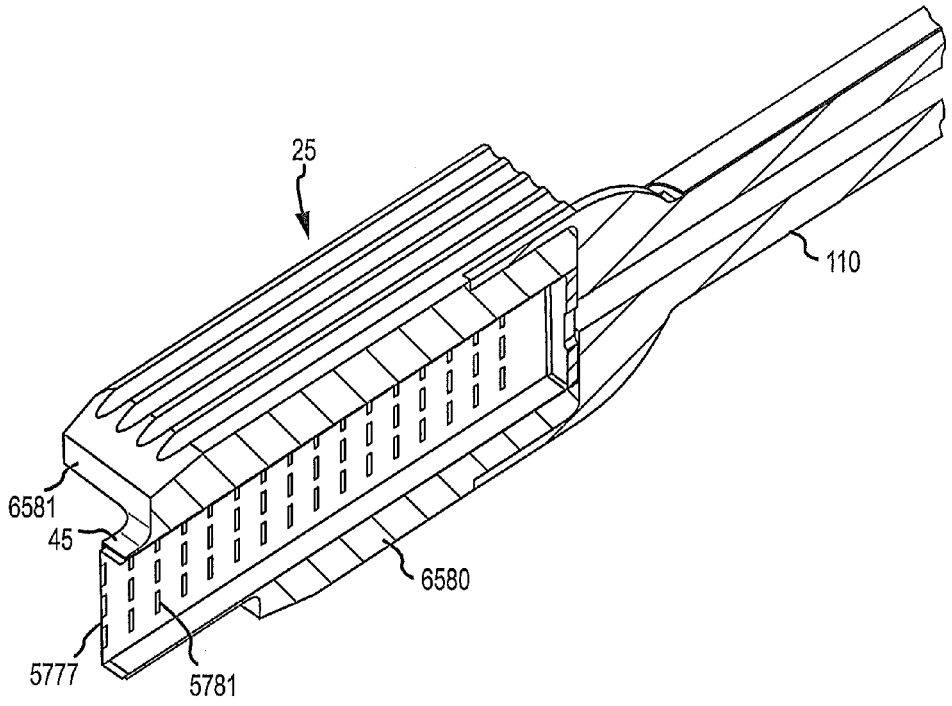


FIG.131I

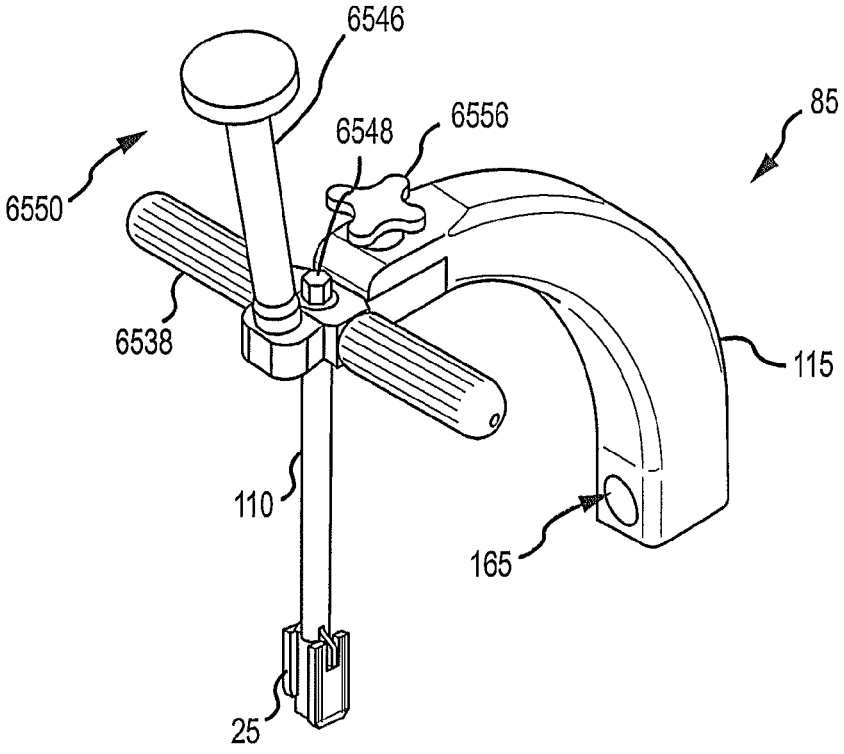


FIG.132A

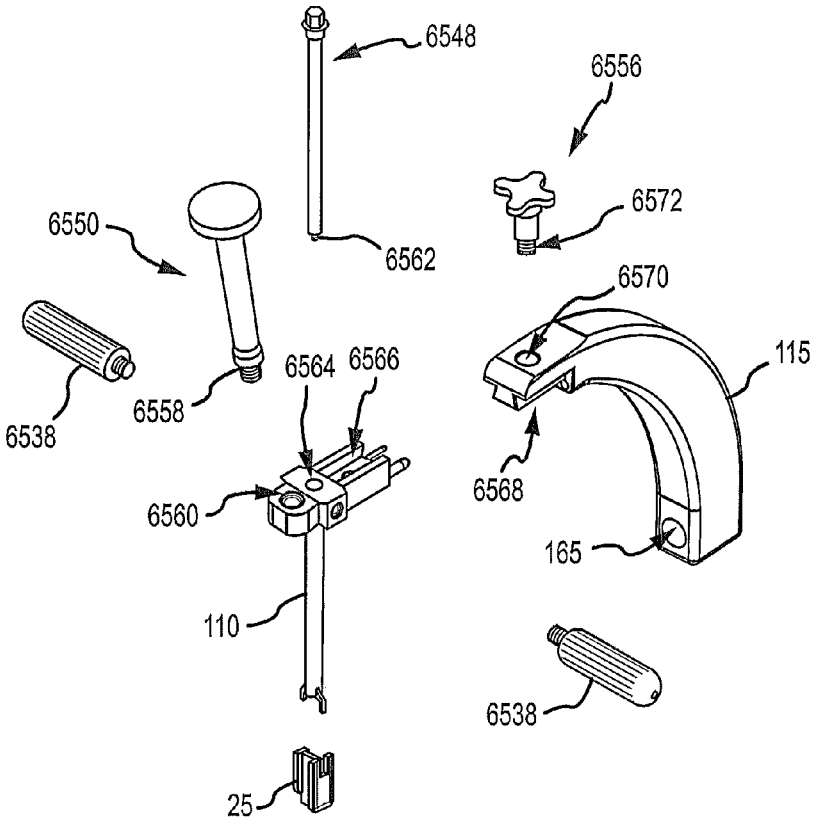

6548
6556
6572
6550
6562
6570
115
6564
6566
6558
6538
6560
6568
165
110
6538
25

FIG.132B

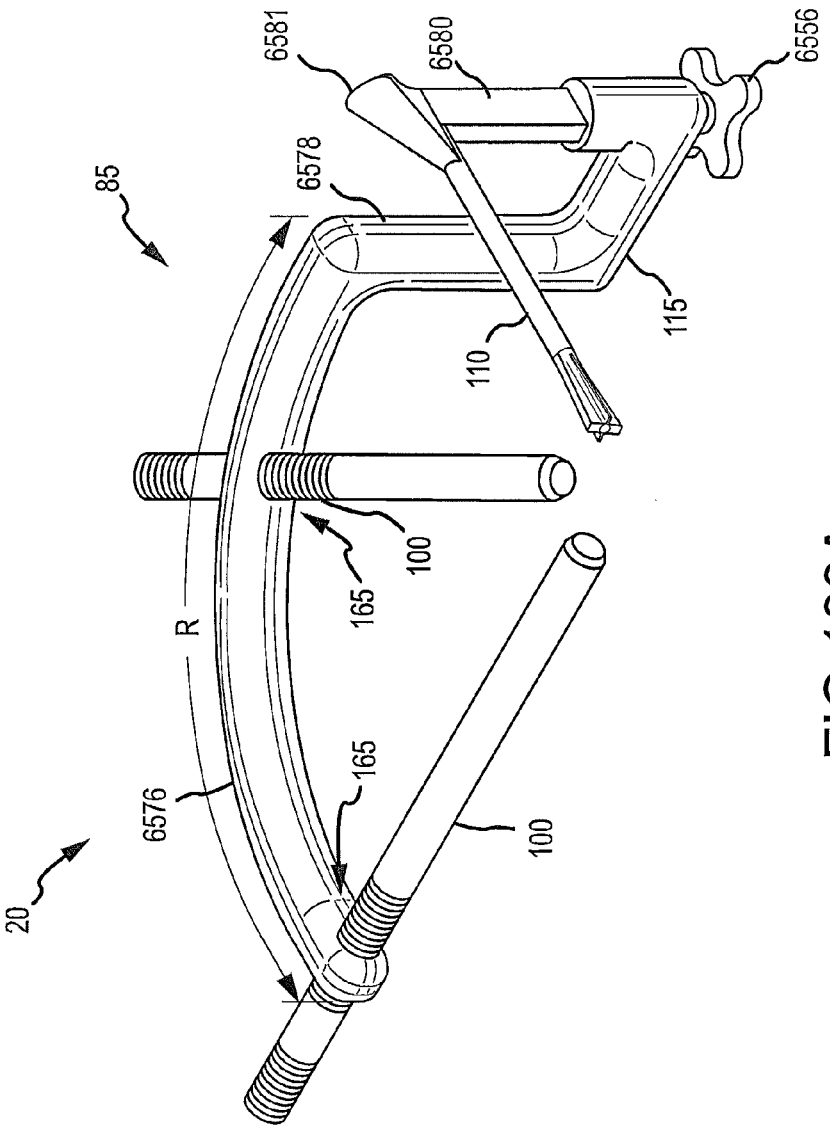


FIG.133A

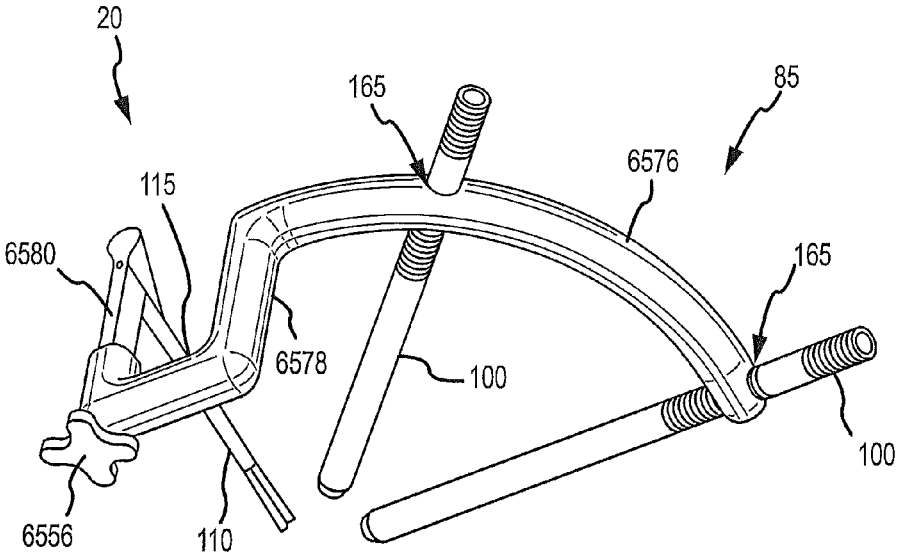


FIG.133B

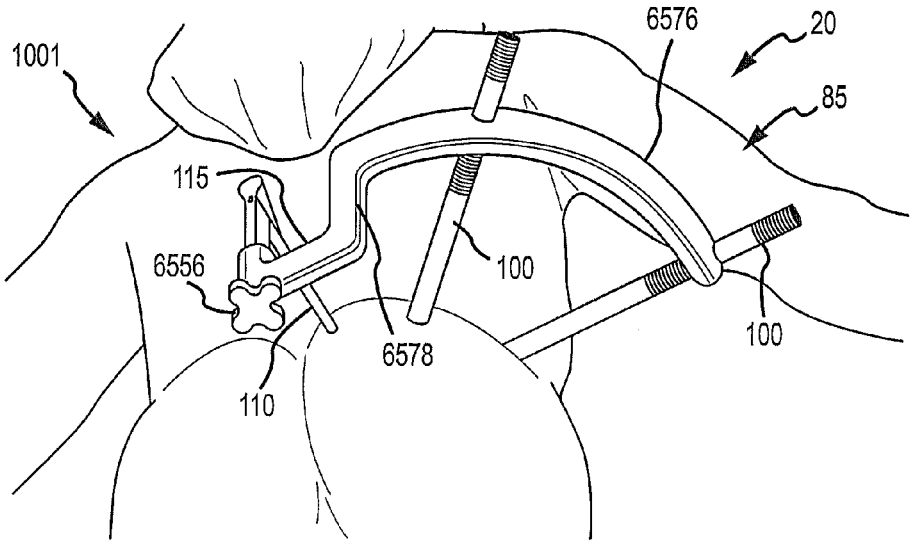


FIG.133C

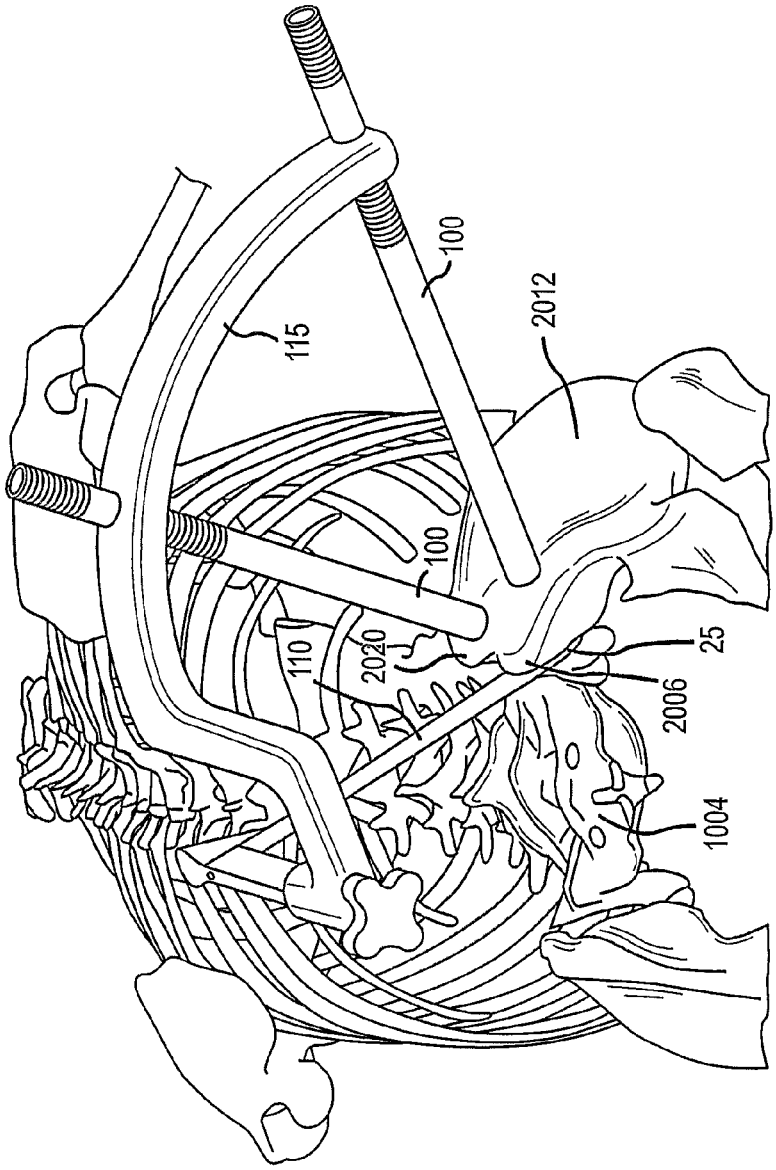


FIG.133D

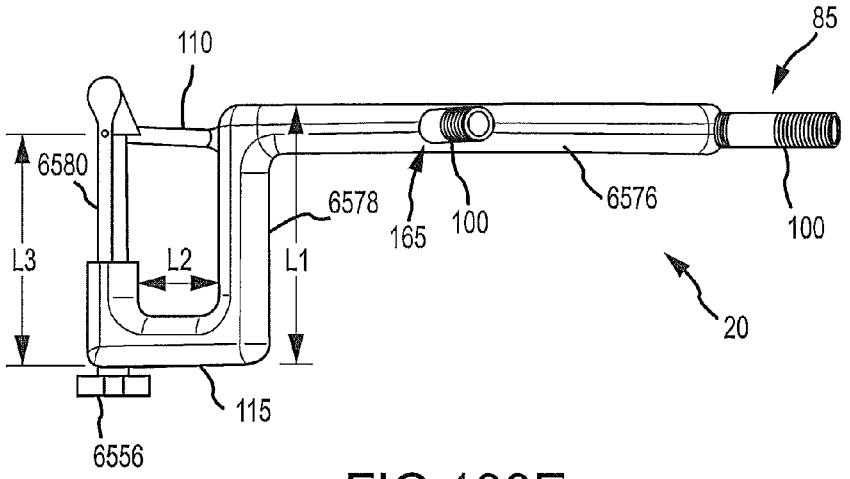


FIG.133E

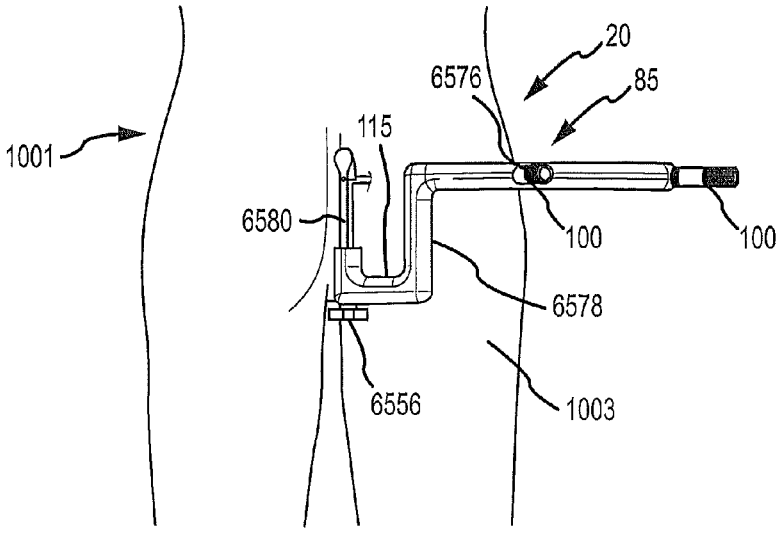


FIG.133F

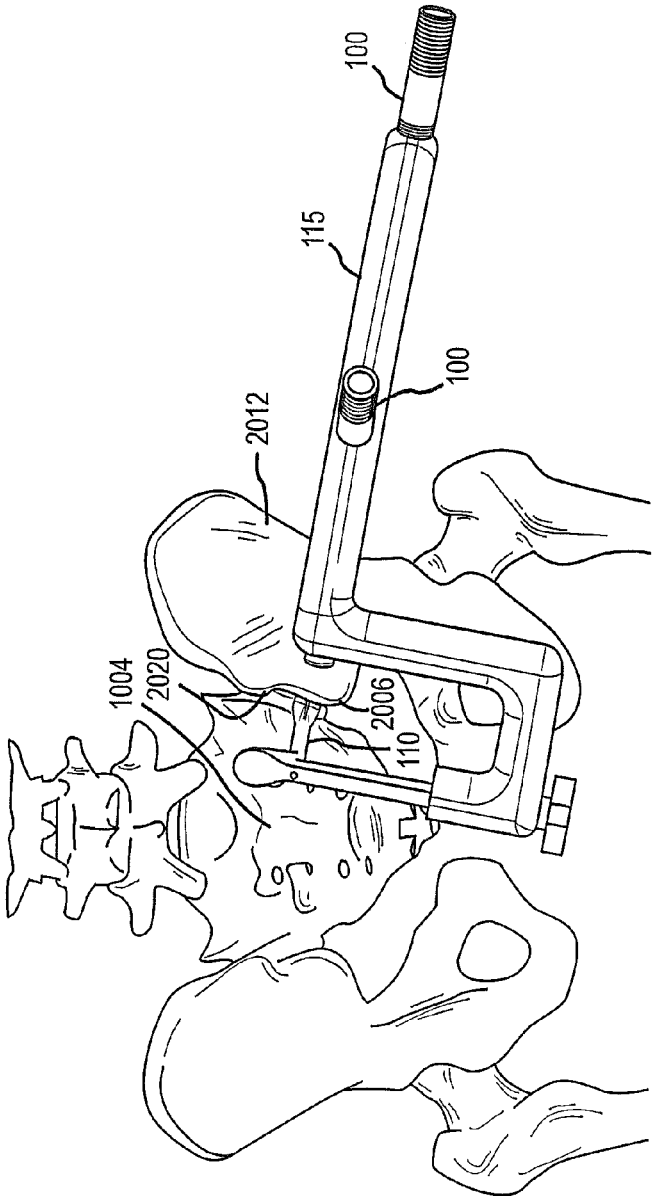


FIG.133G

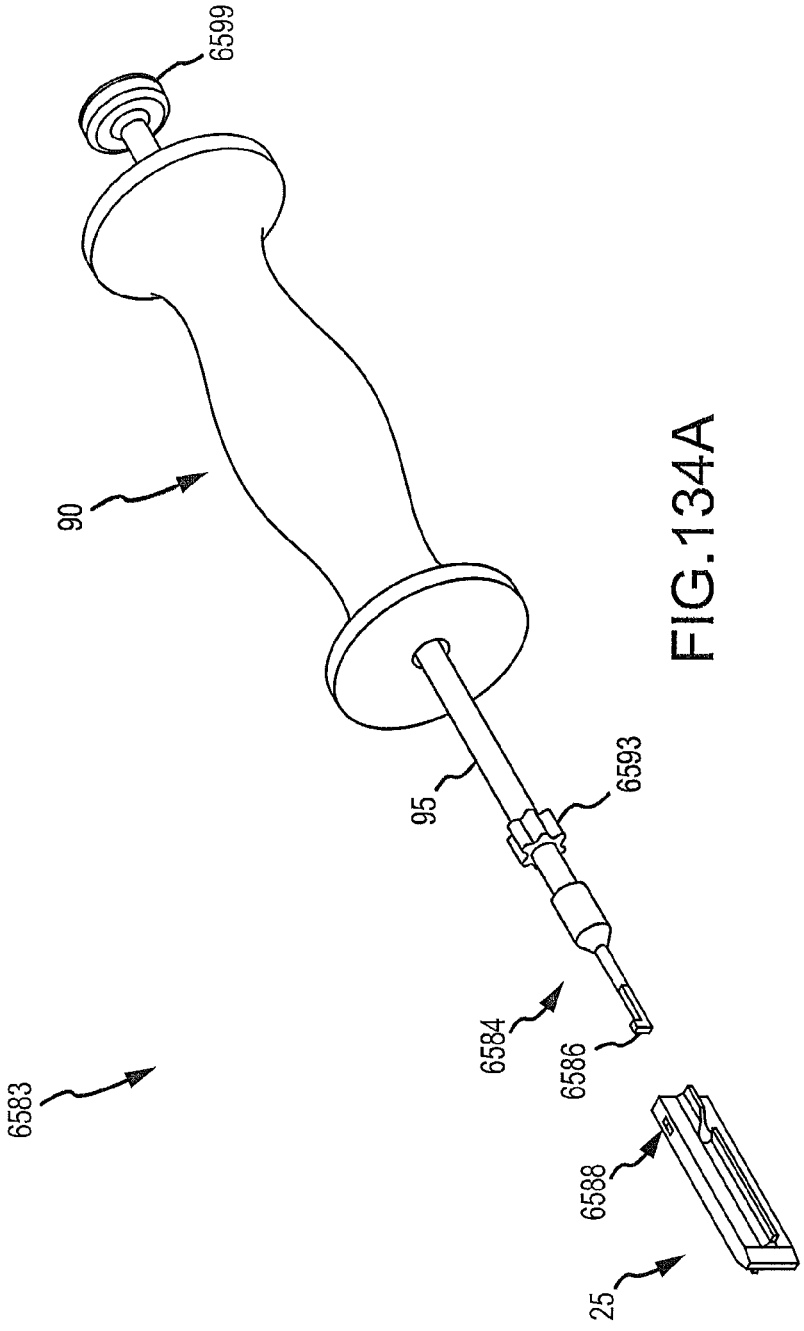


FIG.134A

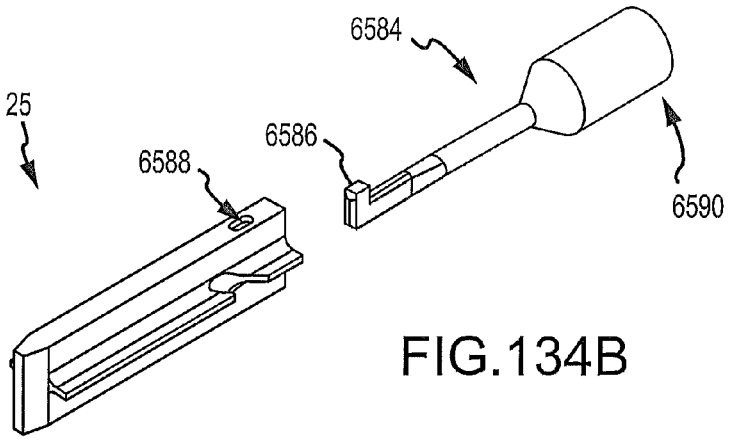


FIG.134B

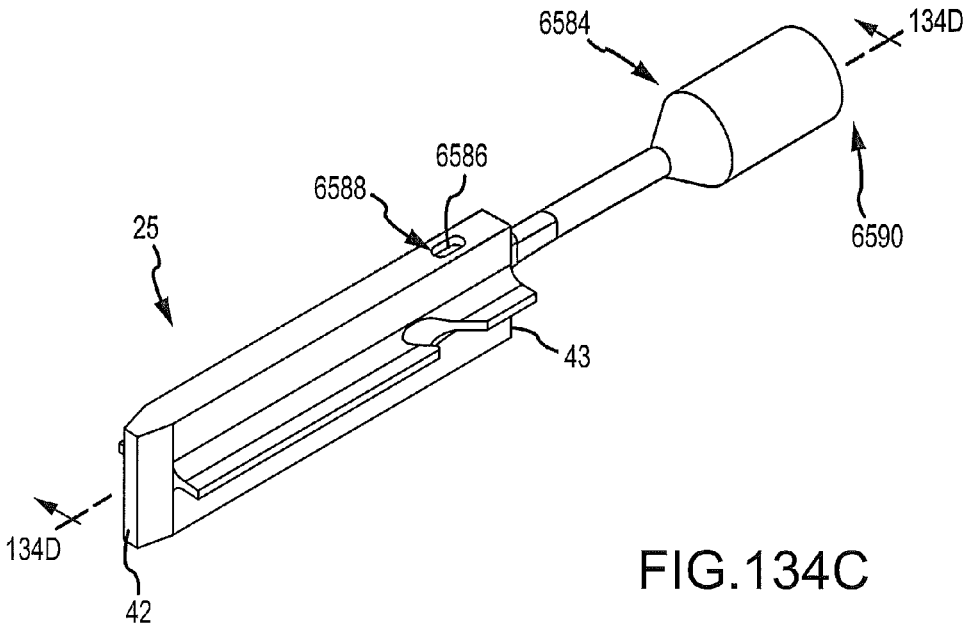


FIG.134C

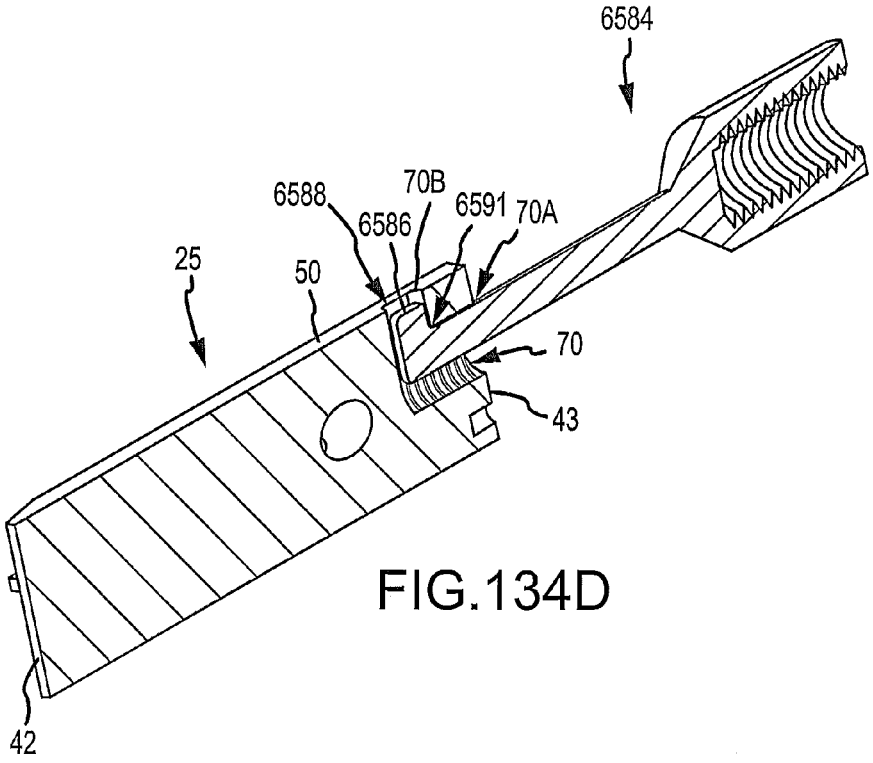


FIG.134D

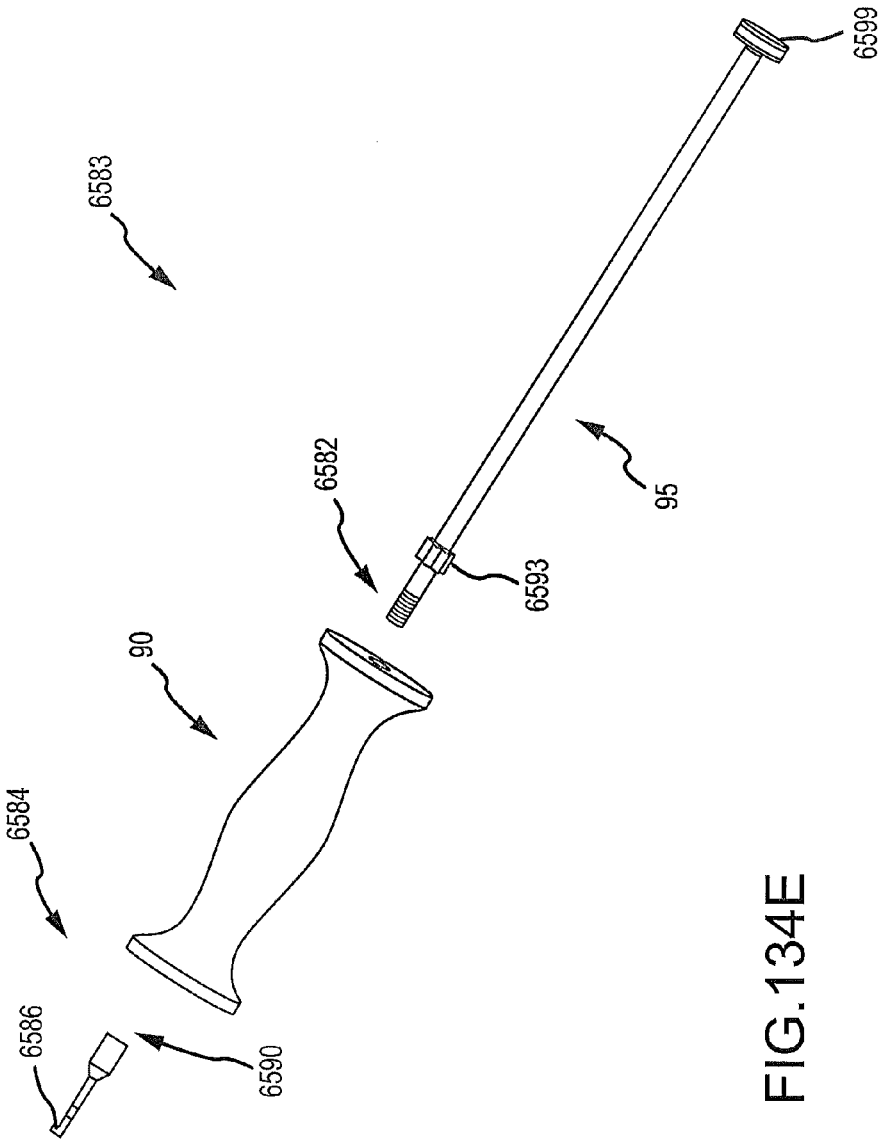


FIG.134E

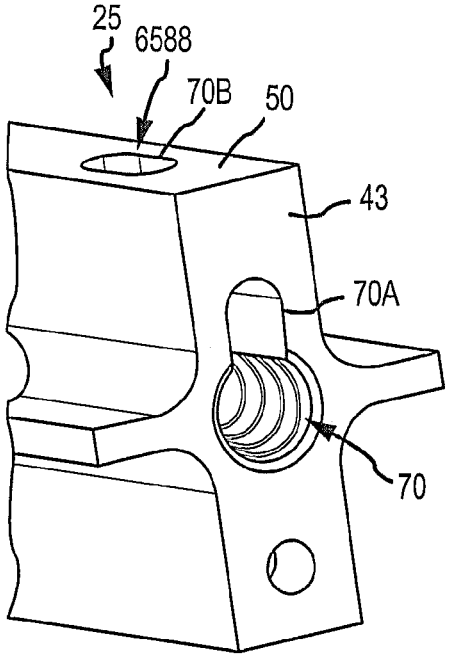
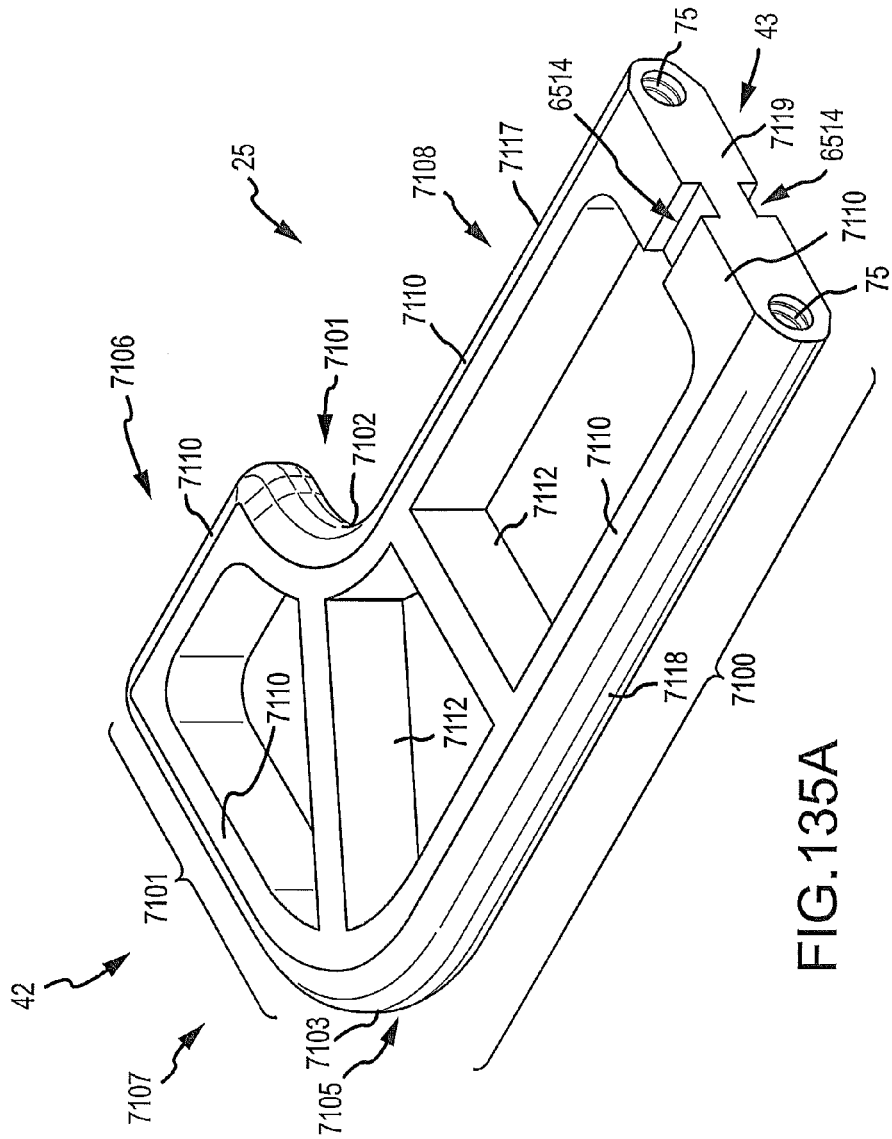


FIG.134F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7107
7105

FIG.135A

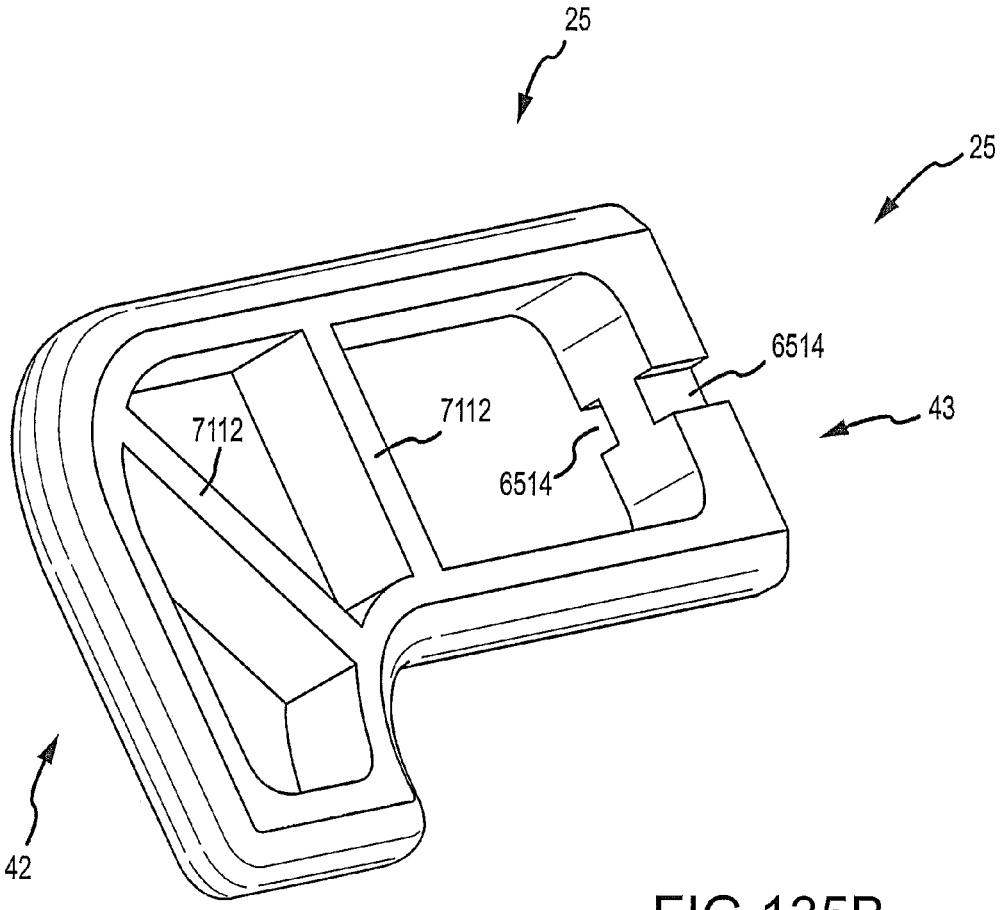
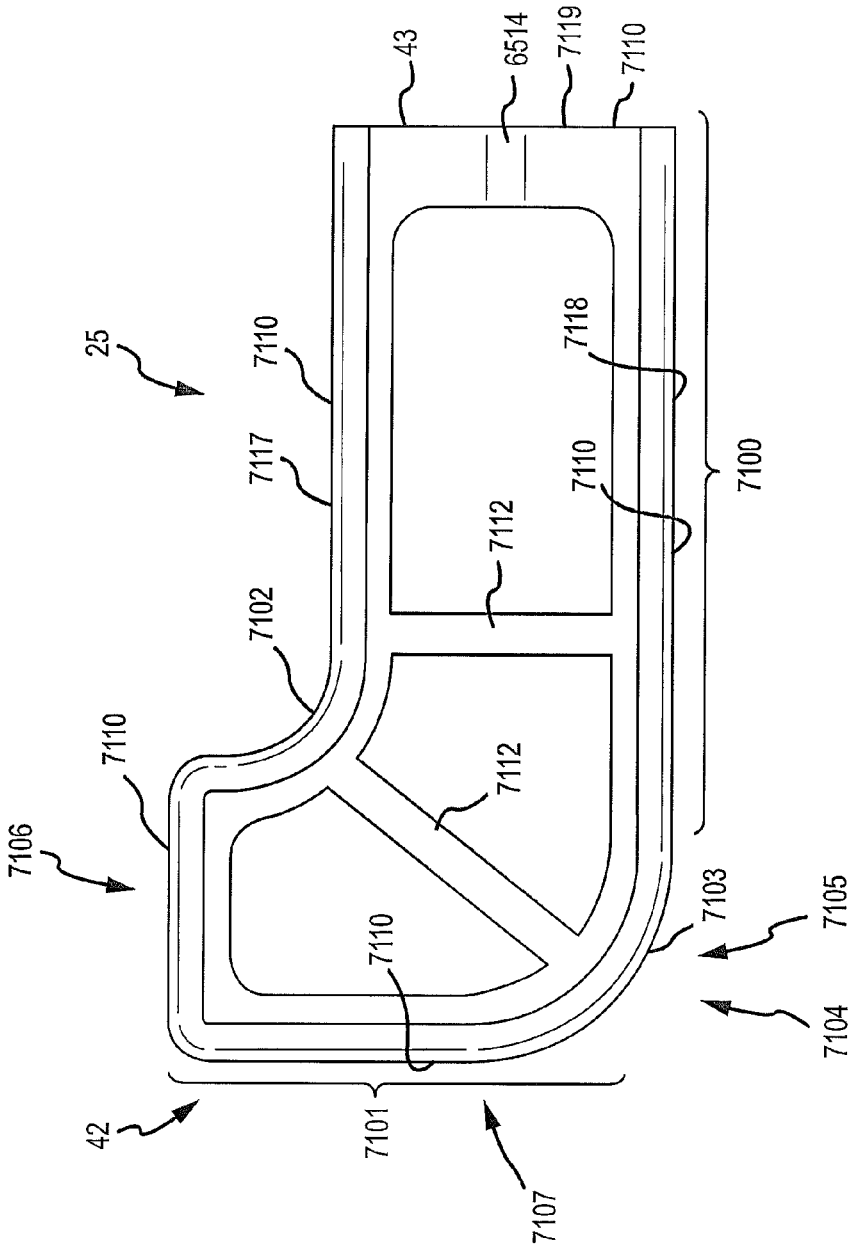


FIG.135B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7107

FIG.135C

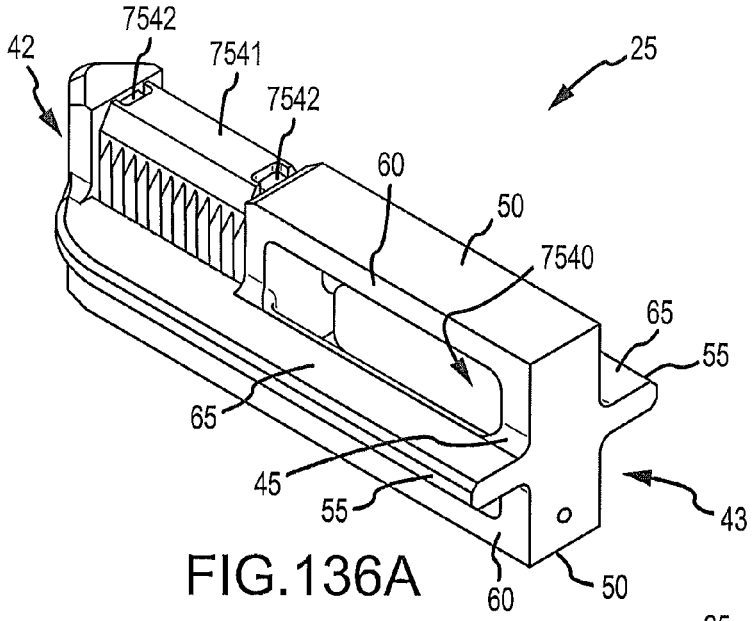


FIG.136A

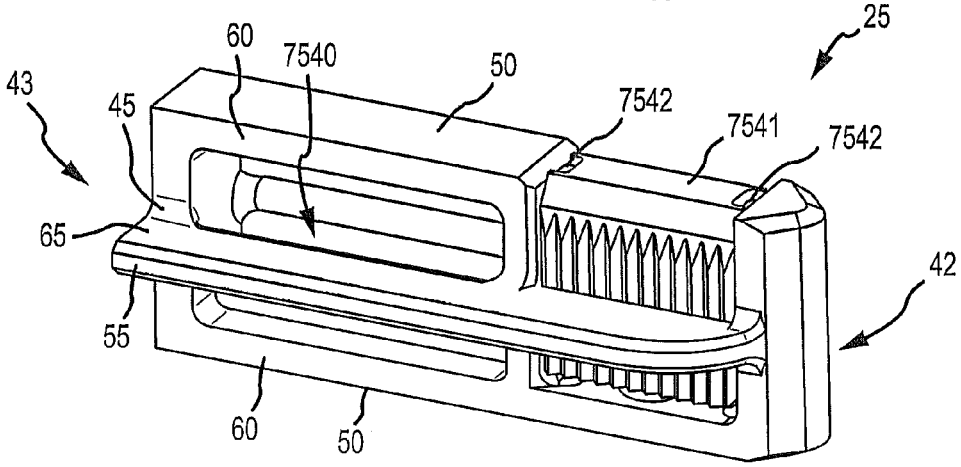


FIG.136B

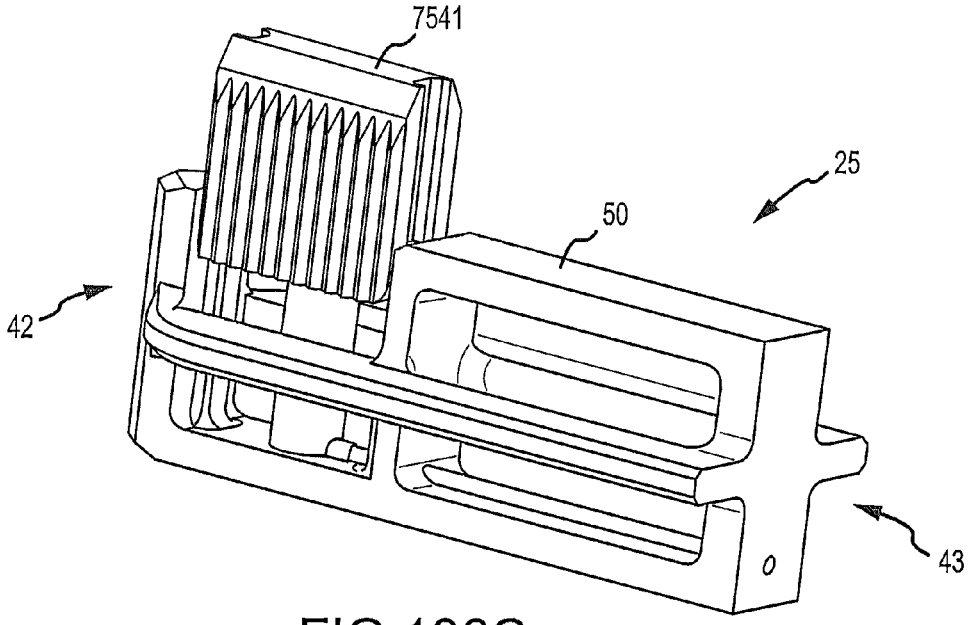


FIG.136C

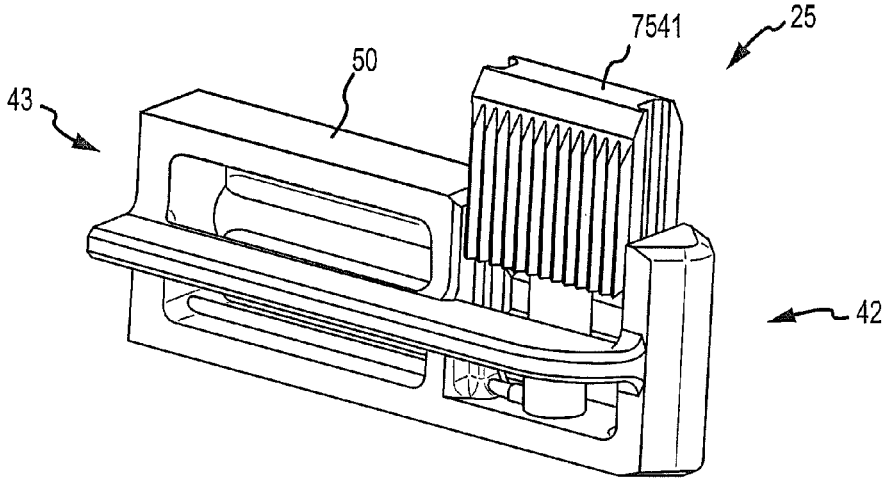


FIG.136D

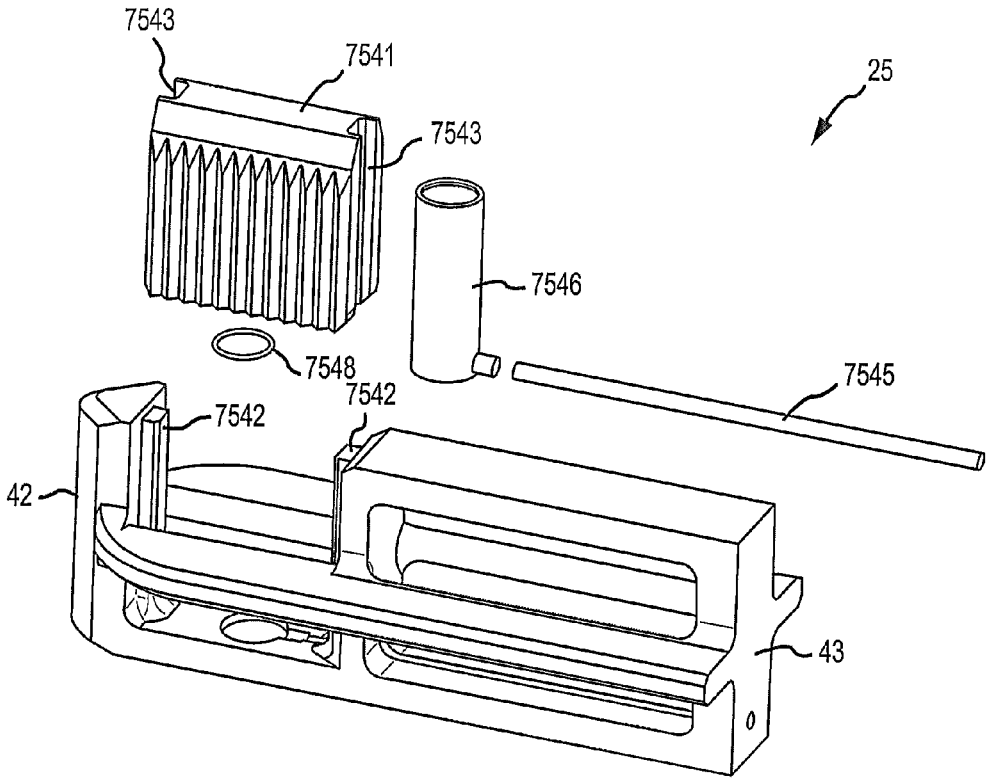


FIG.136E

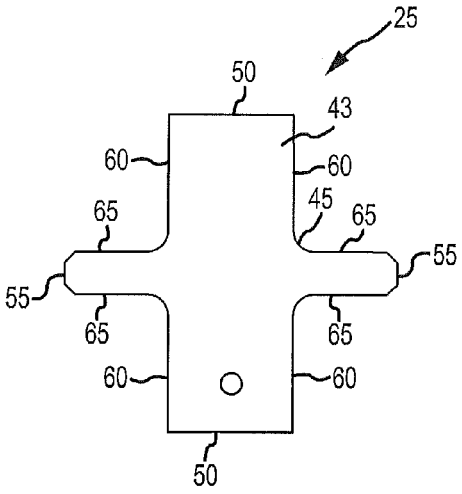


FIG.136F

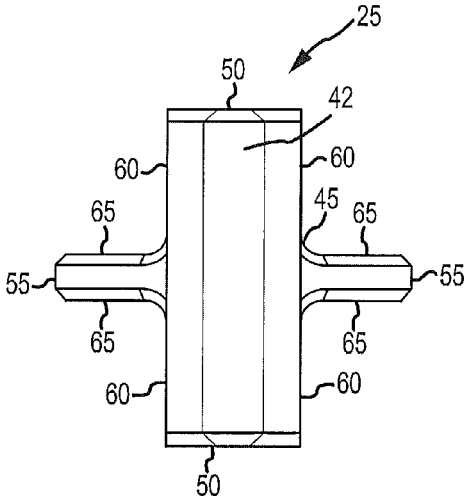


FIG.136G

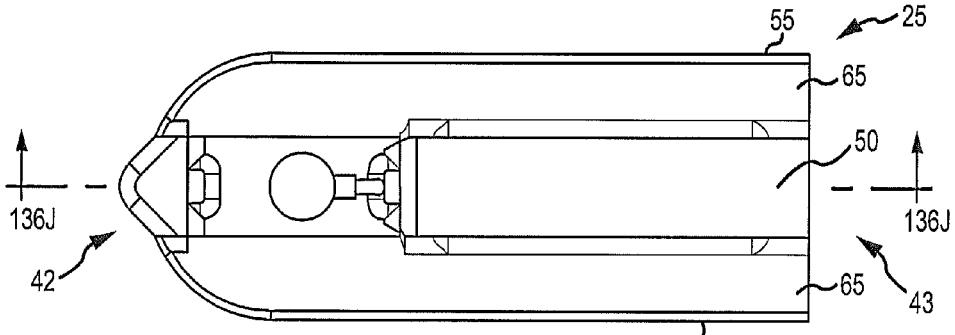


FIG.136H

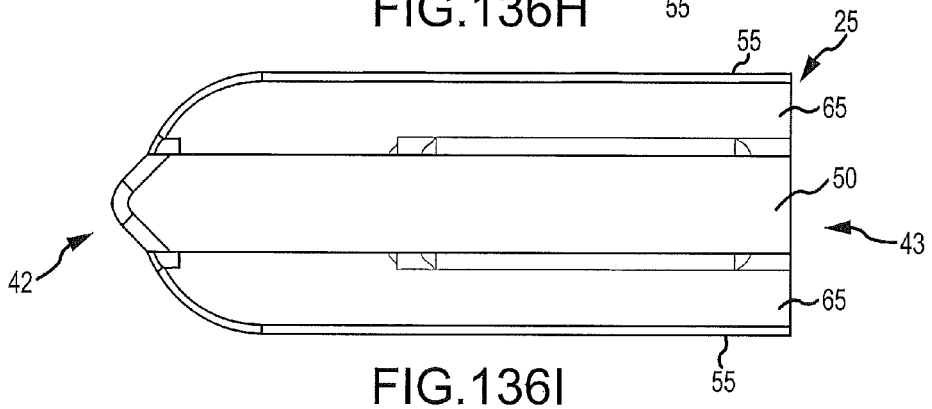


FIG.136I

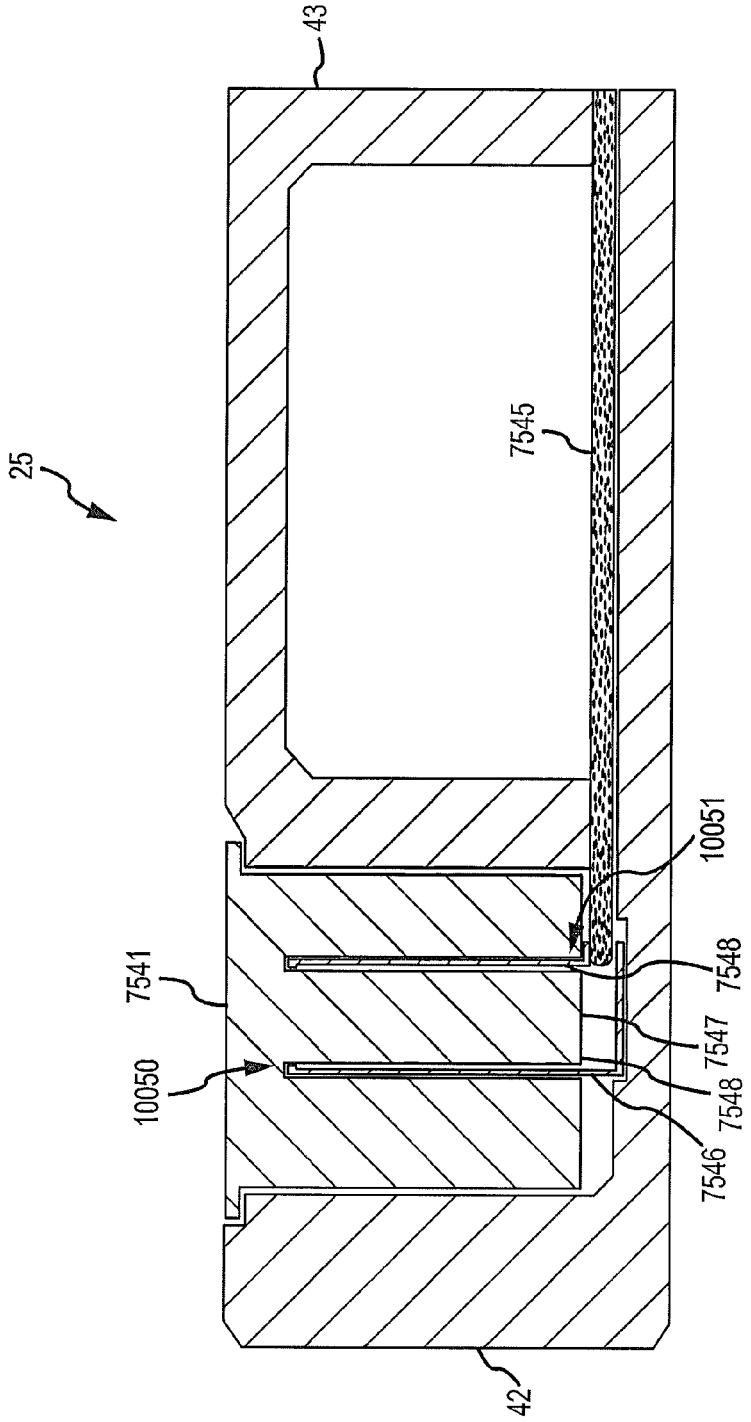


FIG.136J

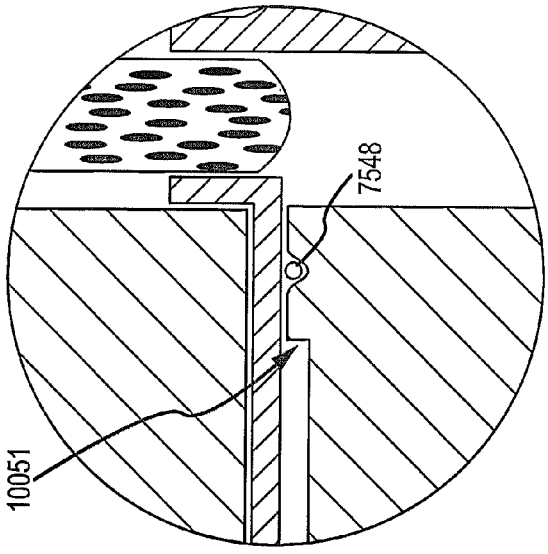


FIG.136L

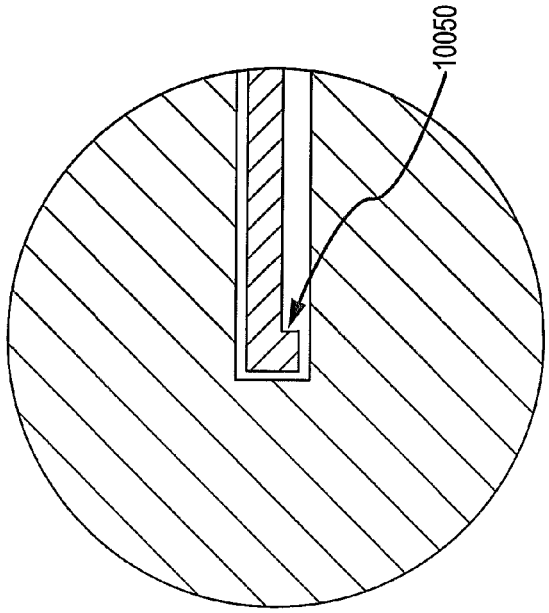


FIG.136K

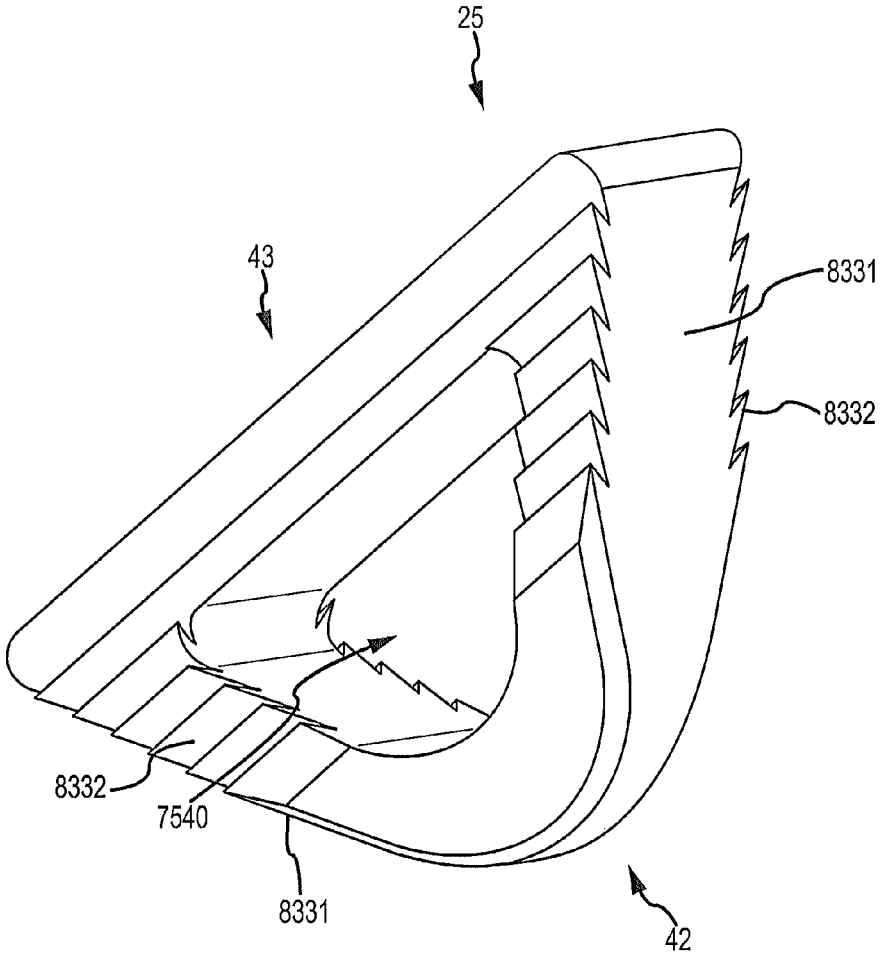


FIG.137A

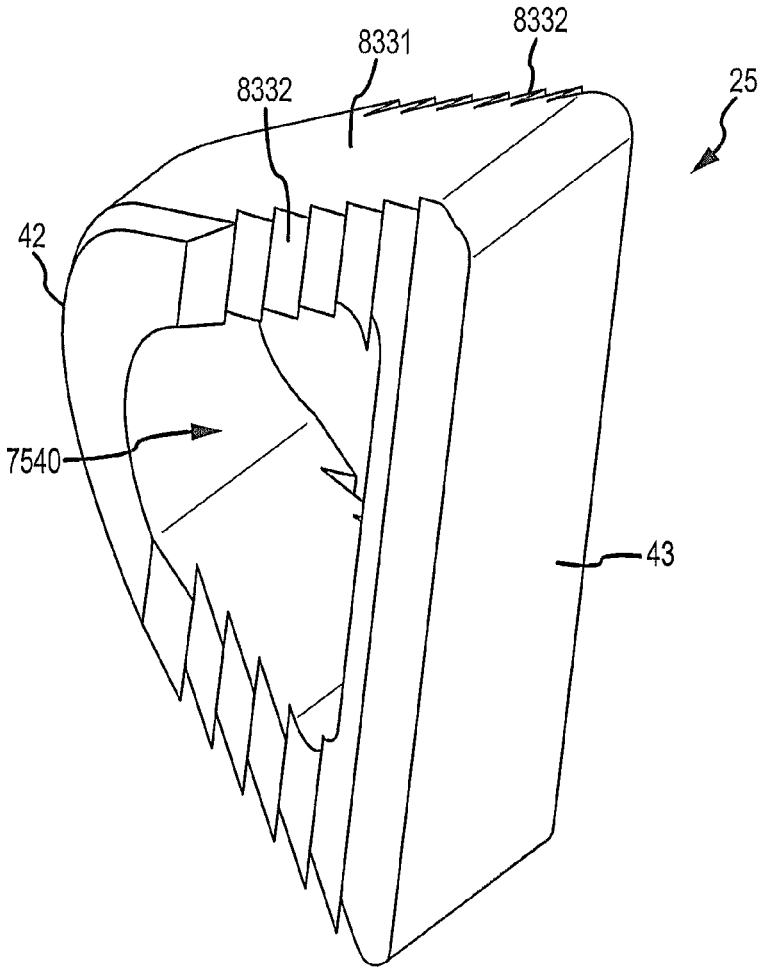


FIG.137B

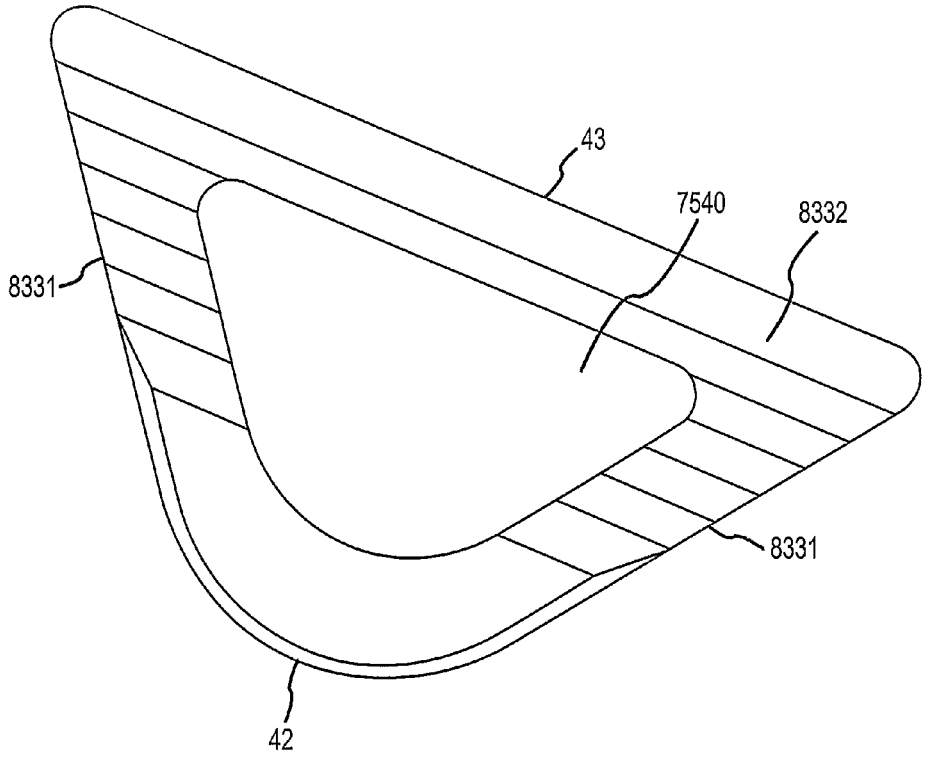


FIG.137C

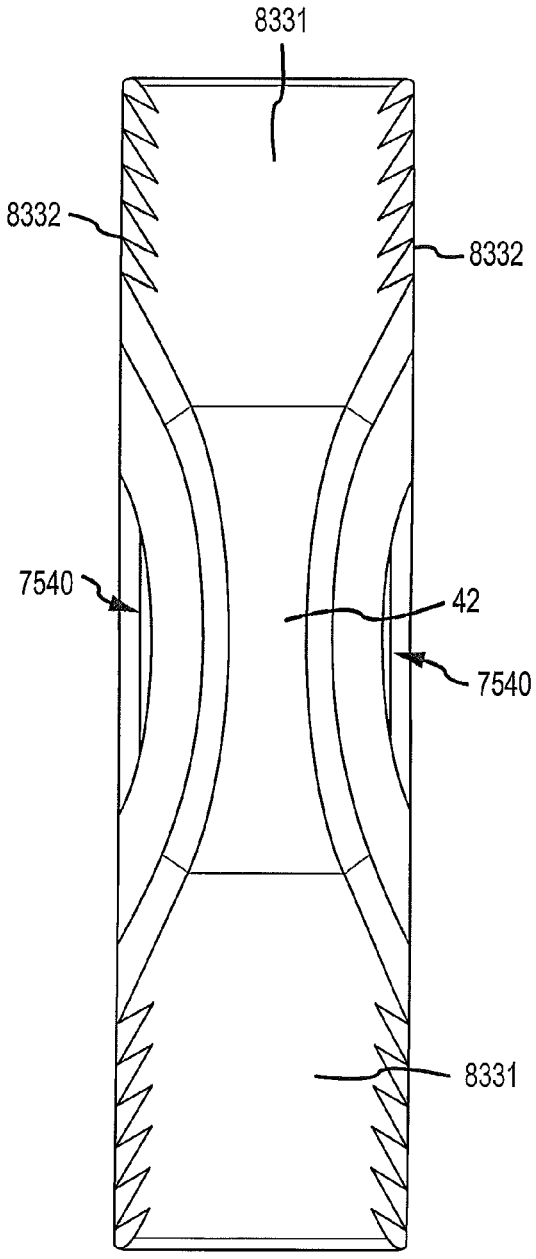


FIG.137D

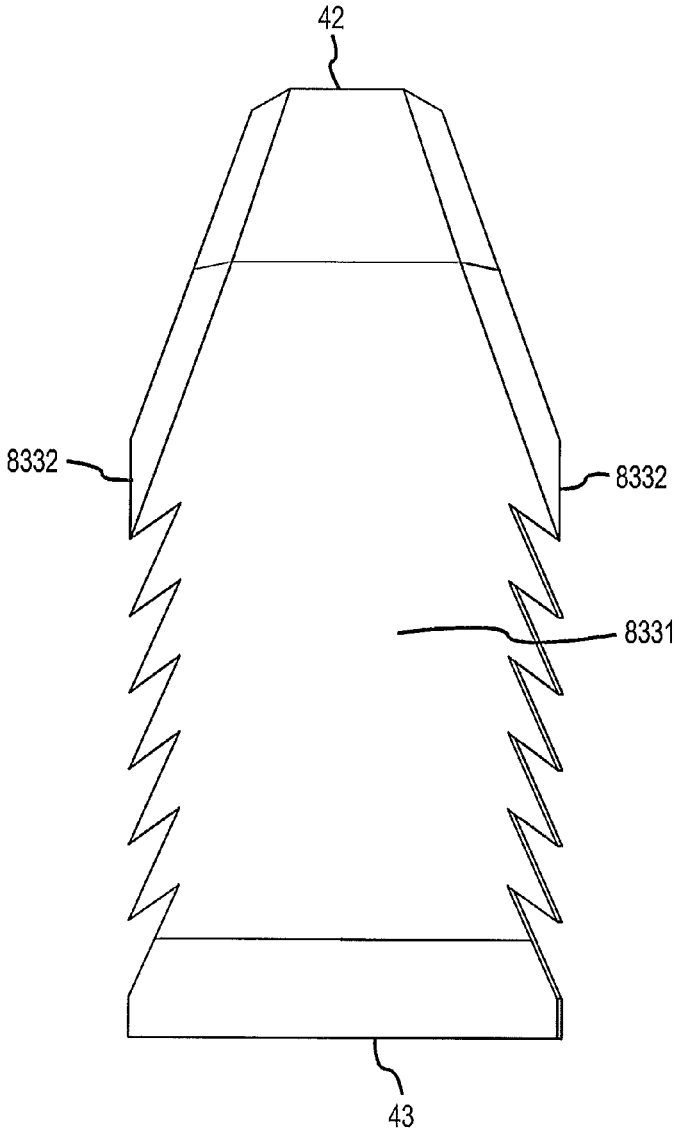


FIG.137E

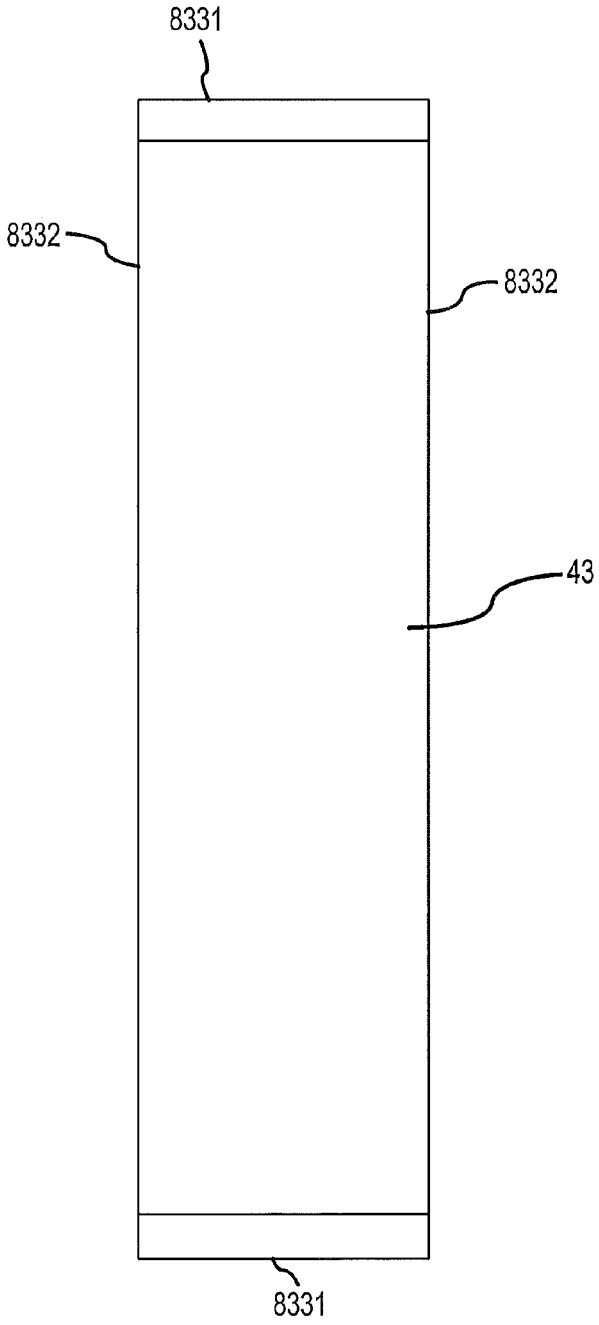


FIG.137F

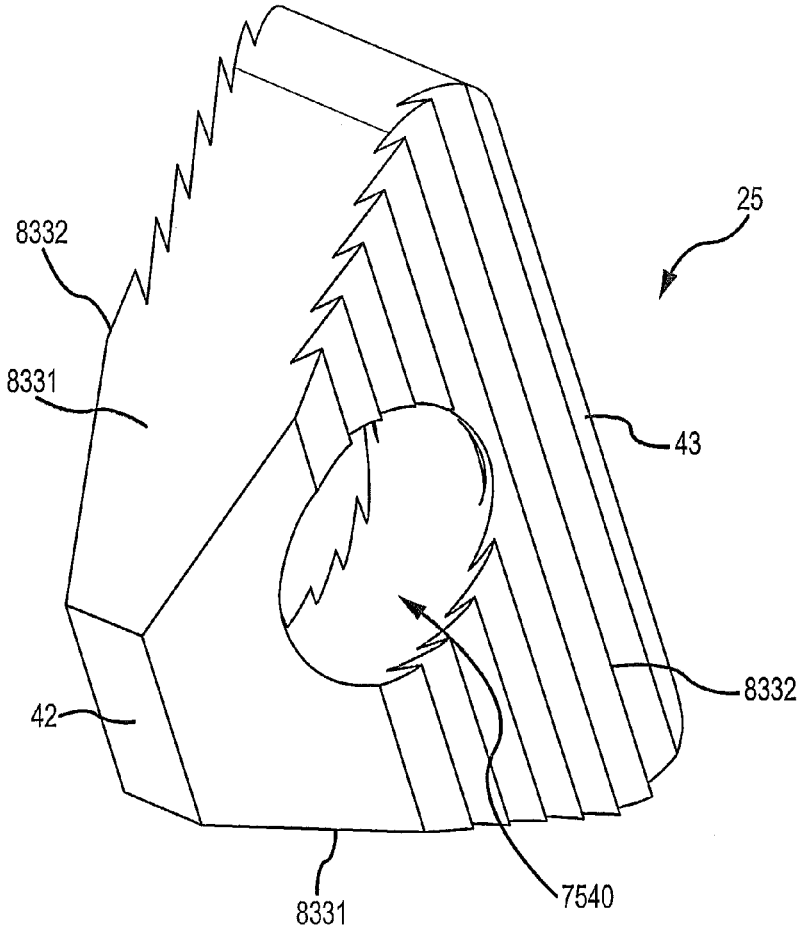


FIG.138A

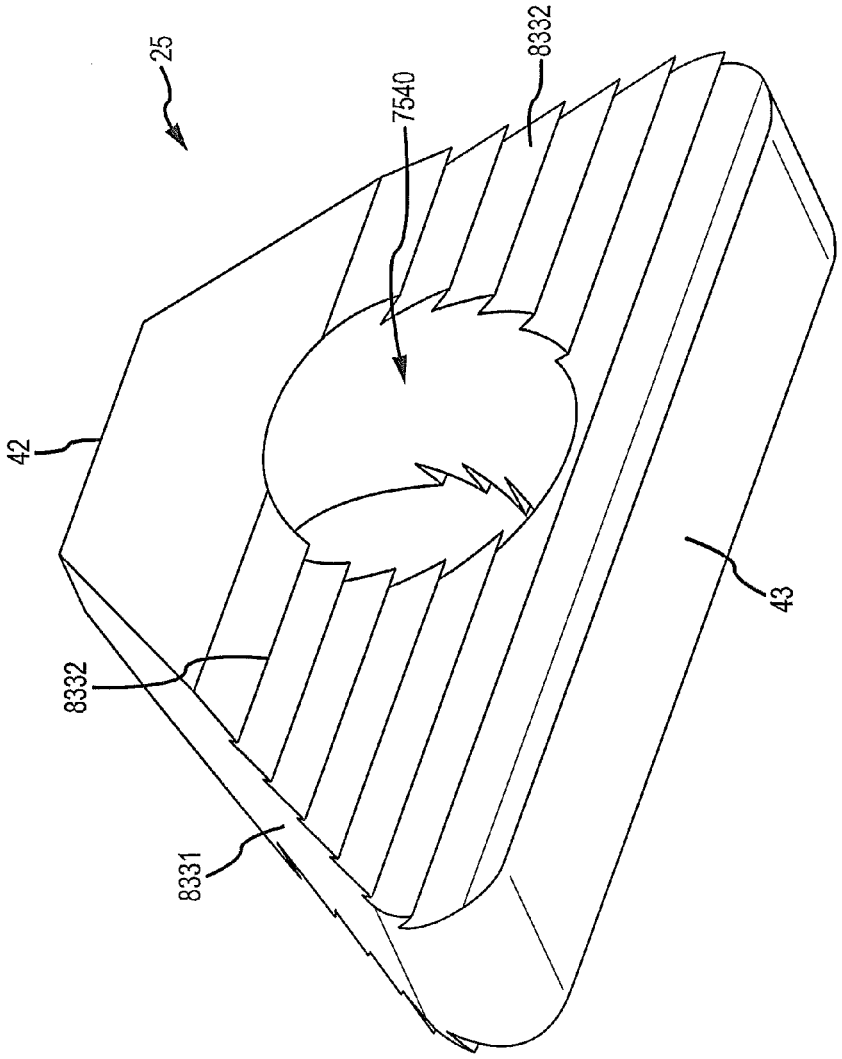


FIG.138B

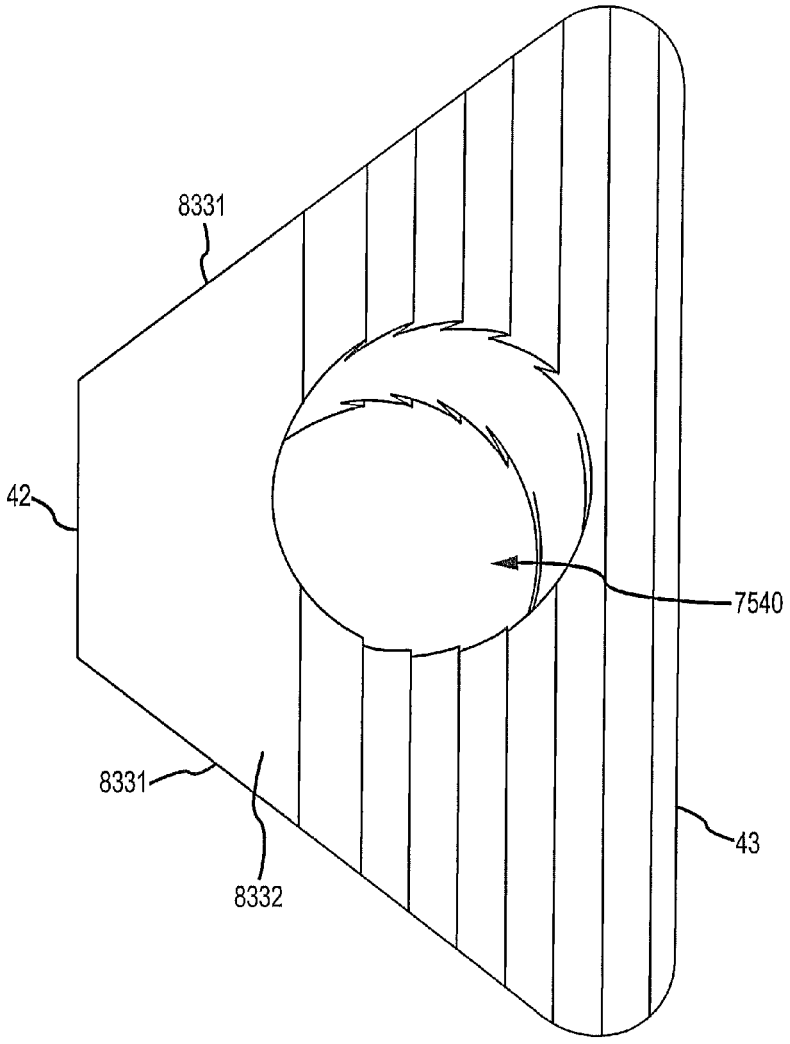


FIG.138C

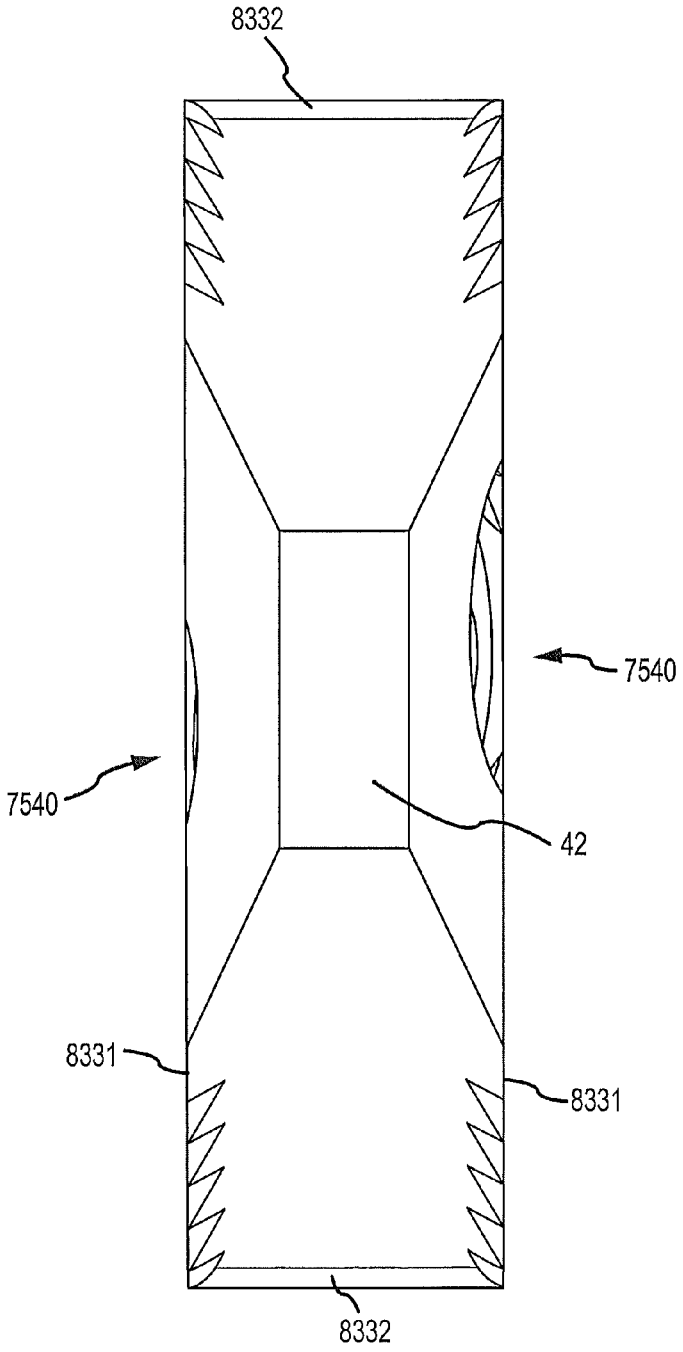


FIG.138D

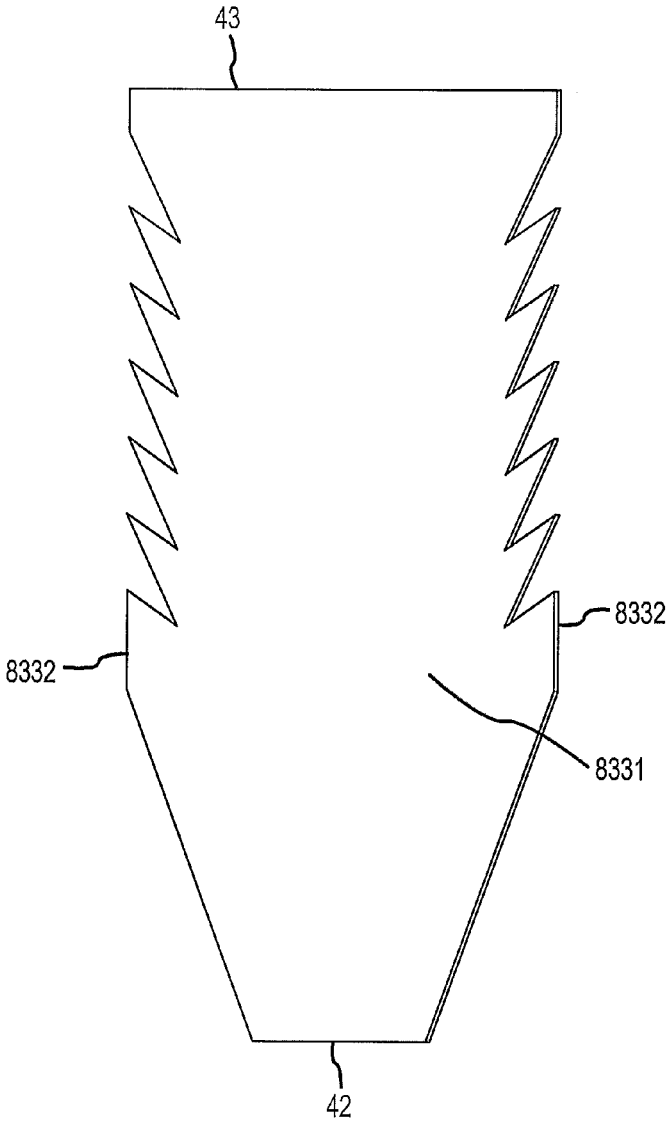


FIG.138E

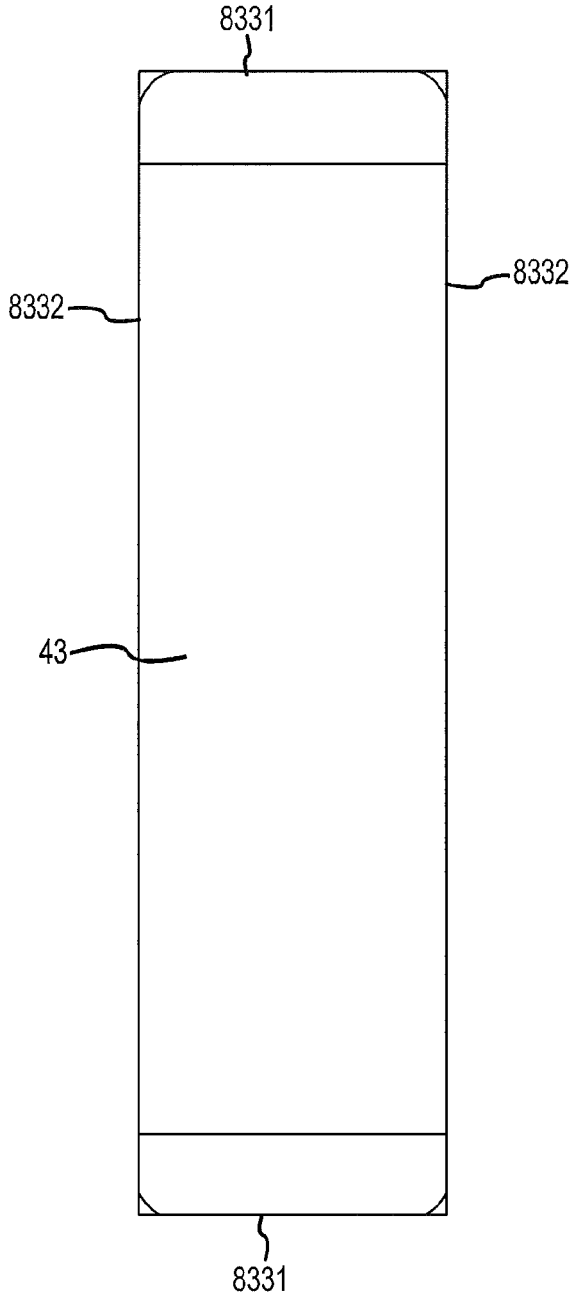


FIG.138F

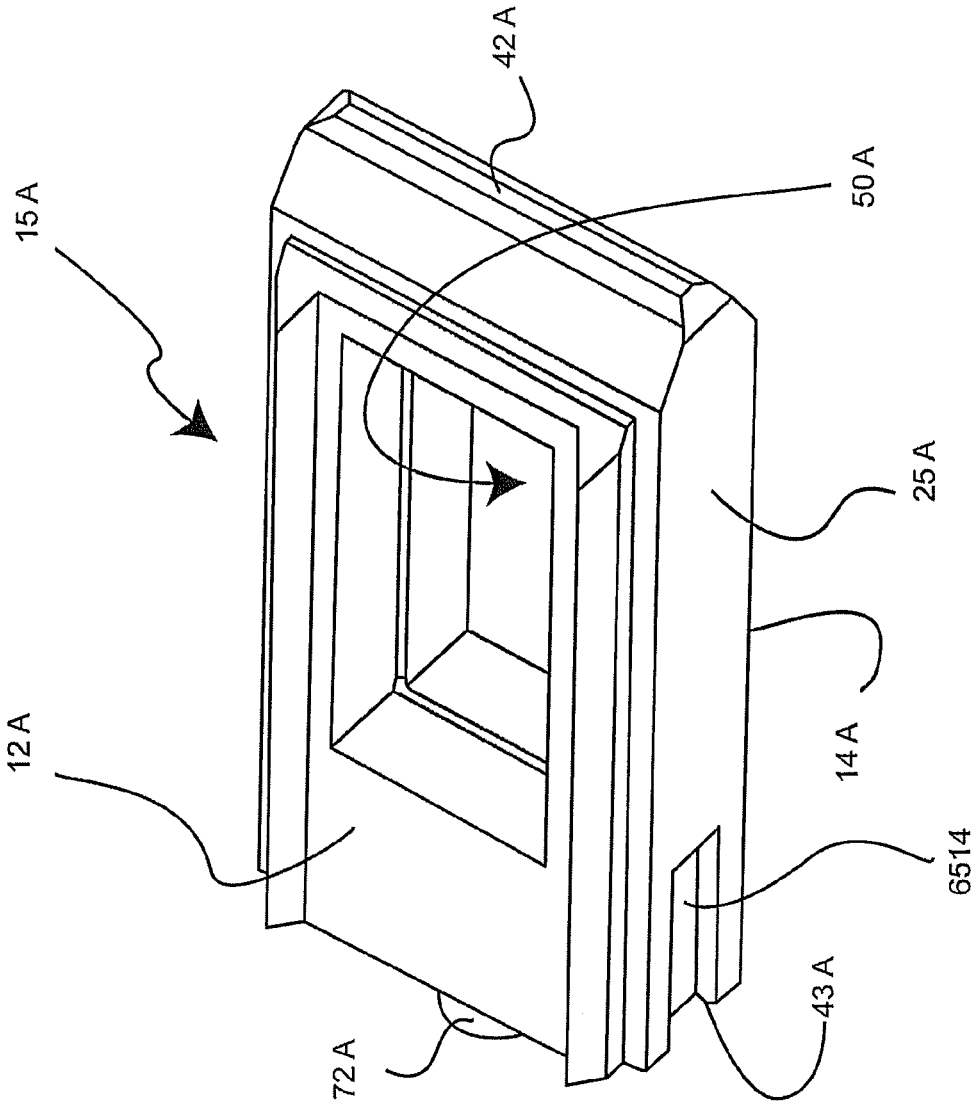


FIG. 139

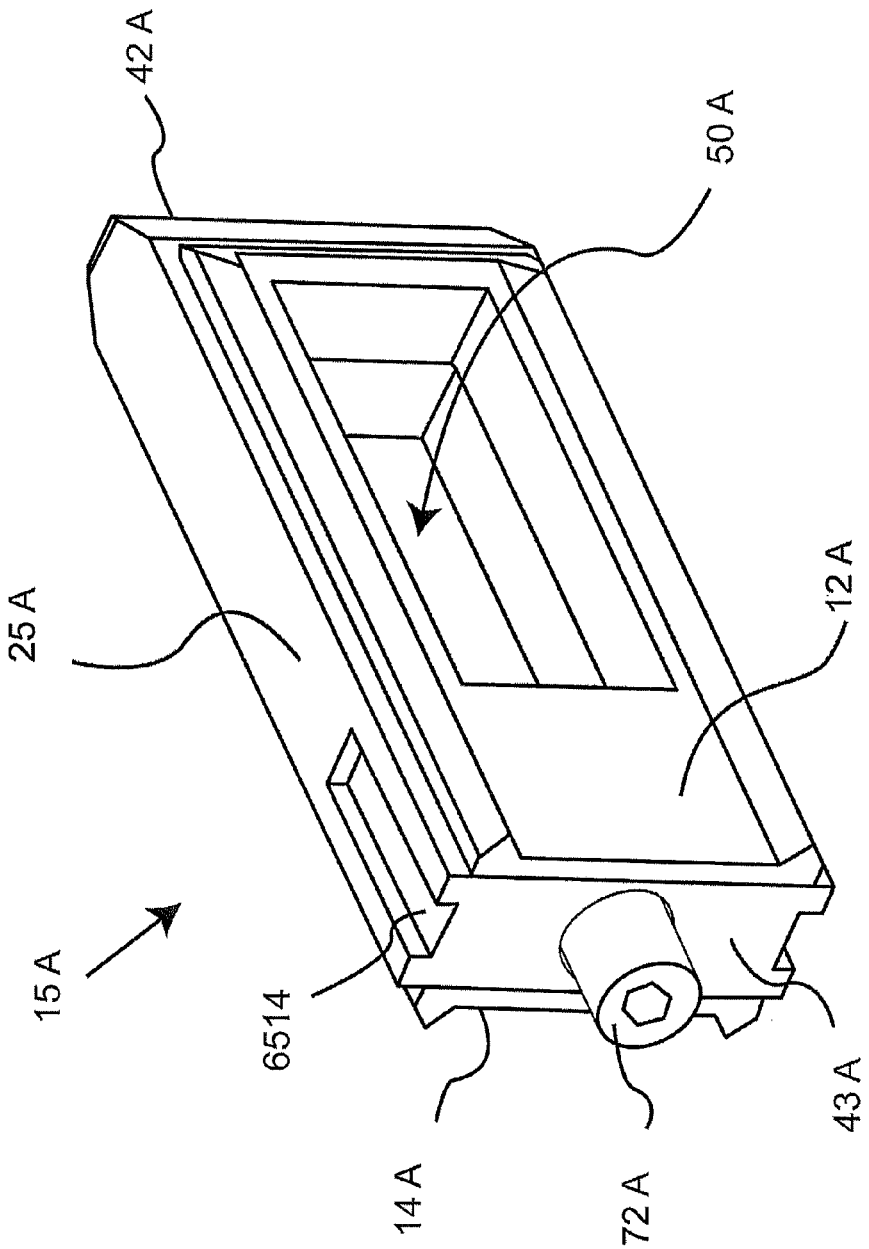


FIG. 140

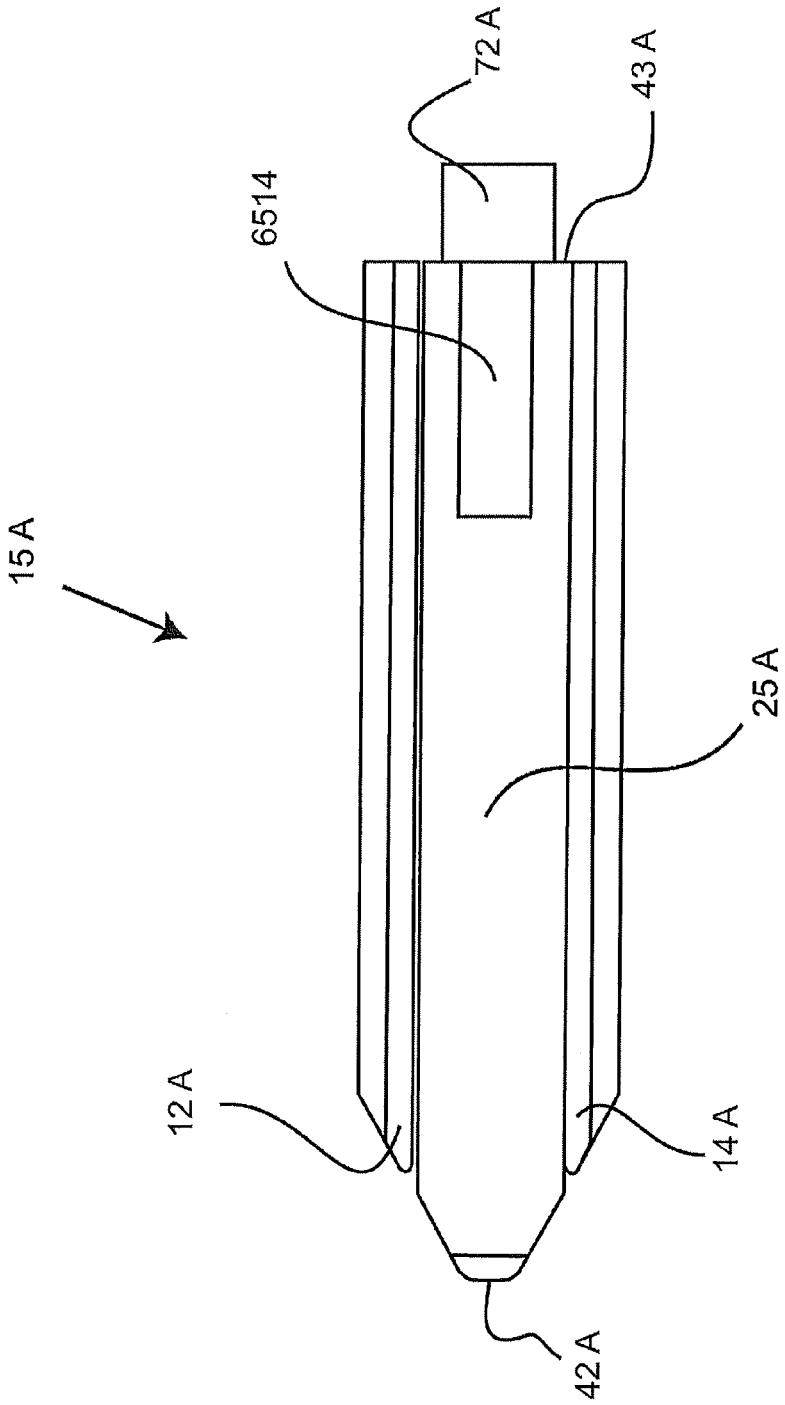


FIG. 141

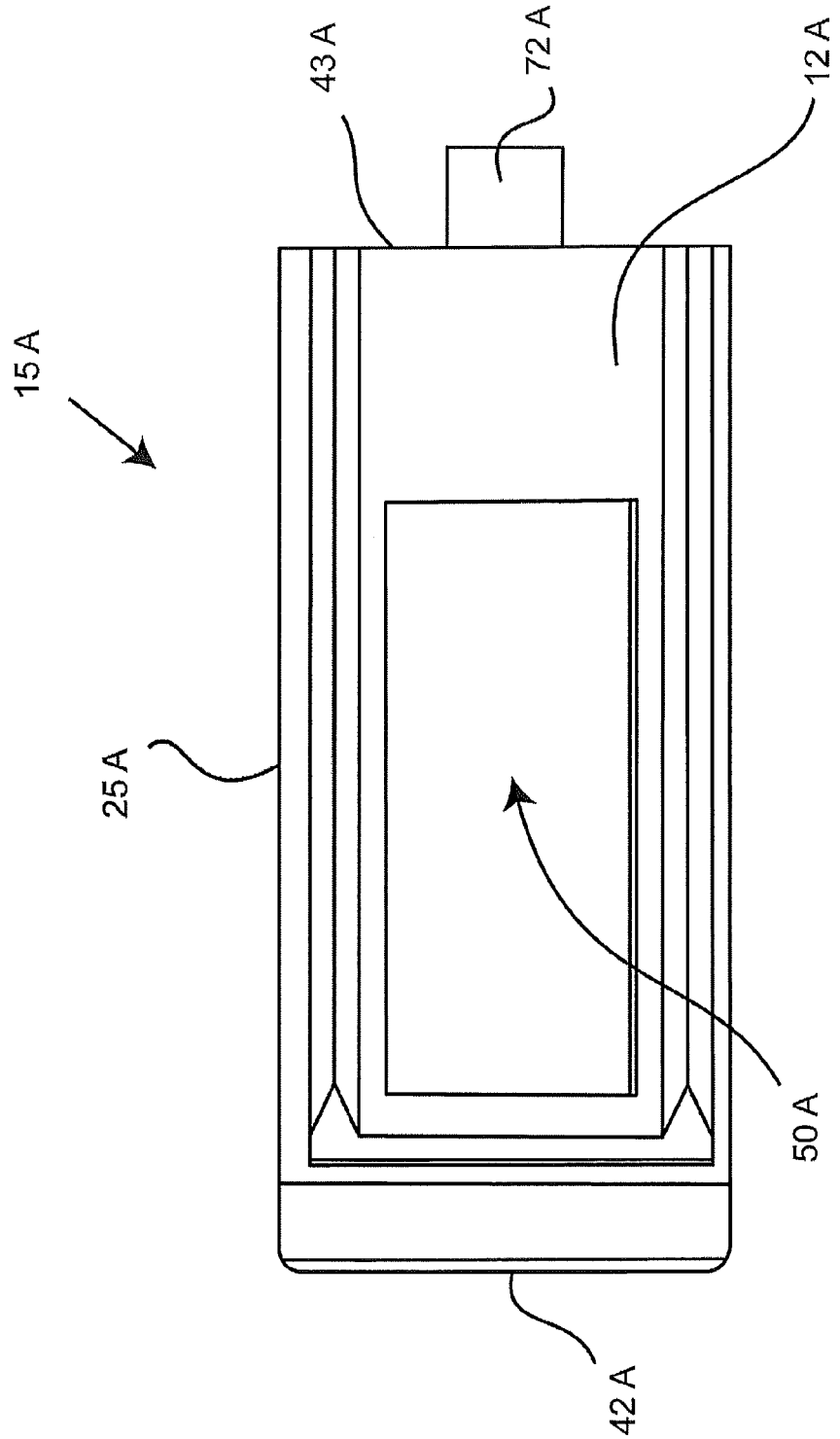


FIG. 142

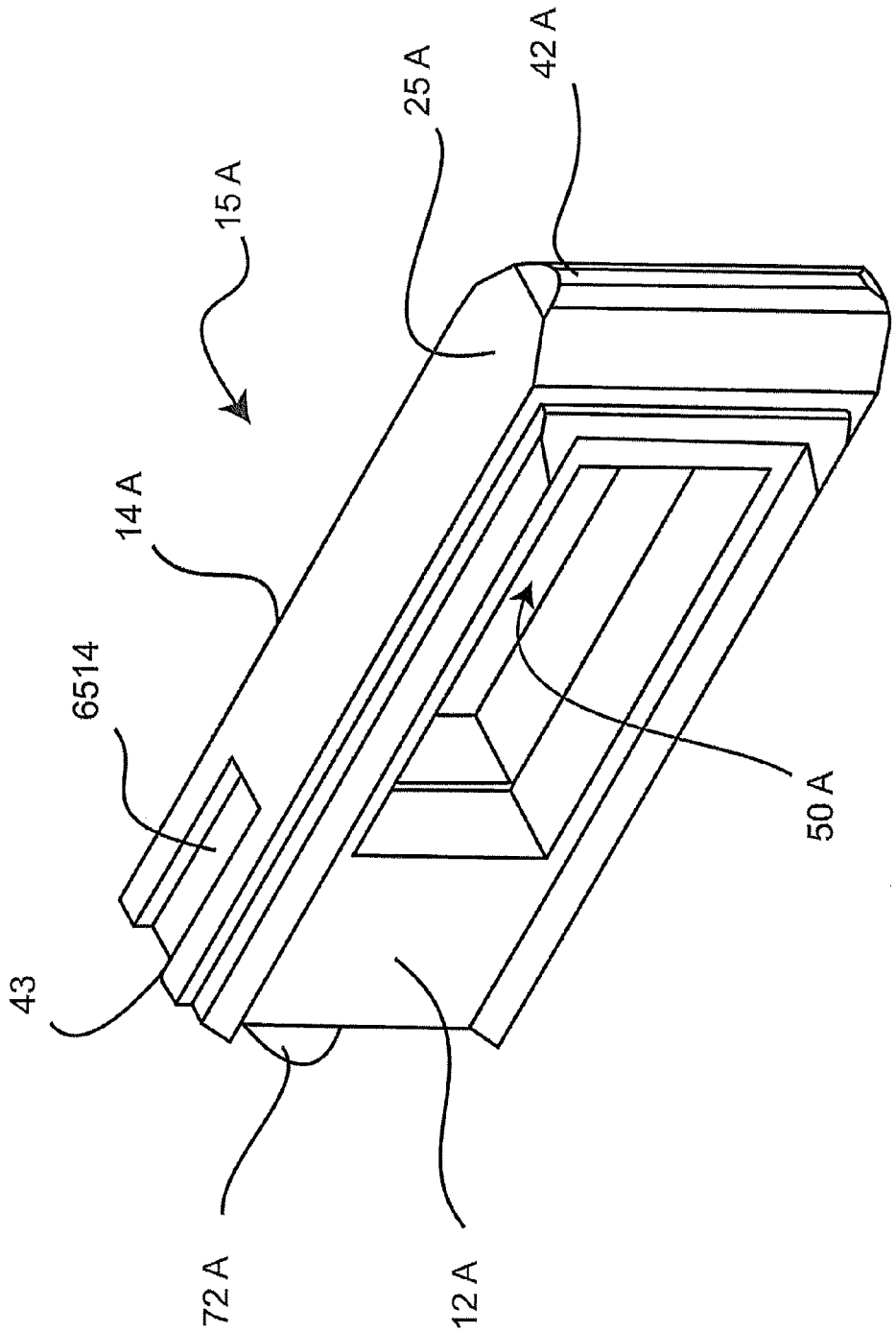


FIG. 143

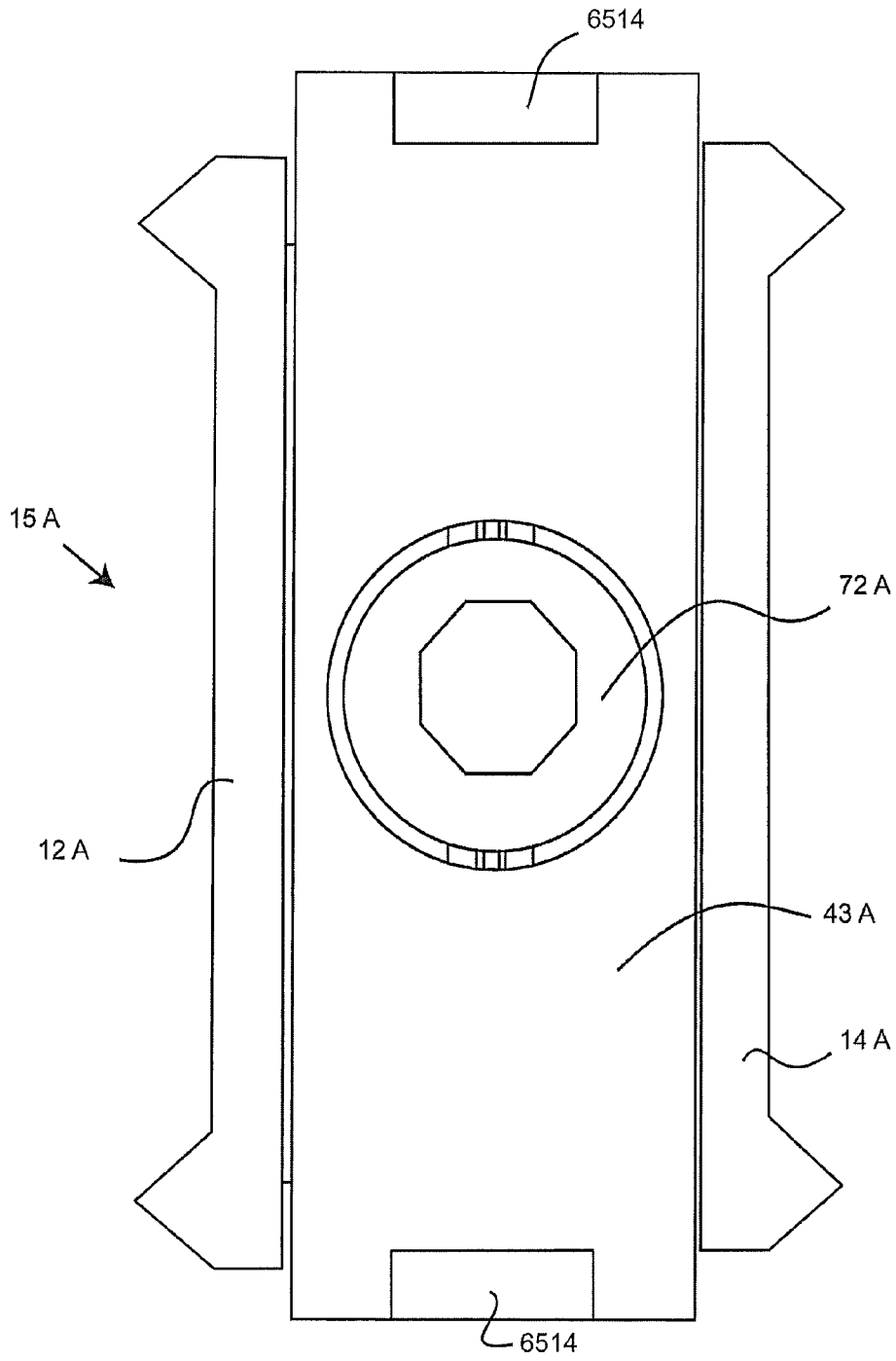


FIG. 144

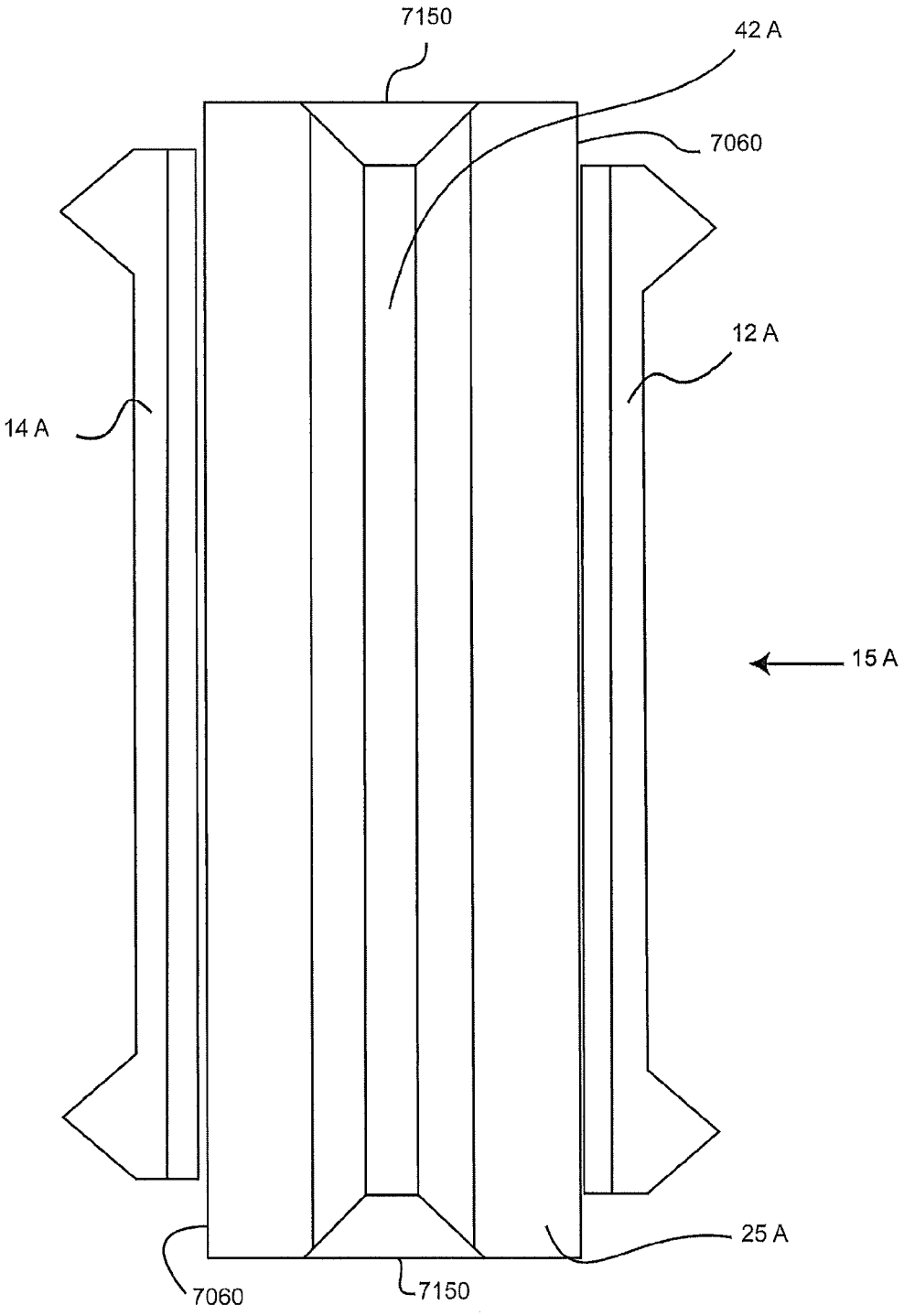
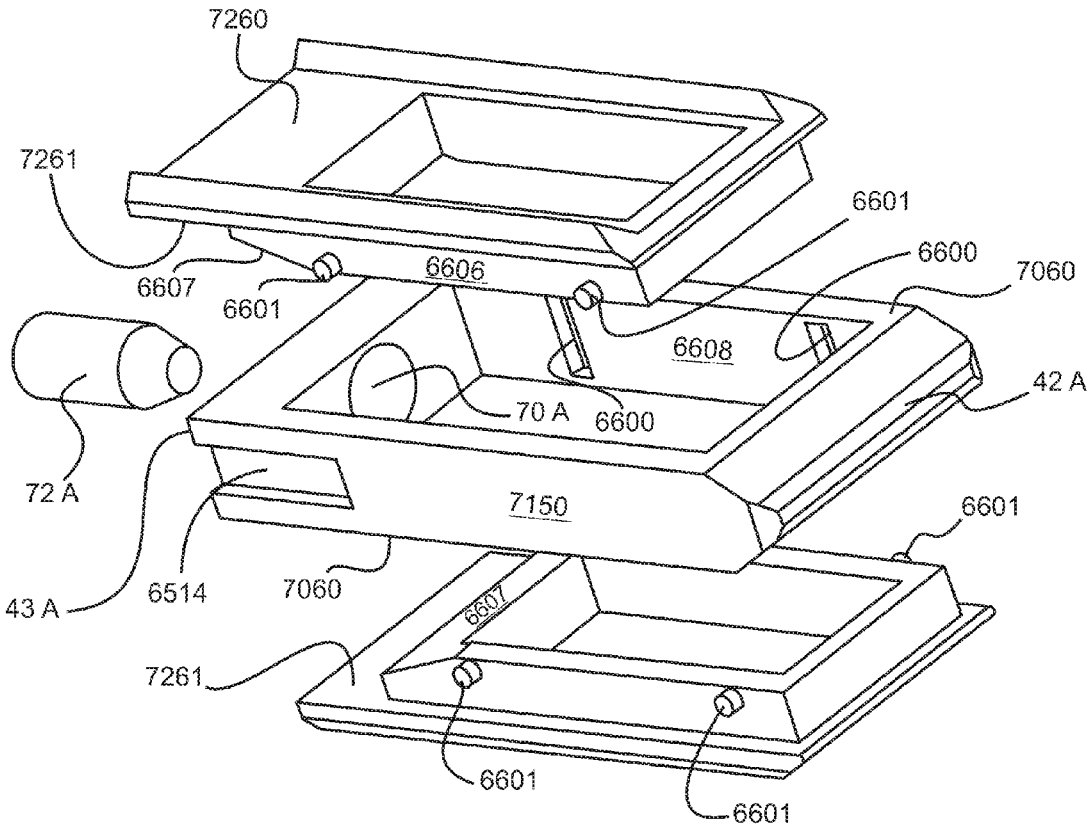


FIG. 145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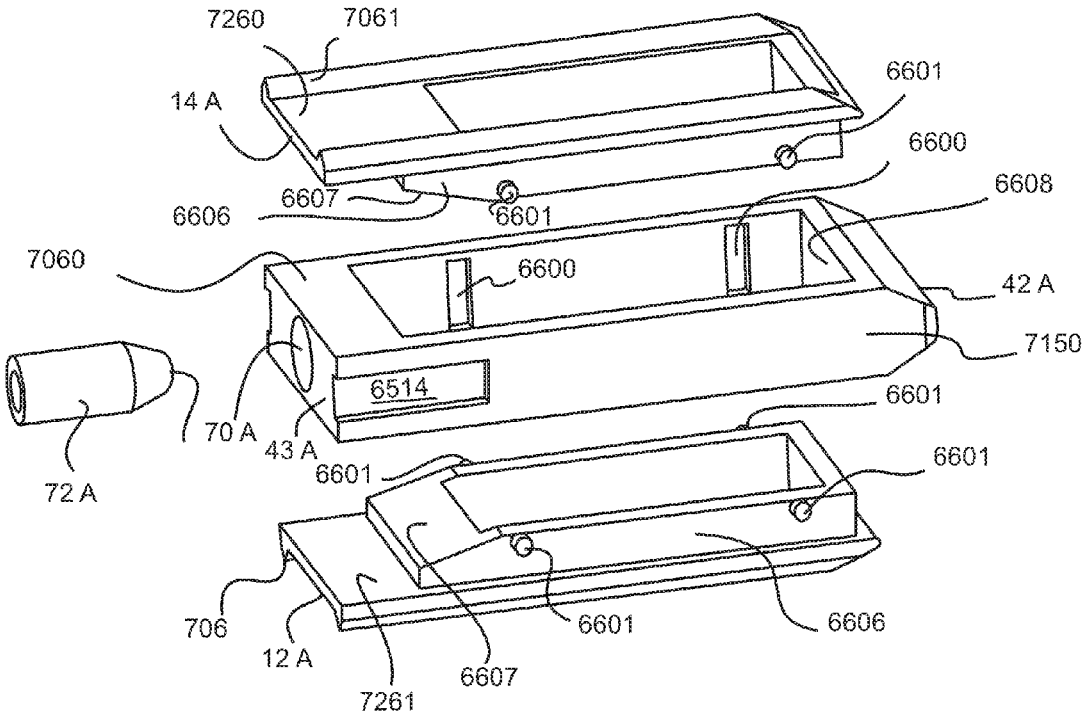
7060
6607
7261
6601
6601

FIG. 146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6606
6607
6601
7060
6600
42 A
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70 A
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6601
72 A
706
12 A
7261
6607
6601
6606

FIG. 147

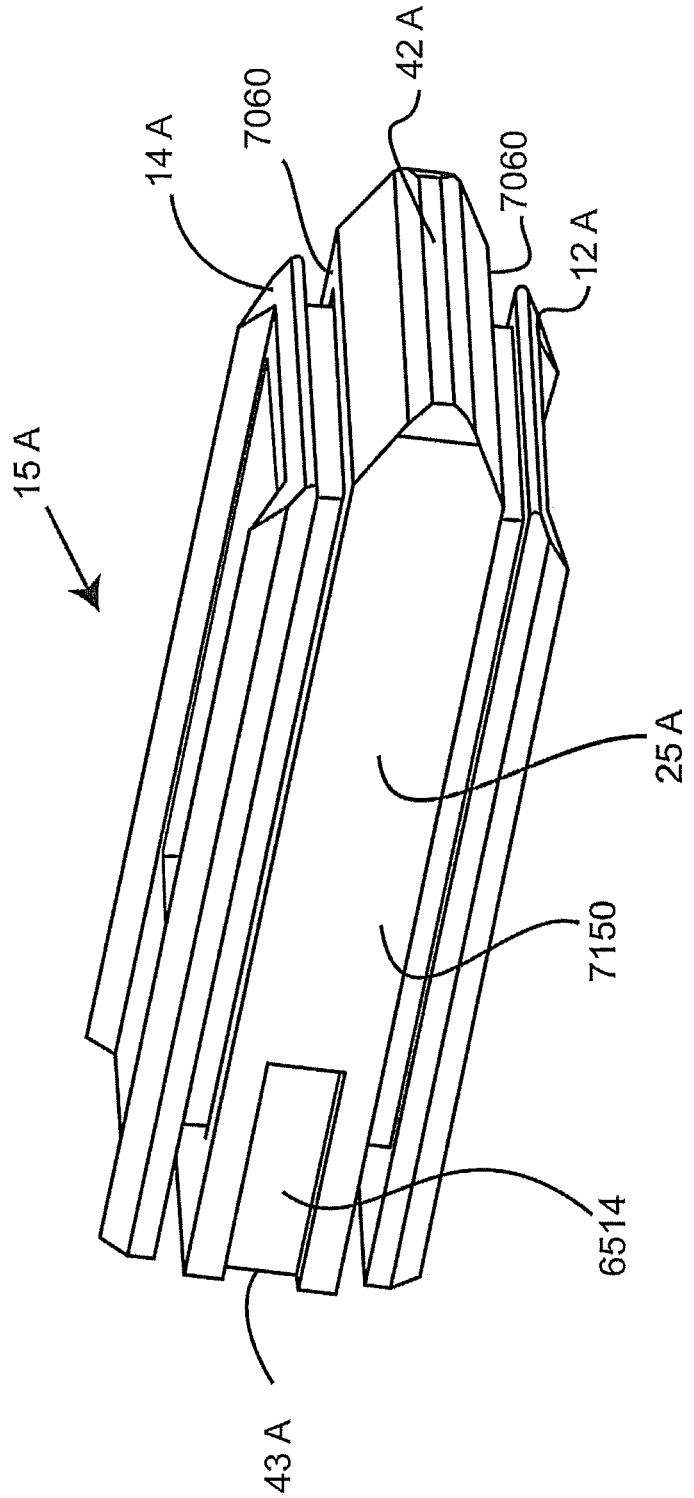


FIG. 148

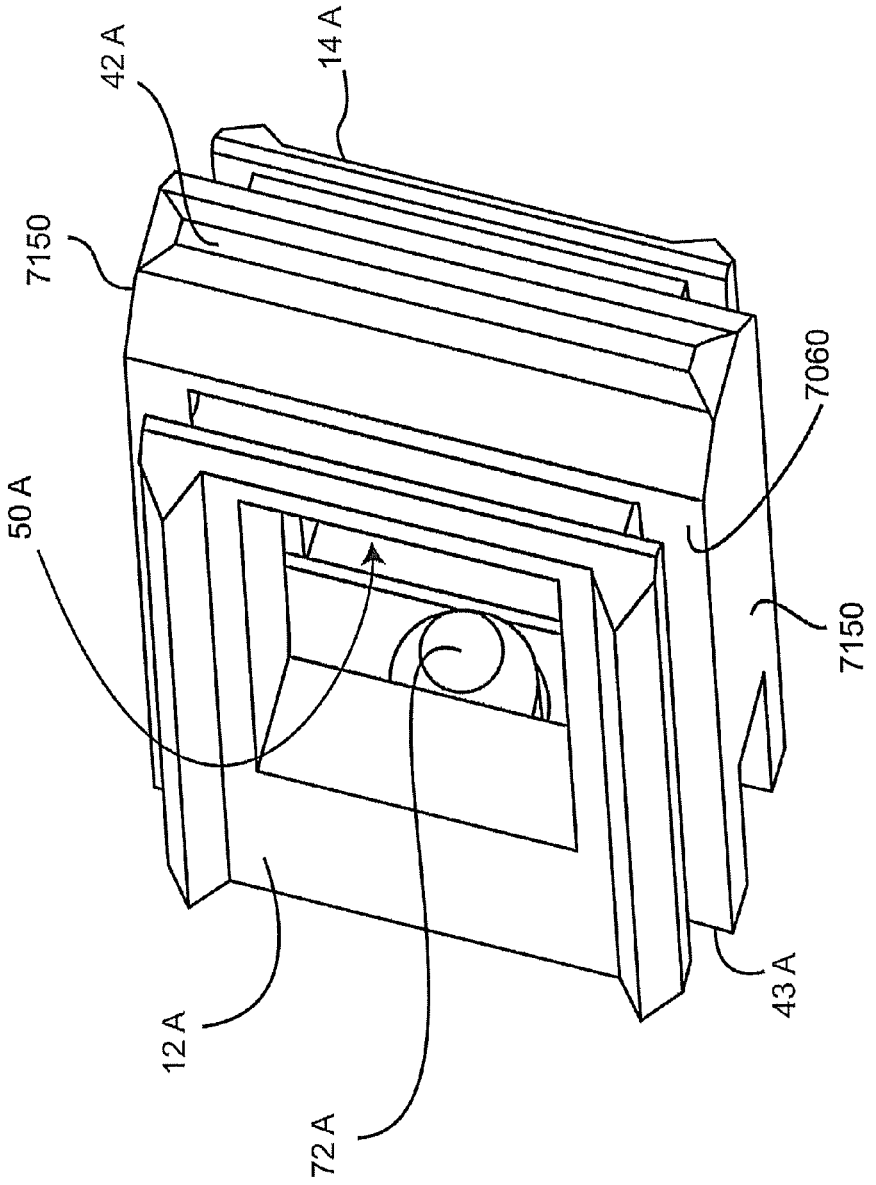


FIG. 149

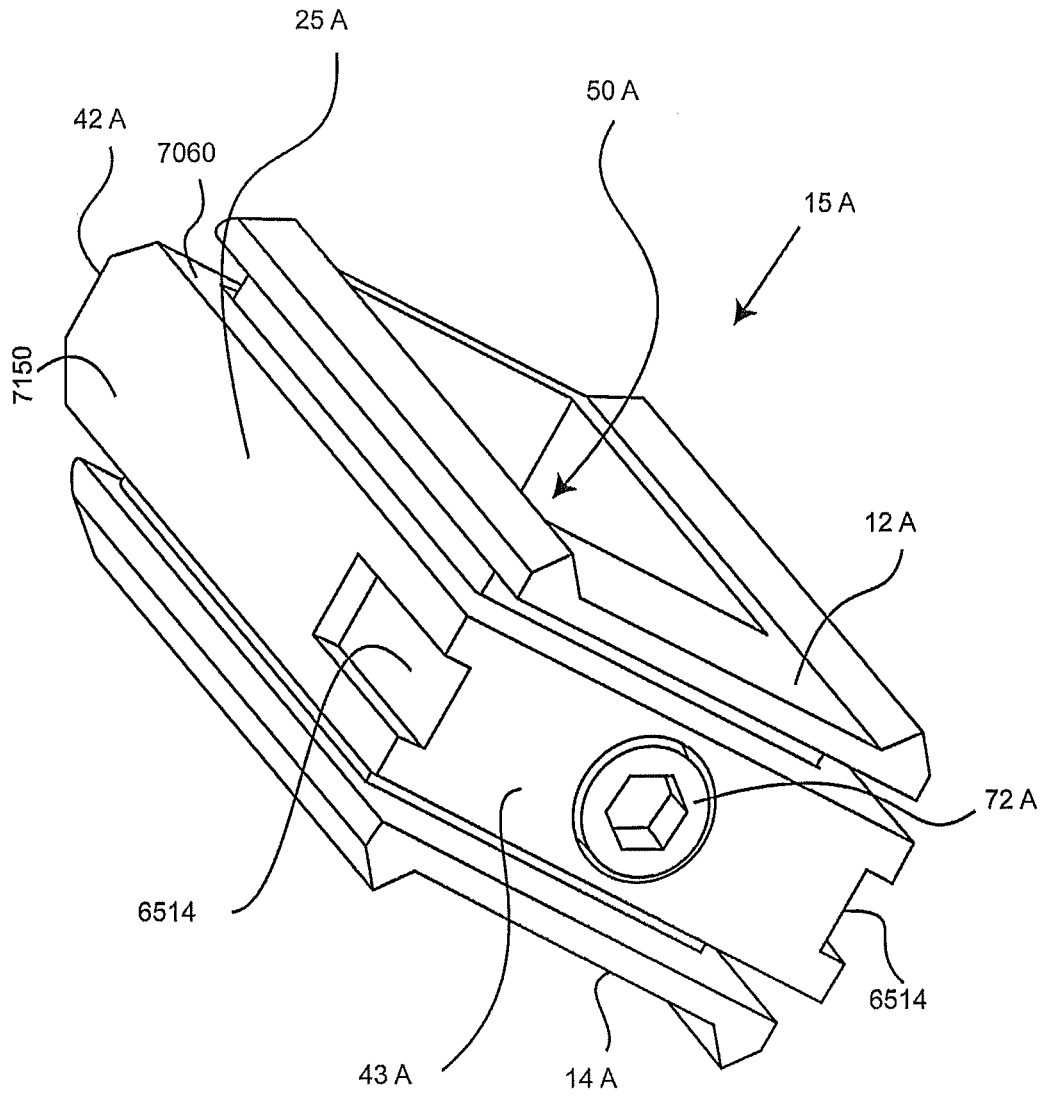


FIG. 150

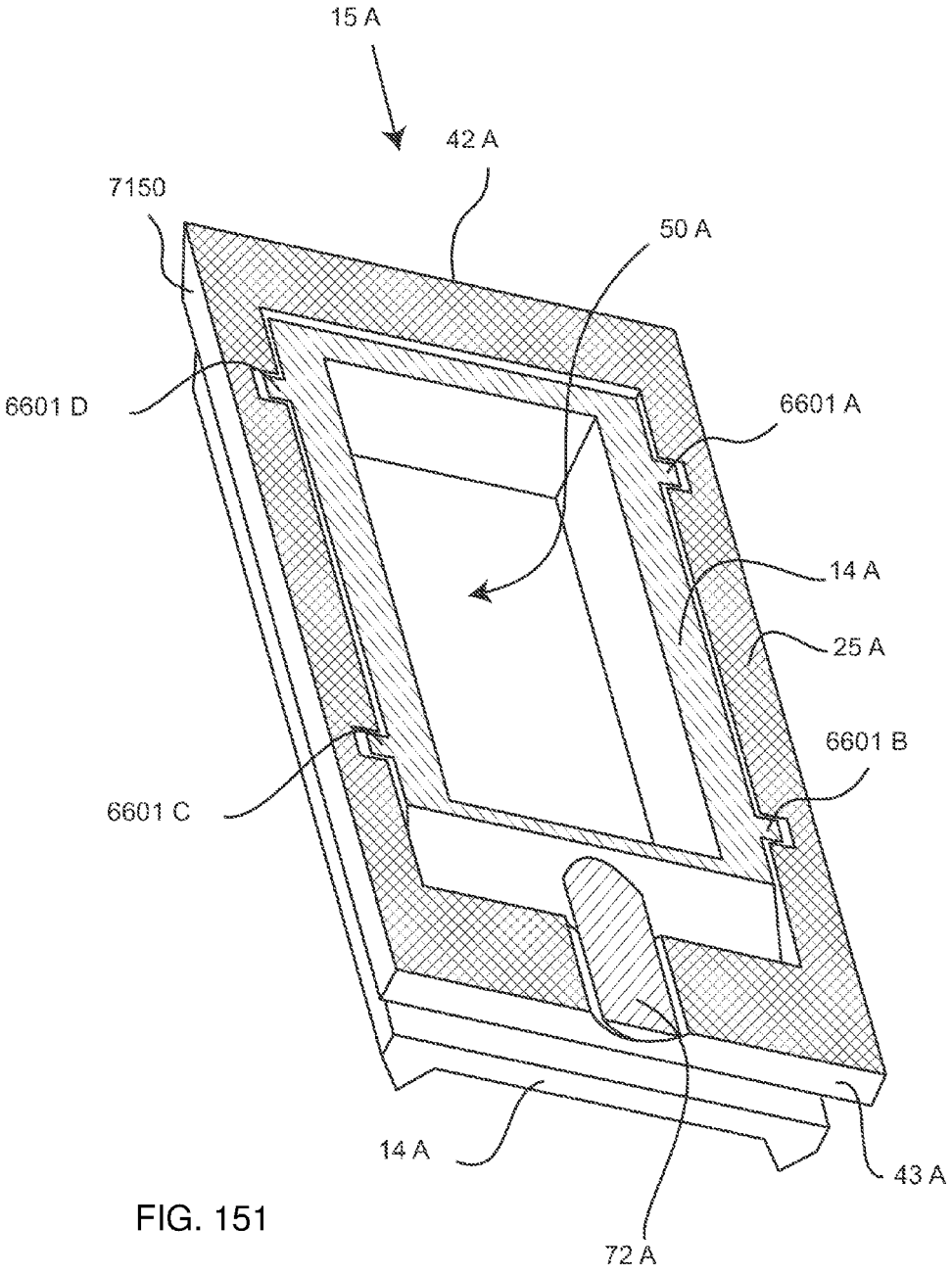


FIG. 151

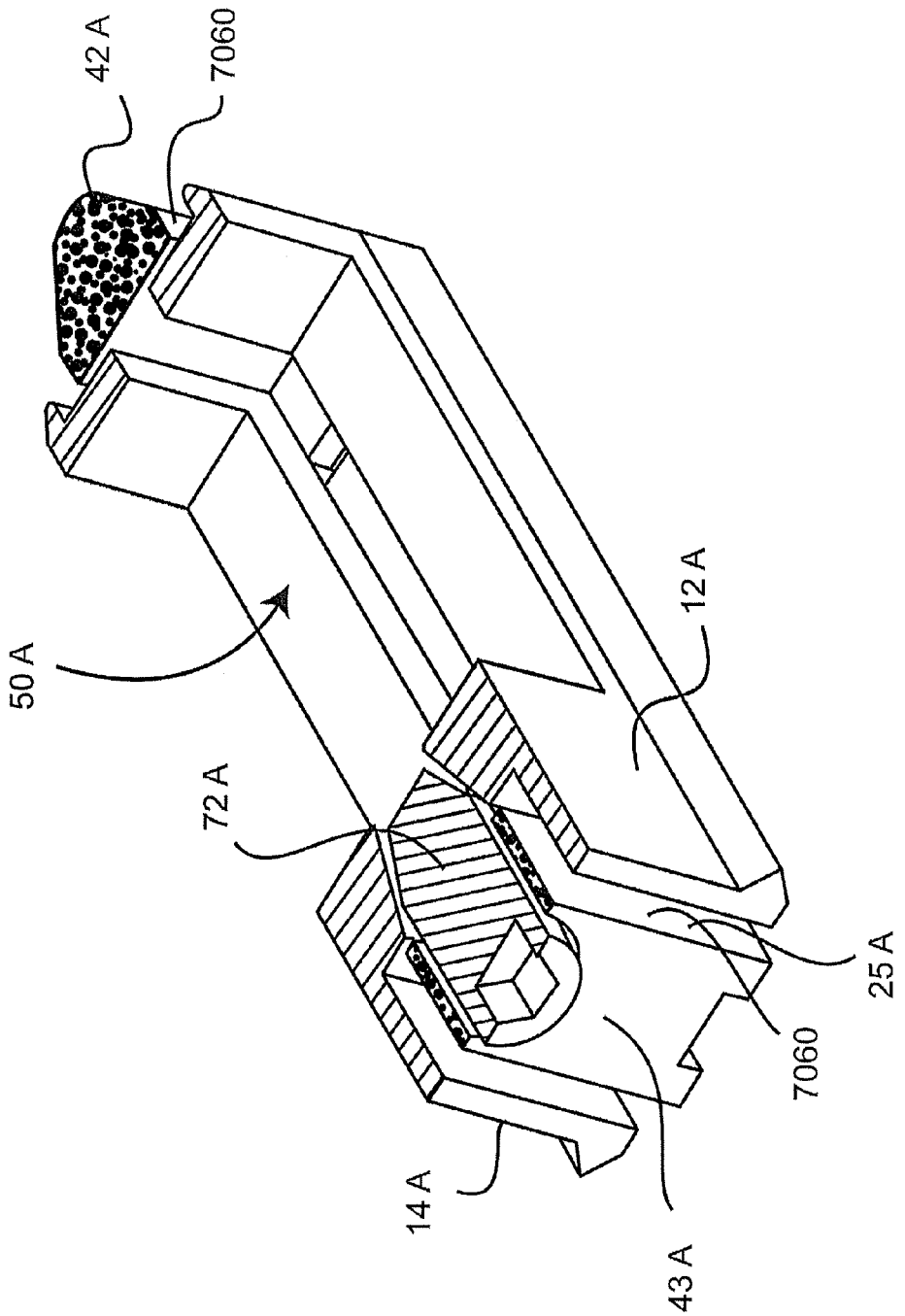
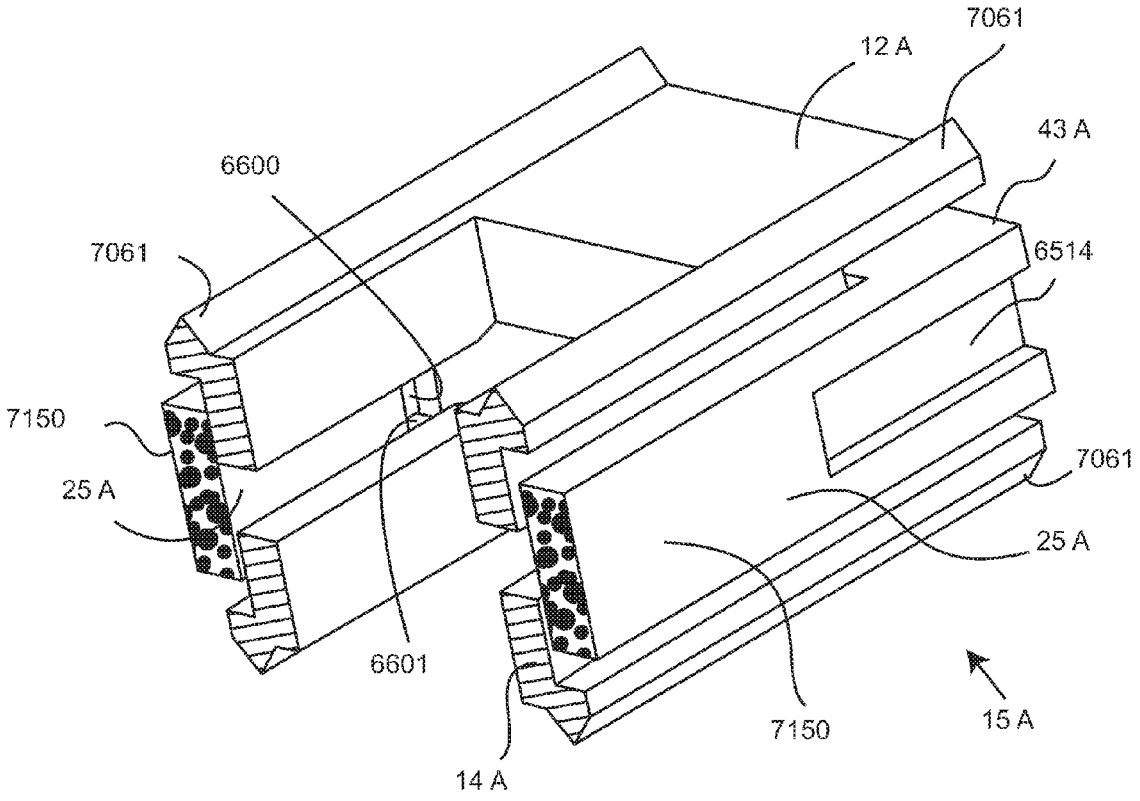


FIG. 152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25 A
7061
25 A
6601
7150
15 A
14 A

FIG. 153

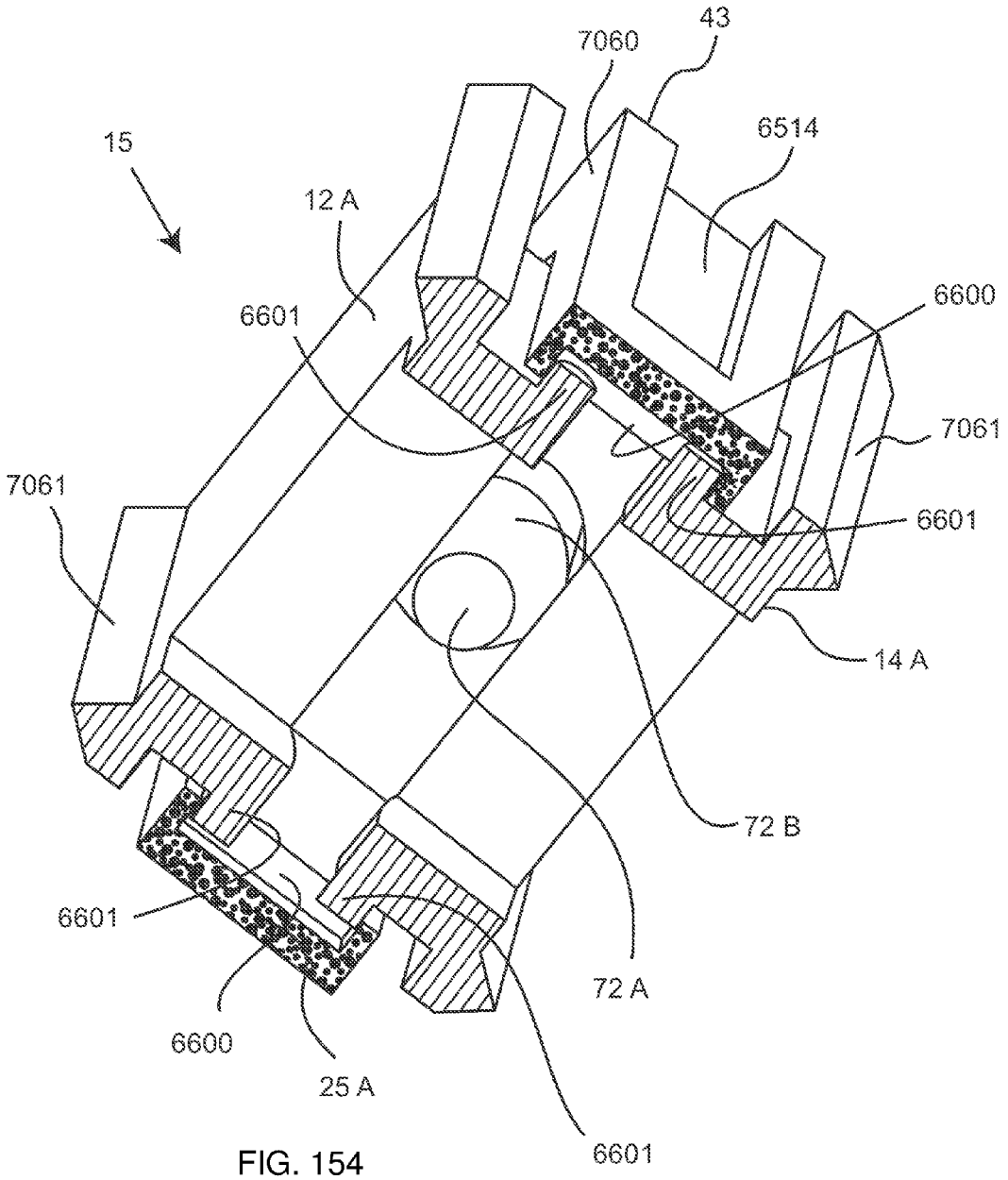
43
7060
6514
15
12 A
6601
6600
7061
7061
6601
14 A
72 B
6601
72 A
6600
25 A
6601

FIG. 154

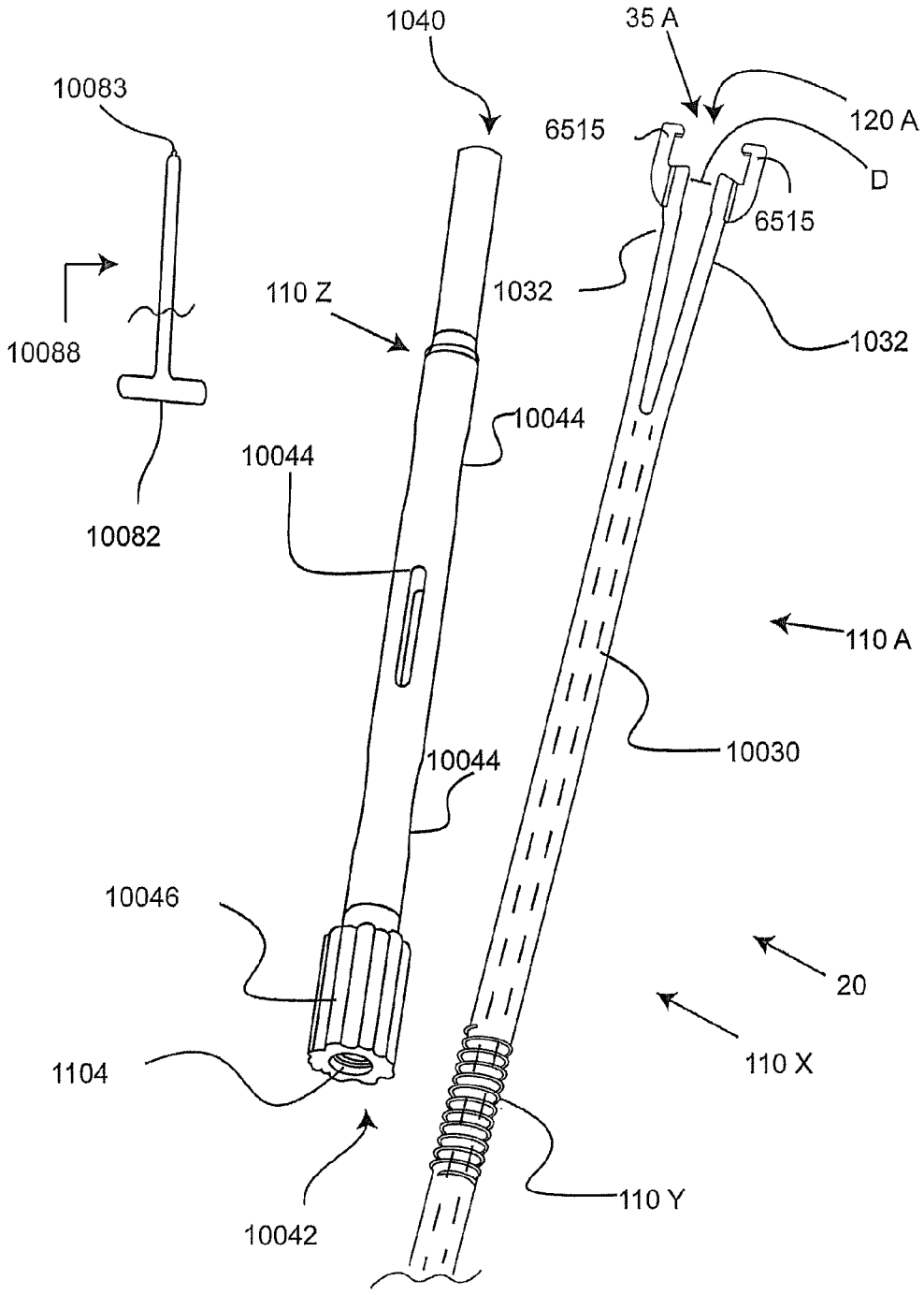
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FIG. 155

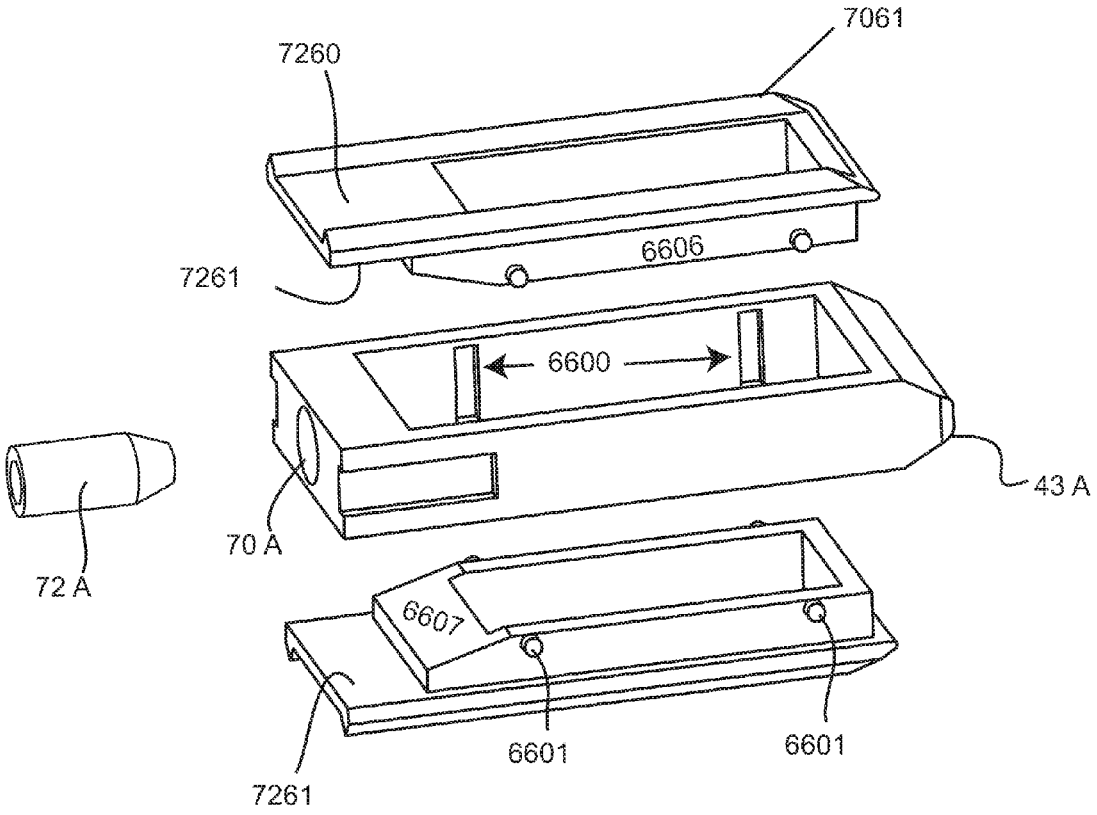


FIG. 156

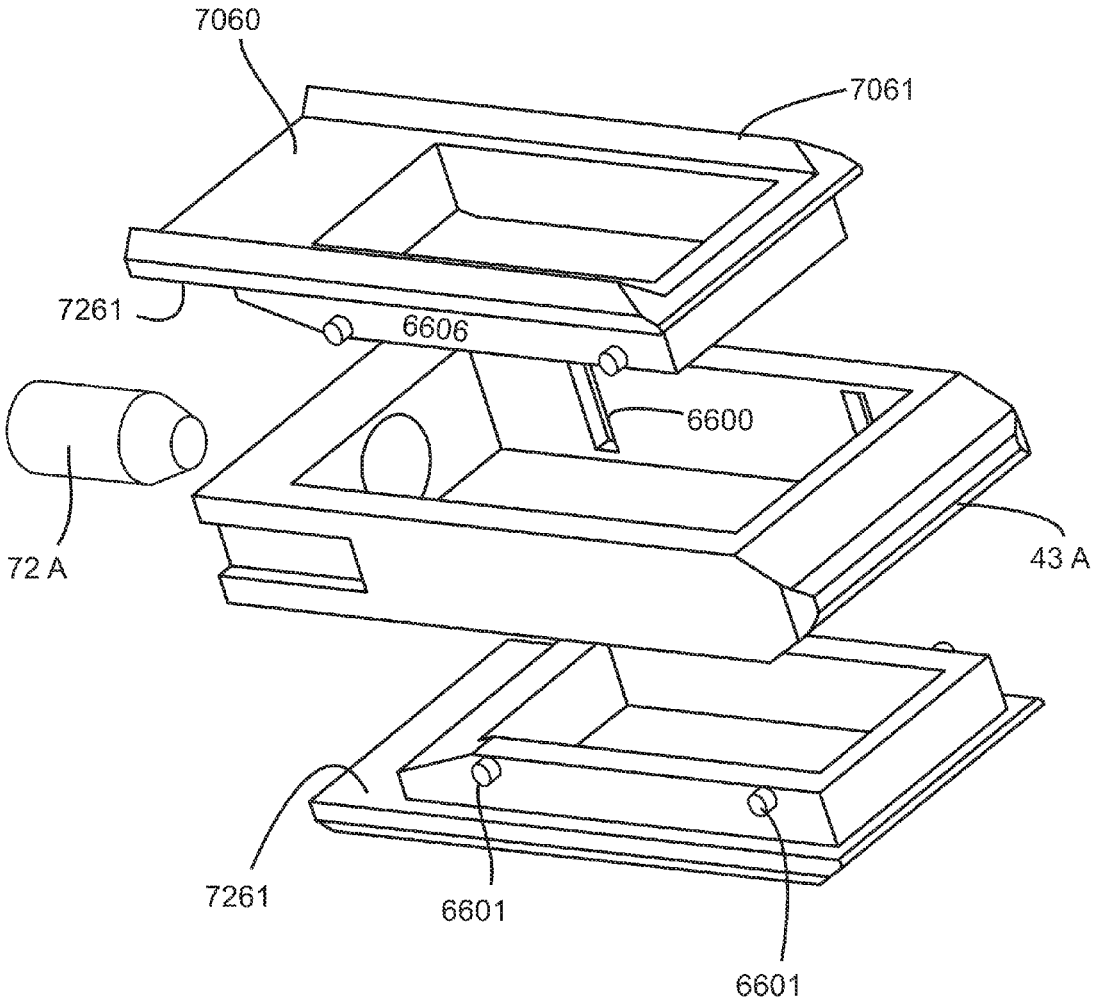
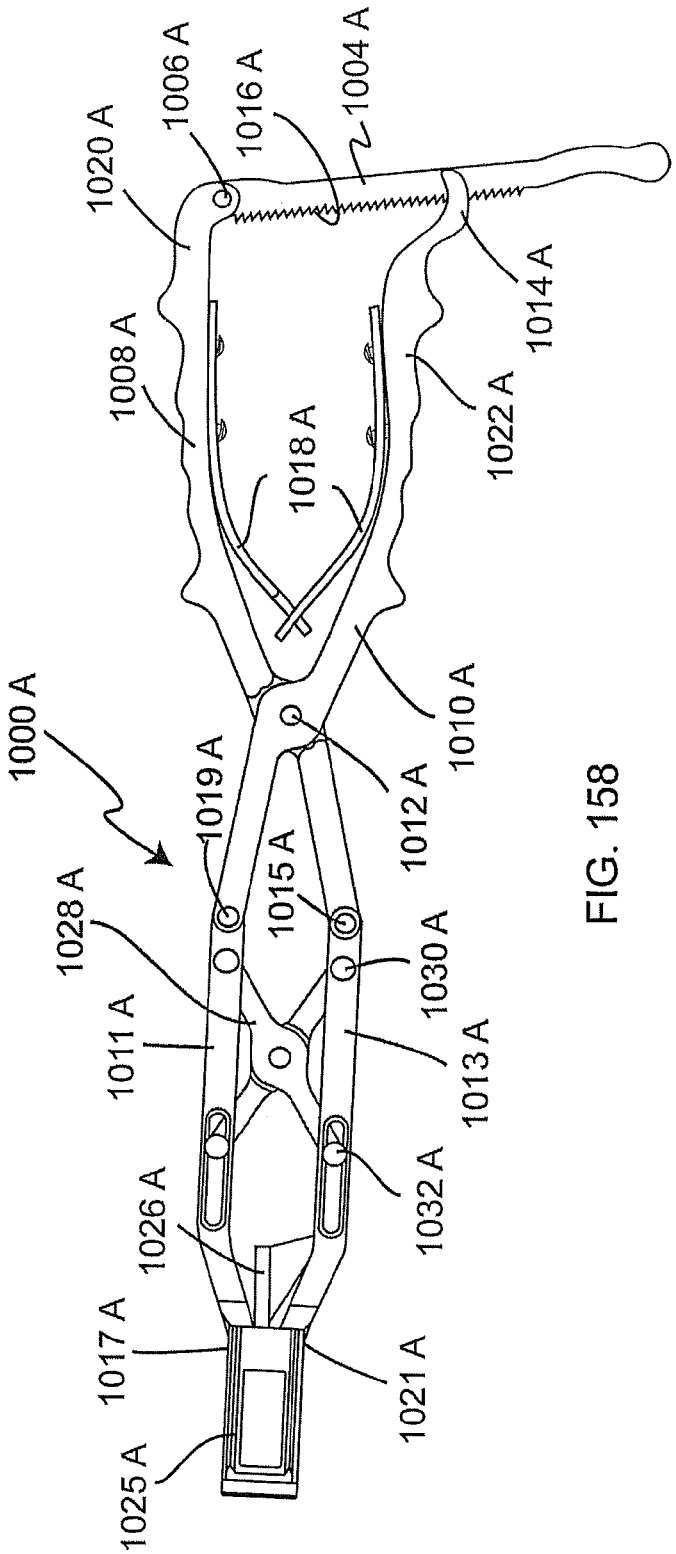


FIG. 157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1026 A
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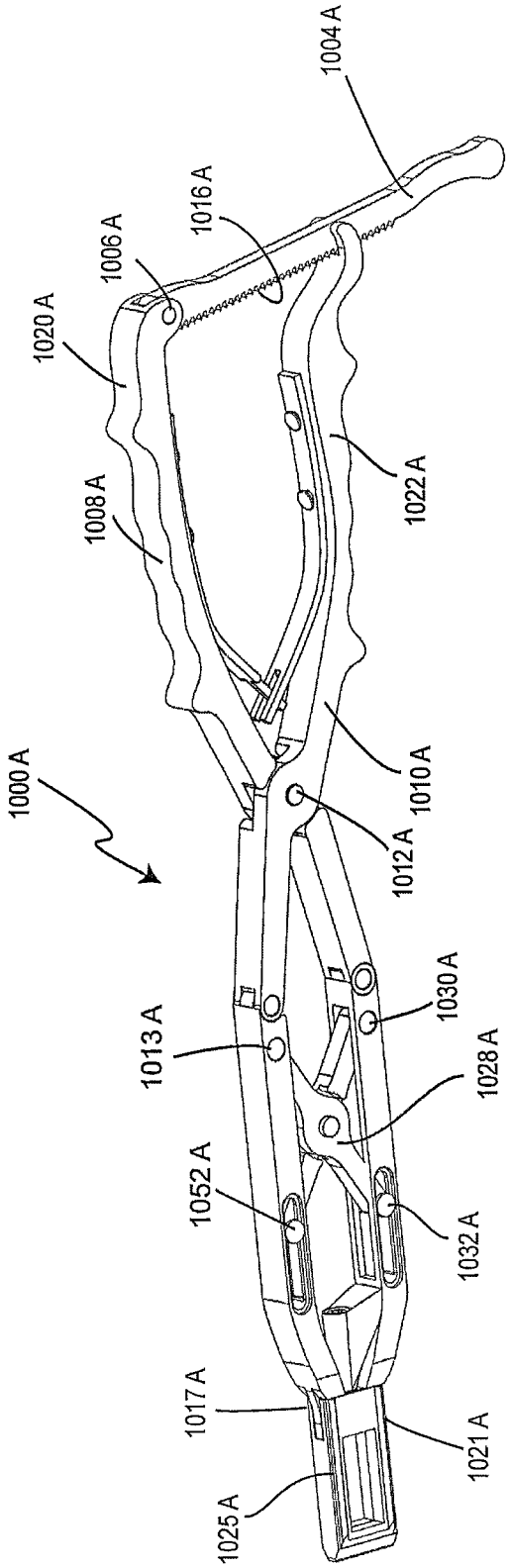
1032 A

FIG. 158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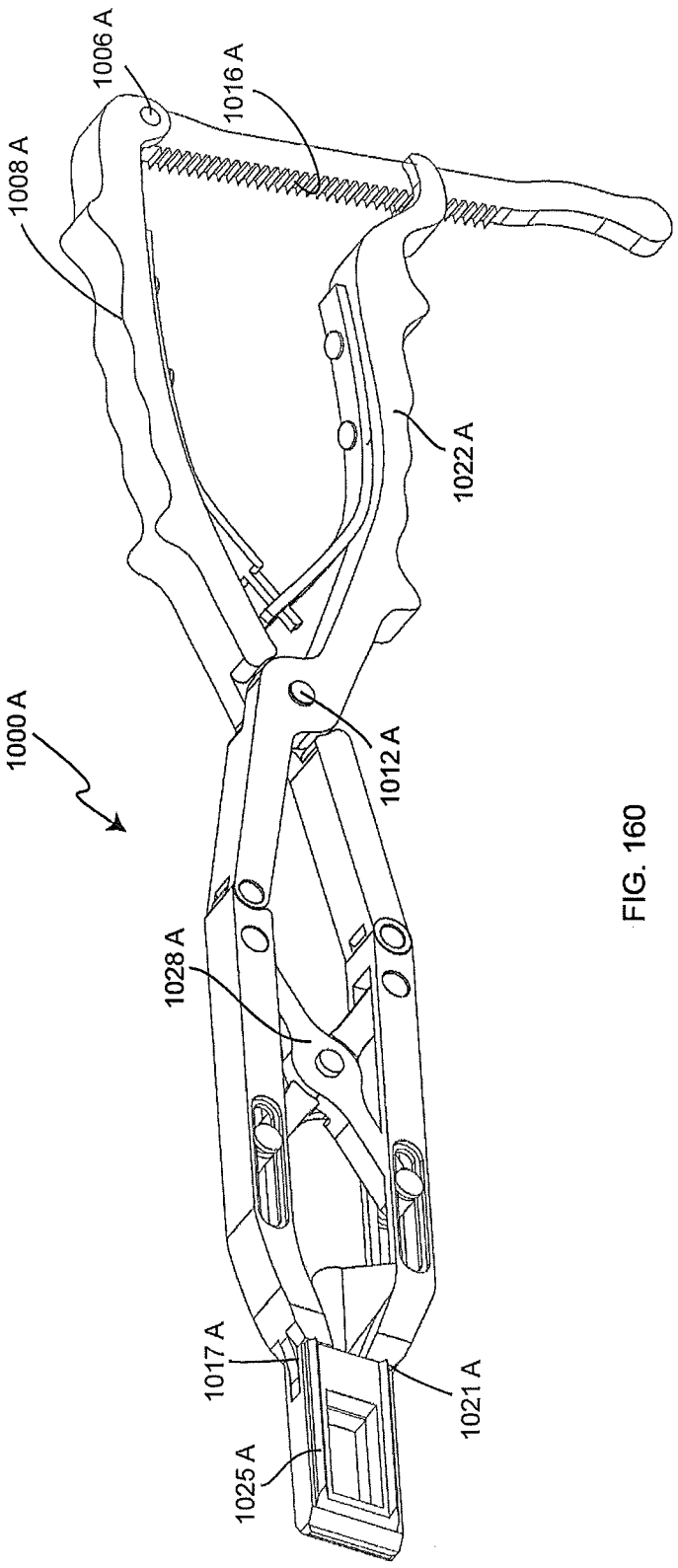
1021 A
1025 A

FIG. 159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1017 A
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FIG. 160

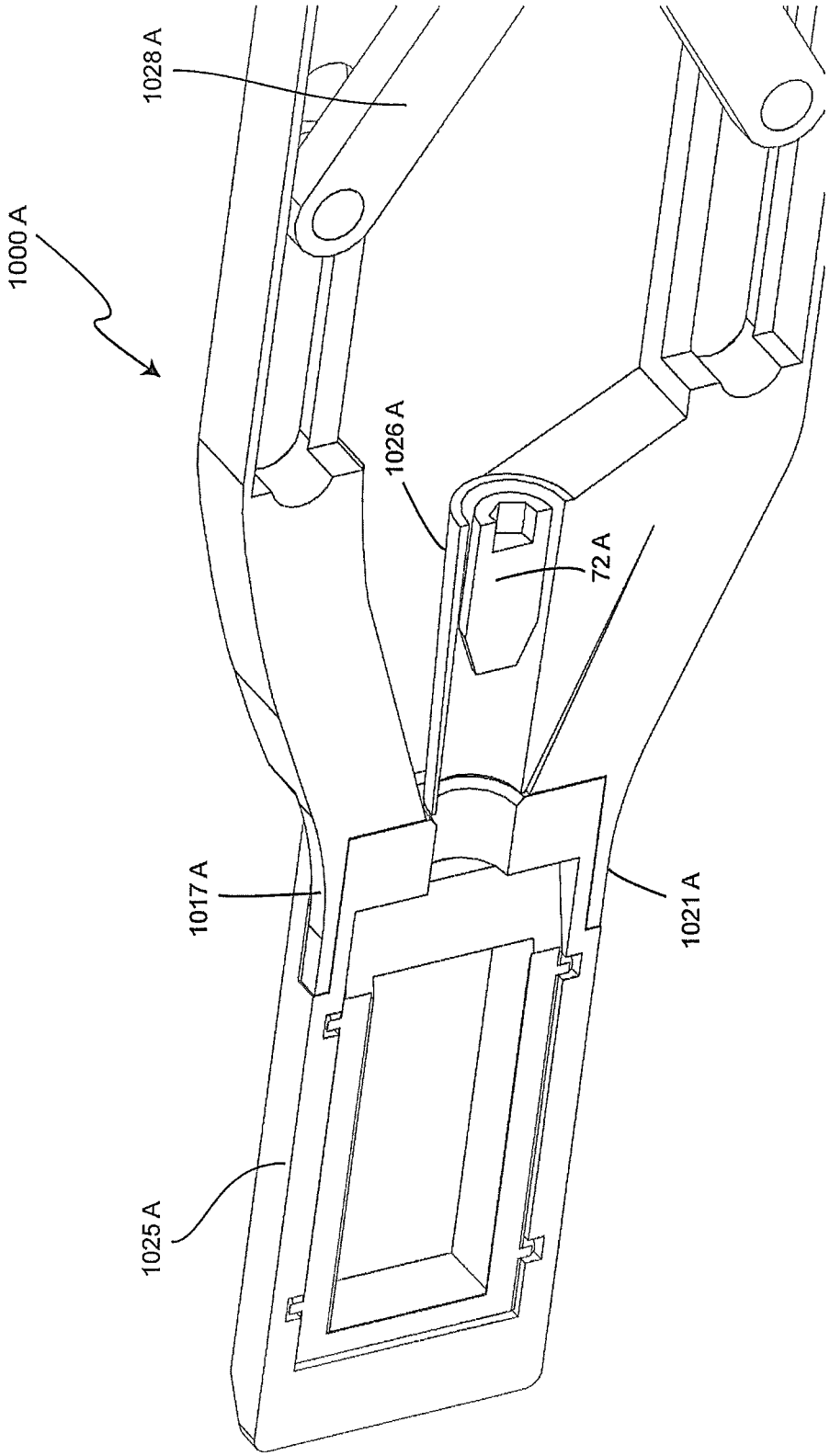
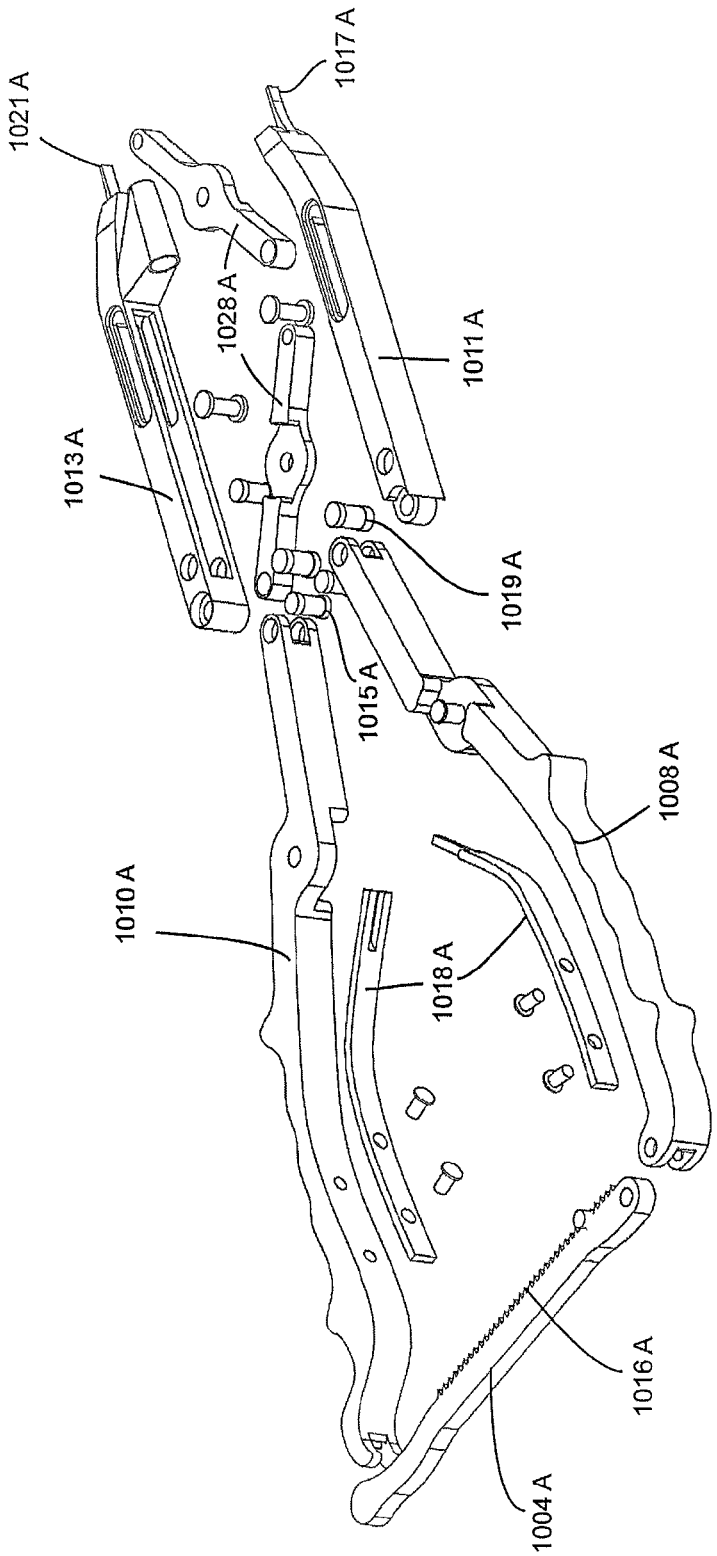


FIG. 161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1018 A
1016 A
1004 A

FIG. 162

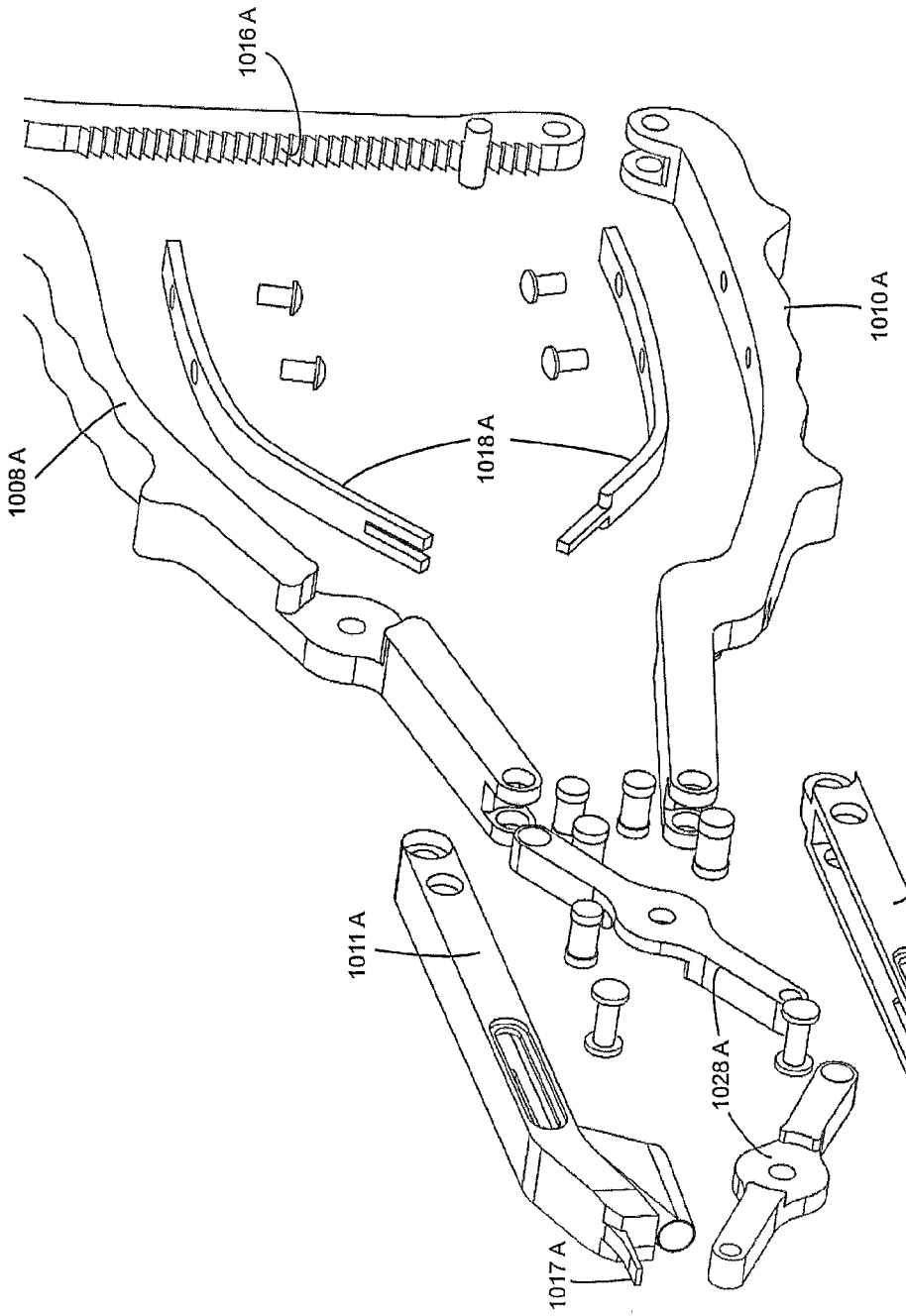
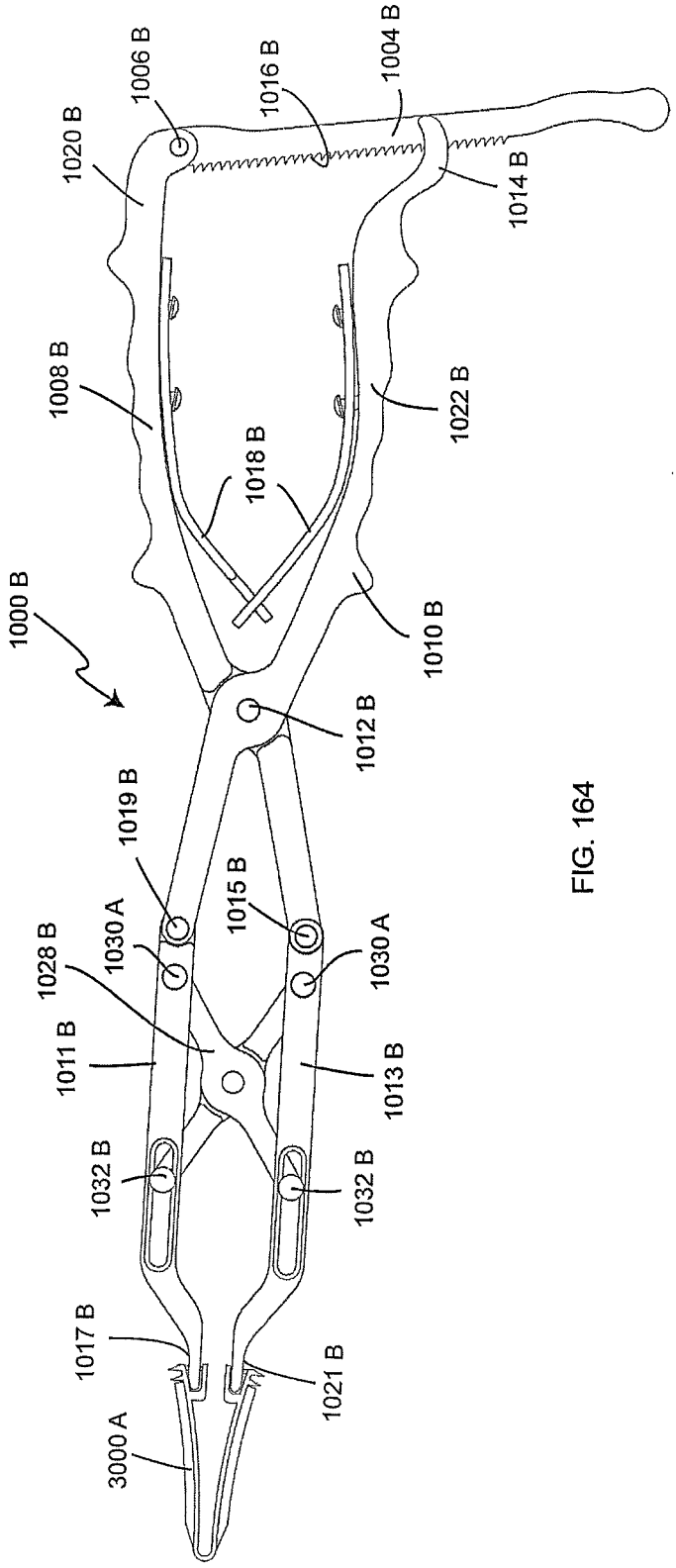


FIG. 163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1020 B
1021 B
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1028 B
1030 A
1030 A
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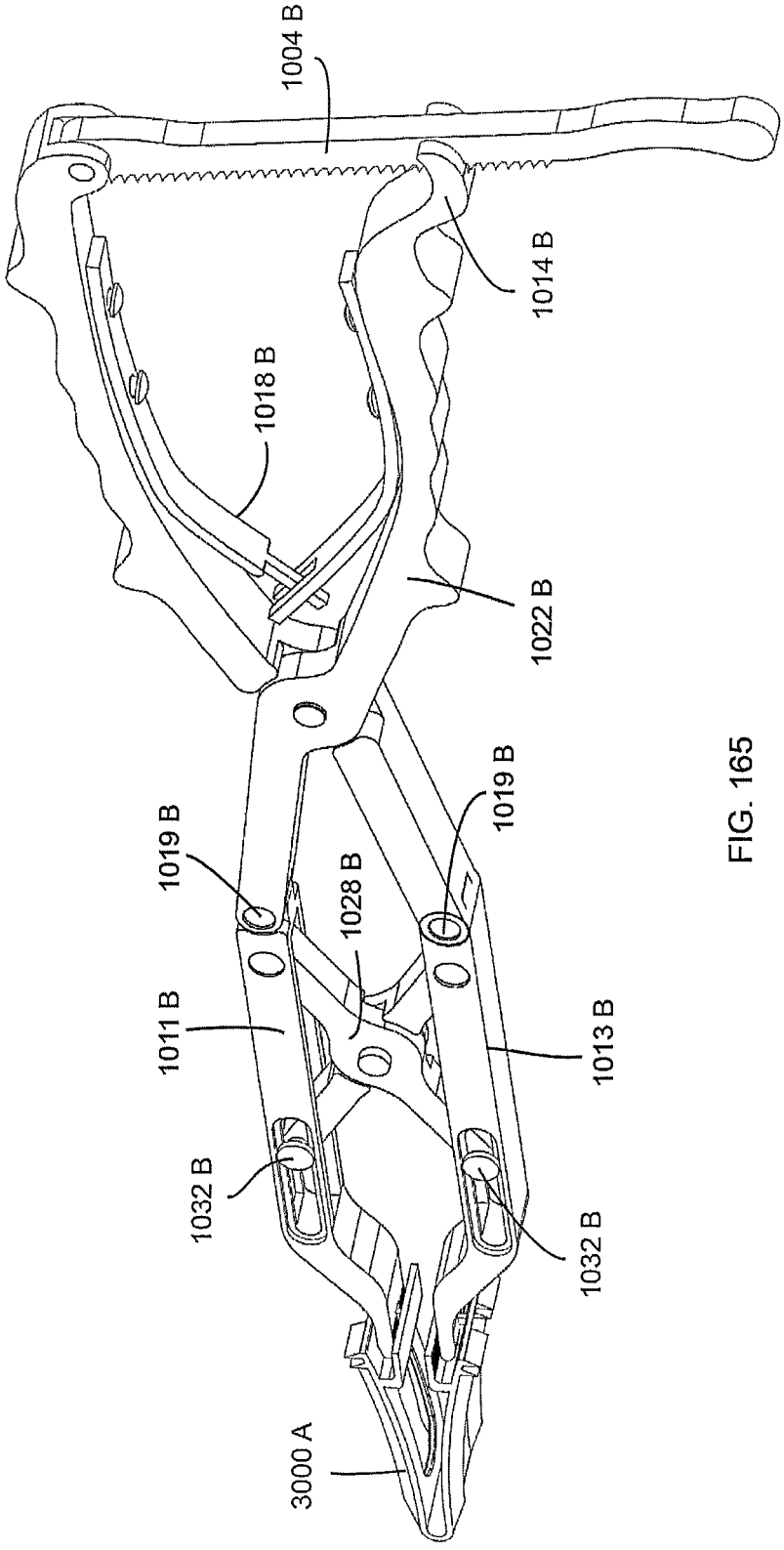
3000 A

FIG. 164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1019 B
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1032 B
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FIG. 165

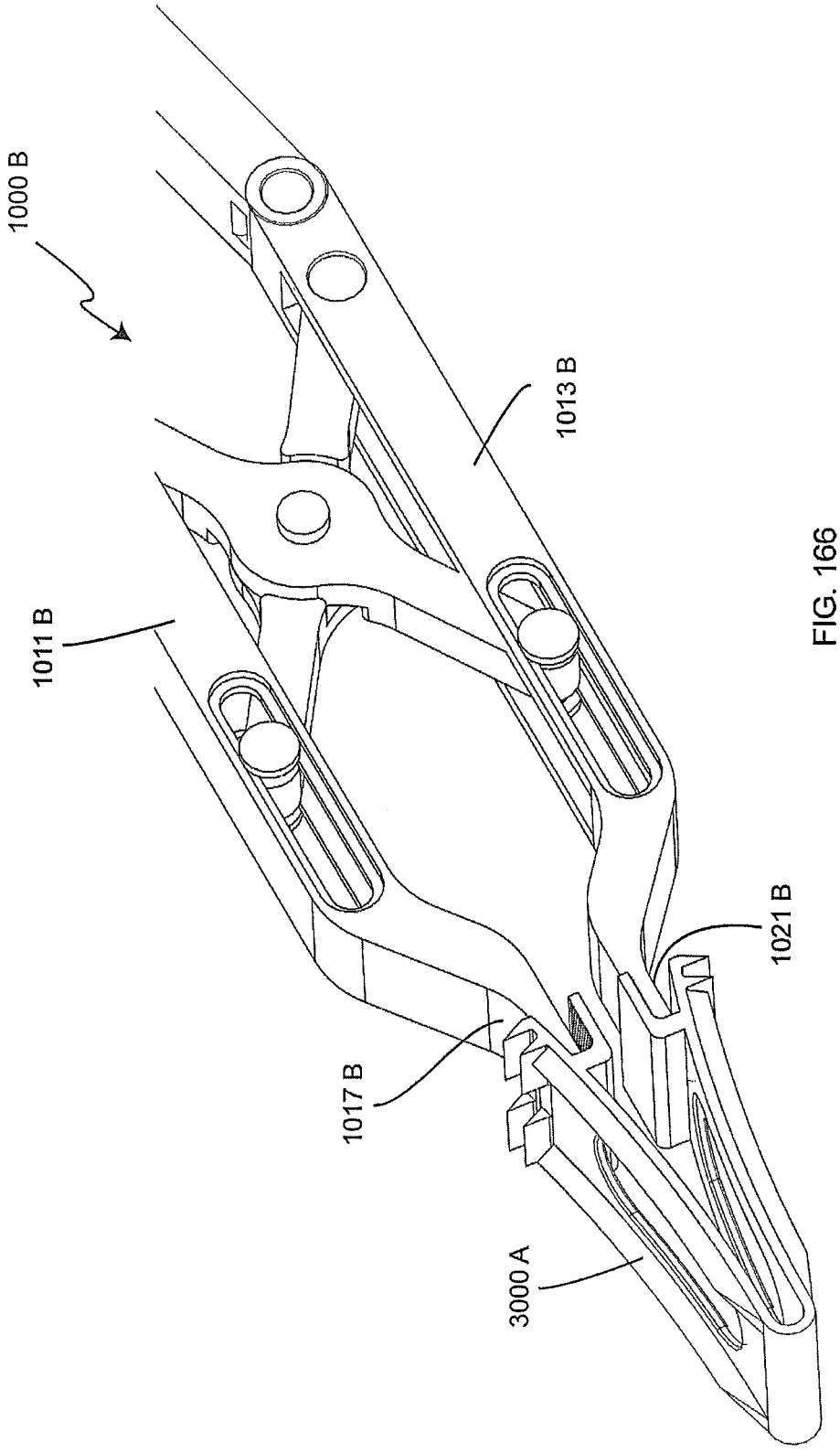


FIG. 166

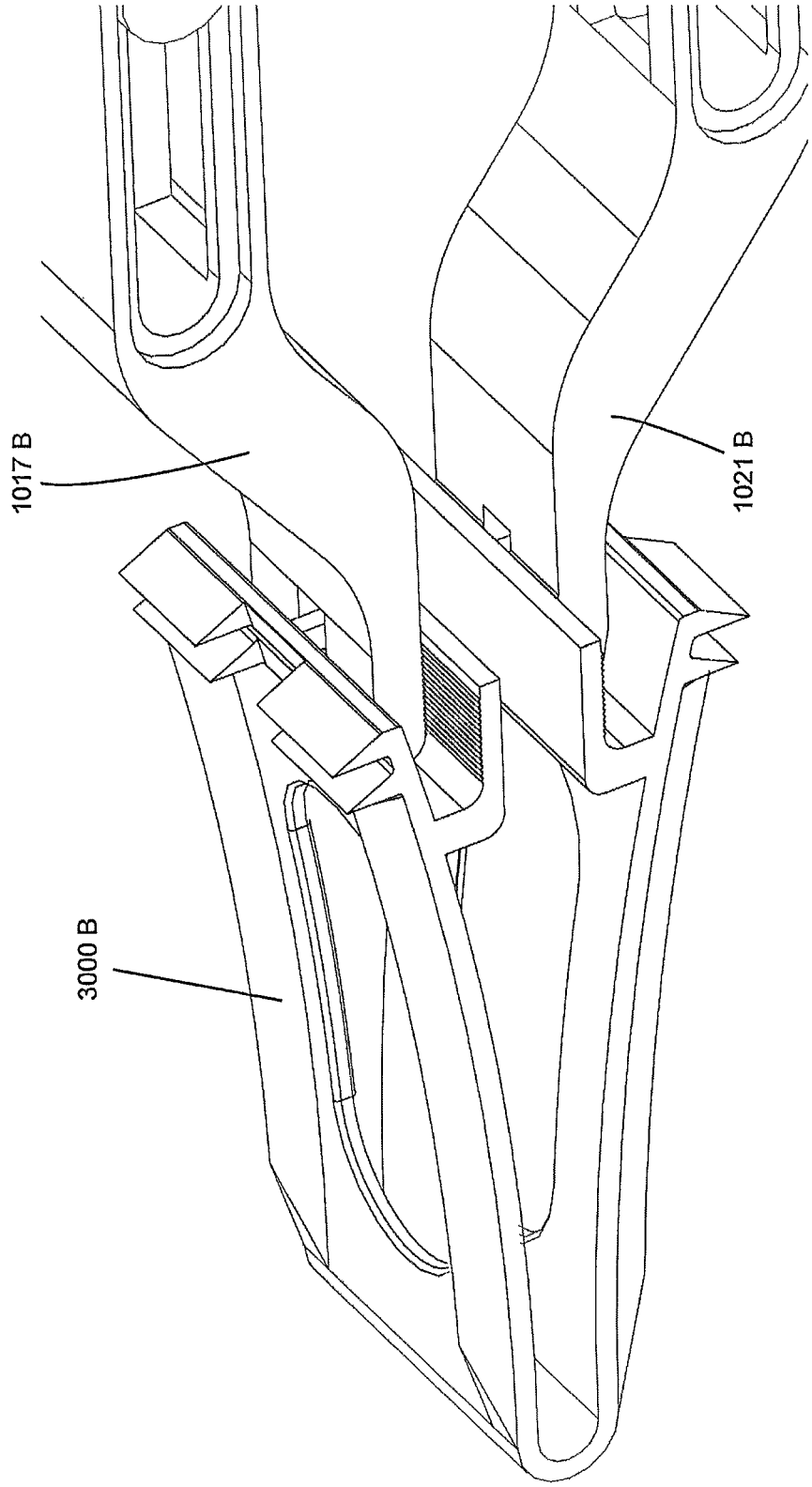


FIG. 167

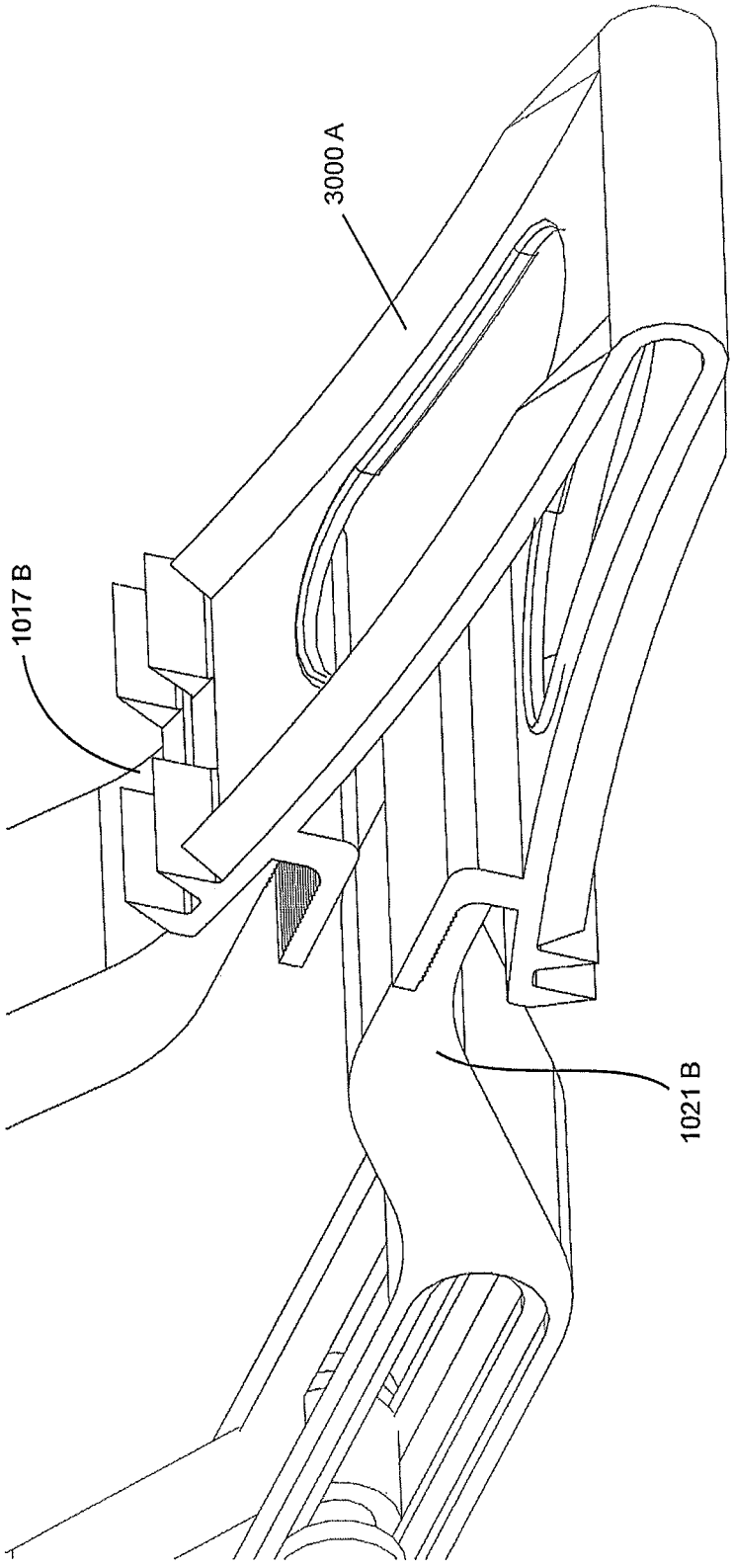
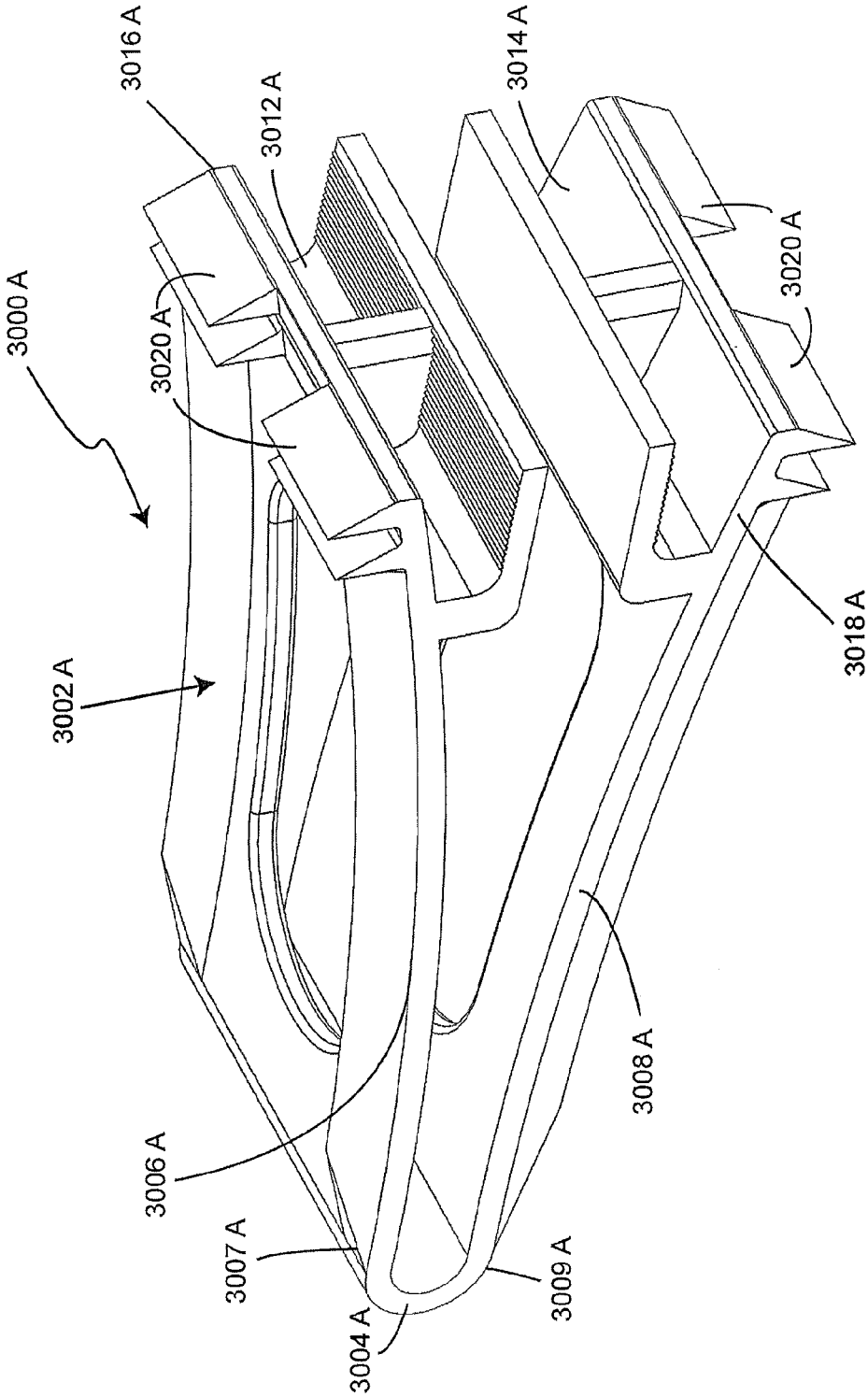


FIG. 168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3012 A
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3002 A
3018 A
3008 A
3006 A
3007 A
3009 A
3004 A

FIG. 169

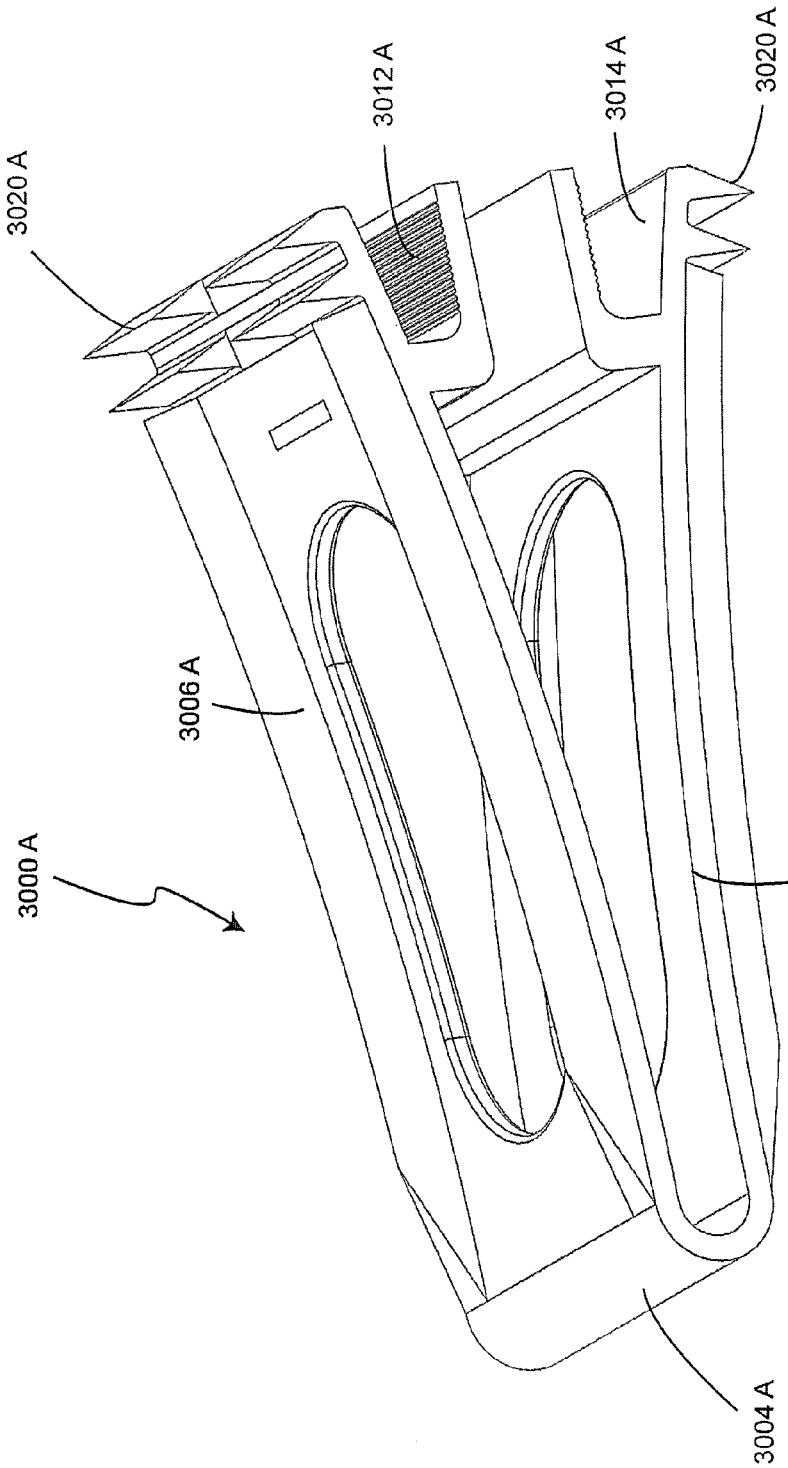


FIG. 170

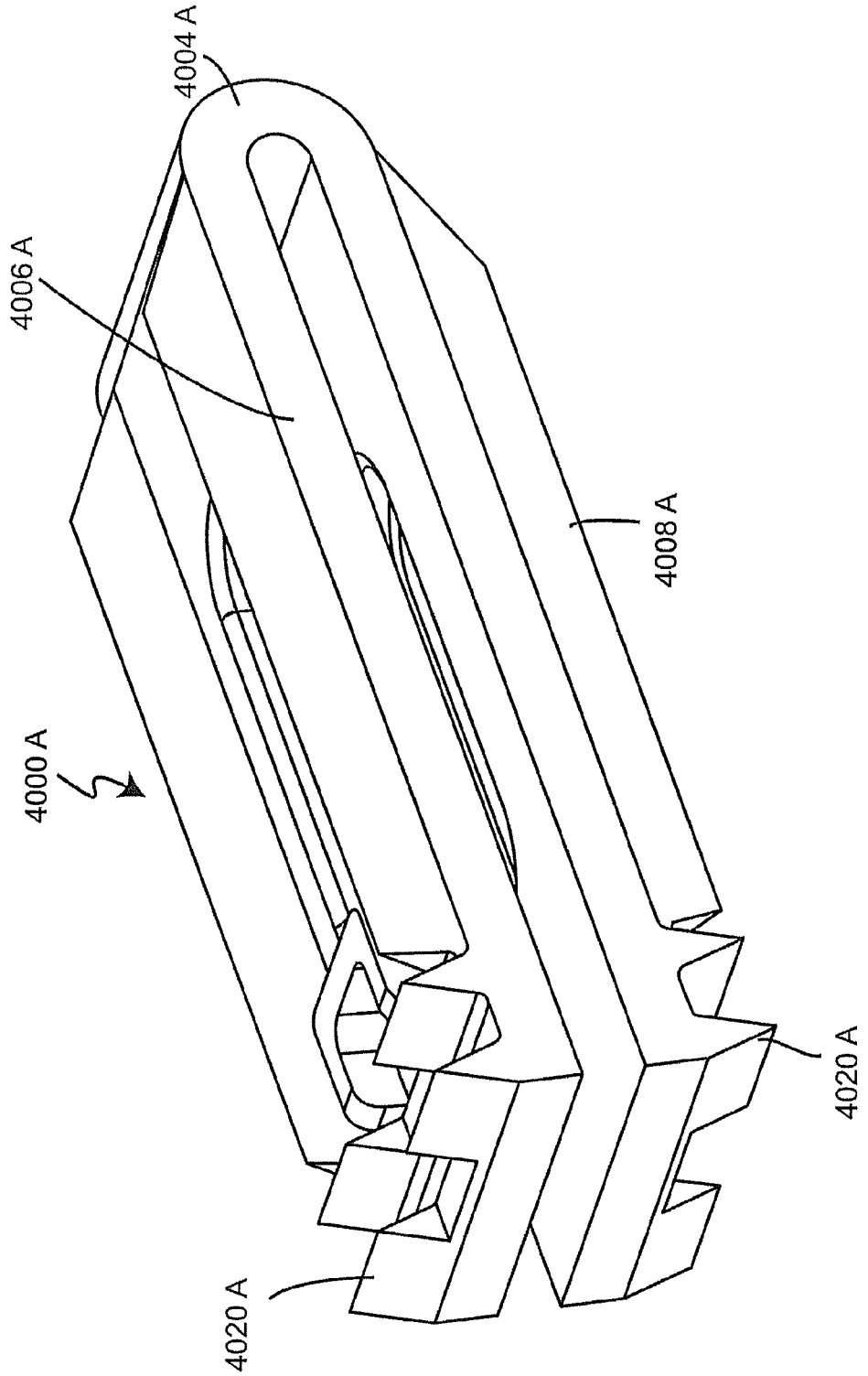


FIG. 171

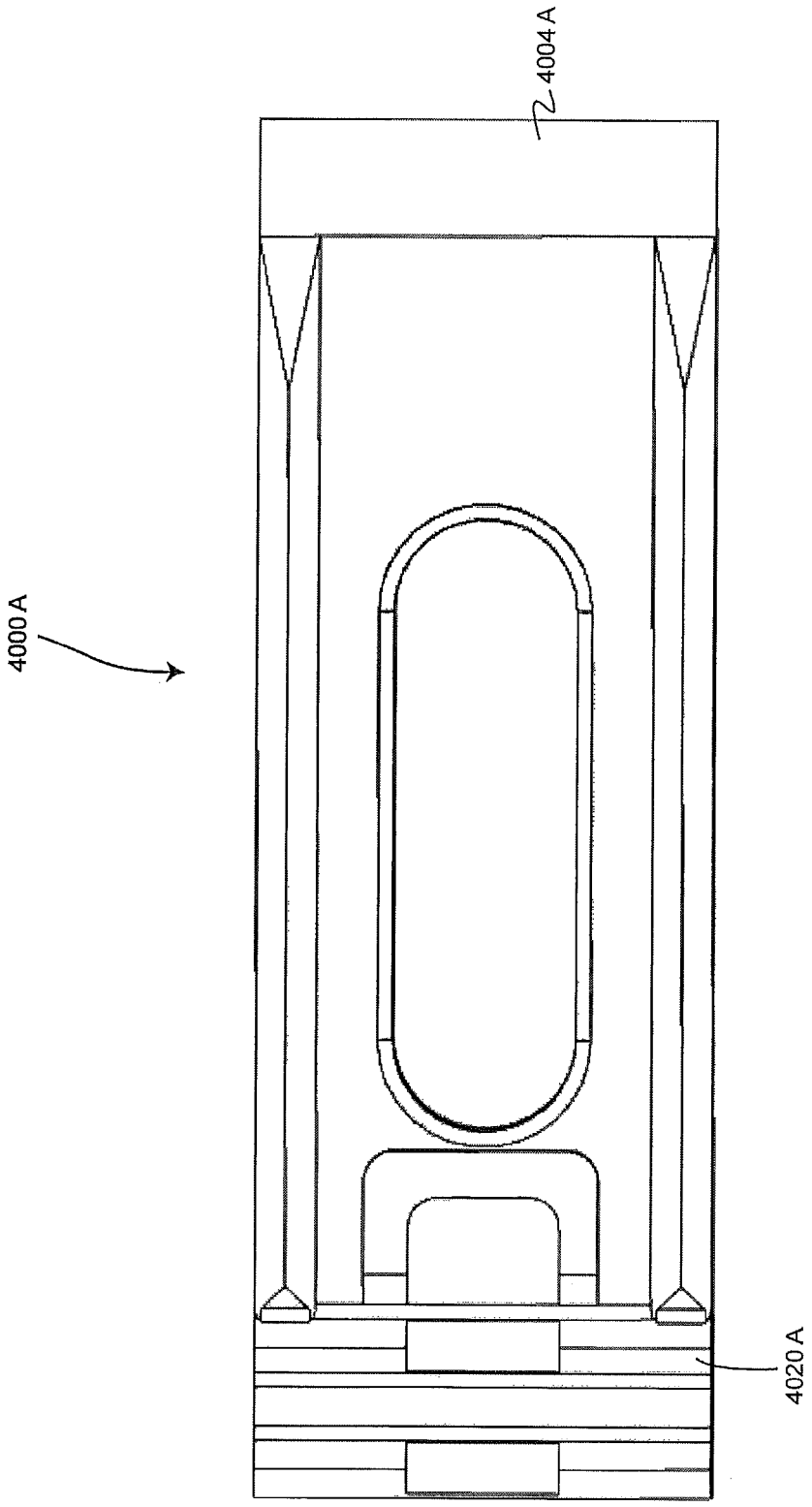


FIG. 172

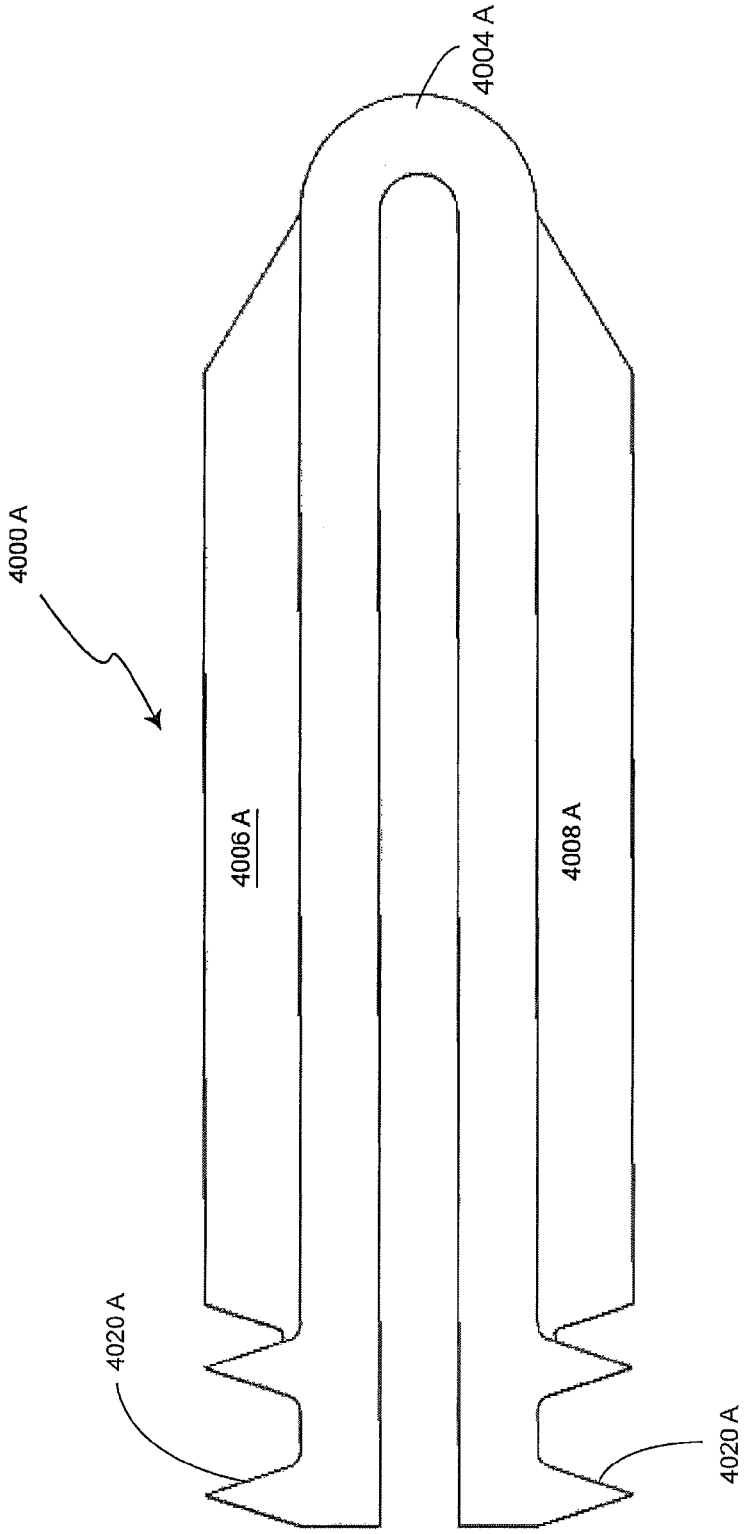
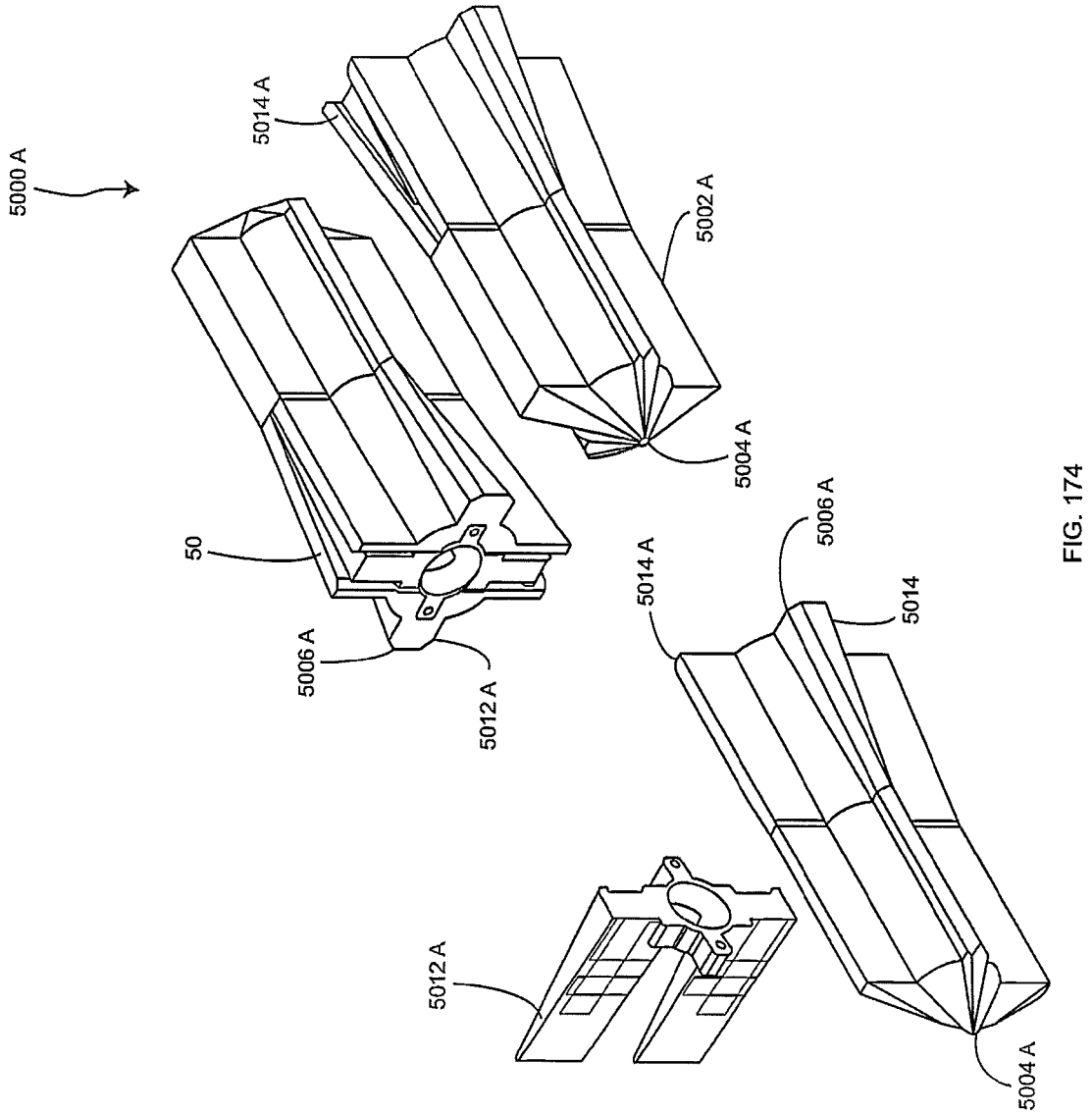


FIG. 173


5000 A
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5002 A
5004 A
50
5006 A
5012 A
5014 A
5006 A
5014
5012 A
5004 A

FIG. 174

SYSTEMS FOR AND METHODS OF FUSING A SACROILIAC JOINT

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims priority to and incorporates by reference in its entirety U.S. Provisional Patent Application No. 61/674,277, filed Jul. 20, 2012 and No. 61/800,120, filed Mar. 15, 2013.

The present application is a continuation-in-part (CIP) application of U.S. patent application Ser. No. 13/475,695 ("the '695 application"), which was filed May 18, 2012. The '695 application is a continuation-in-part (CIP) application of U.S. patent application Ser. No. 12/998,712 ("the '712 application"), which was filed May 23, 2011. 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 priority to U.S. Provisional Patent Application 61/335,947, which was filed Jan. 13, 2010.

The present application is also a continuation-in-part of and claims priority to U.S. patent application Ser. No. 13/236,411, which is entitled "Systems for and Methods of Fusing a Sacroiliac Joint" and was filed Sep. 19, 2011. All of the aforementioned applications are hereby incorporated by reference in their entireties into the present application.

The present application also claims priority to and incorporates by reference in its entirety U.S. Provisional Patent Application No. 61/674,130, which is entitled "Systems for and Methods of Fusing a Sacroiliac Joint" and was filed Jul. 20, 2012.

The delivery approaches and methodologies disclosed in the above-listed applications and incorporated herein are applicable to the implants and delivery tools disclosed in 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 malplacement 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 suf-

ficient 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, an anchor element and a delivery tool. The joint implant includes a distal end, a proximal end, a body extending between the proximal and distal ends, and a first bore extending non-parallel to a longitudinal axis of the body. The anchor element includes a distal end and a proximal end and is configured to be received in the first bore. The delivery tool includes an implant arm and an anchor arm. The implant arm includes a proximal end and a distal end. The distal end of the implant arm is configured to releasably couple to the proximal end of the joint implant such that a longitudinal axis of the implant arm is substantially at least one of coaxial or parallel with the longitudinal axis of the body of the joint implant. The anchor arm includes a proximal end and a distal end. The distal end of the anchor arm is configured to engage the proximal end of the anchor element. The anchor arm is operably coupled to the implant arm in an arrangement such that the longitudinal axis of the anchor element is generally coaxially aligned with a longitudinal axis of the first bore when the distal end of the implant arm is releasably coupled with the proximal end of the joint implant and the distal end of the anchor arm is engaged with the proximal end of the anchor element. The arrangement is fixed and nonadjustable.

Another implementation of the present disclosure may take the form of a sacroiliac joint fusion system including a joint implant, an anchor element and a delivery tool. The joint implant includes a distal end, a proximal end, a body extending between the proximal and distal ends, and a first bore extending non-parallel to a longitudinal axis of the body. The anchor element includes a distal end and a proximal end and is configured to be received in the first bore. The delivery tool includes an implant arm and an anchor arm. The implant arm includes a proximal end and a distal end. The distal end of the implant arm is configured to releasably couple to the proximal end of the joint implant such that a longitudinal axis of the implant arm is substantially at least one of coaxial or parallel with the longitudinal axis of the body of the joint implant. The anchor arm includes a proximal end and a distal end. The distal end of the anchor arm includes a guide. The anchor arm is pivotally coupled to the implant arm and configured such that a center of the guide moves along an arc that extends through generally the center of the first bore of the implant when the distal end of the implant arm is releasably coupled with the proximal end of the joint implant. The anchor arm is configured to deliver the anchor element to the first bore.

Yet another implementation of the present disclosure may take the form of a sacroiliac joint fusion system including a joint implant and a tool. In one embodiment, the joint implant includes a longitudinal axis and a first bore extending non-parallel to the longitudinal axis. The anchor element is configured to be received in the first bore. The delivery tool includes an implant arm and an anchor arm. The implant arm is configured to releasably couple to the joint implant. The anchor arm is coupled to the implant arm and configured to deliver the anchor element to the first bore. The final manufactured configuration of the tool and final manufactured configuration of the joint implant are such that, when the system is assembled such that the implant arm is releasably coupled to the joint implant, a delivery arrangement automatically exists such that the anchor arm is correctly oriented to deliver the anchor element to the first bore.

Another implementation of the present disclosure may take the form of a method of sacroiliac joint fusion. In one embodiment, the method includes: a) approaching a sacroiliac joint space with a joint implant comprising at least first and second planar members radially extending generally coplanar with each other from opposite sides of a body of the joint implant; b) delivering the joint implant into a sacroiliac joint space, the joint implant being oriented in the sacroiliac joint space such that the first and second planar members are generally coplanar with a joint plane of the sacroiliac joint space; and c) causing an anchor element to be driven generally transverse to the joint plane through bone material defining at least a portion of the sacroiliac joint space and into a bore of the joint implant that extends generally transverse to the body of the joint implant.

Yet another implementation of the present disclosure may take the form of a medical kit for the fusion of a sacroiliac joint including a caudal access region and a joint plane. In one embodiment, the kit includes: a) a delivery tool comprising an implant arm and an anchor arm coupled to the implant arm; b) a joint implant comprising a bore defined therein that extends generally transverse to a longitudinal length of the joint implant; and c) an anchor element configured to be received in the bore of the joint implant. The bore of the implant, the implant, the implant arm and the anchor arm have an as-manufactured configuration that allows the anchor arm to properly align the anchor element to be received in the bore of the implant when the implant is coupled to the implant arm.

One implementation of the present disclosure may take the form of various embodiments of a sacroiliac joint fusion system including joint implants and delivery tools.

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.

FIG. **4** is a top-side isometric view of the implant assembly.

FIG. **5** is a distal end isometric view of the implant of the implant assembly of FIG. **4**.

FIG. **6** is a proximal end isometric view of the implant.

FIG. **7** is a bottom-side isometric view of the implant assembly.

FIG. **8** is another proximal end isometric view of the implant.

FIG. **9** is another distal end isometric view of the implant.

FIGS. **10** and **11** are opposite side elevation views of the implant.

FIGS. **12** and **13** are opposite plan views of the implant.

FIG. **14** is a distal end elevation of the implant.

FIG. **15** is a proximal end elevation of the implant.

FIG. **16** is an isometric longitudinal cross section of the implant as taken along section line **16-16** of FIG. **11**.

FIG. **17** is an isometric longitudinal cross section of the implant as taken along section line **17-17** of FIG. **13**.

FIG. **18** is a proximal isometric view of the arm assembly.

FIG. **19** is a distal isometric view of the arm assembly **85**.

FIG. **20** is a longitudinal cross section of the implant arm as taken along section line **20-20** in FIG. **18**.

FIG. **21**A is a side elevation of the system wherein the tool is attached to the implant assembly for delivery of the implant assembly to the sacroiliac joint.

FIG. **21**B is the same view as FIG. **21**A, except illustrating a series of interchangeable anchor arms that may be coupled to the implant arm to adjust the tool for the patient, but maintain the angular relationship between the components of system that allows the anchor member to be delivered into the implant bore without adjustment to the delivery tool.

FIG. **21**C is the same view of FIG. **21**A, except illustrating a version of the same embodiment wherein the anchor arm is more proximally located along the implant arm.

FIG. **22** is the same view as FIG. **21**A, except shown as a longitudinal cross section.

FIG. **23** is an enlarged view of the distal region of the system circled in FIG. **22**.

FIG. **24** is an enlarged cross sectional plan view taken in a plane 90 degrees from the section plane of FIG. **23**.

FIG. **25** is a proximal isometric view of the handle.

FIG. **26** is a distal isometric view of the handle.

FIG. **27** is a cross sectional distal isometric view of the handle.

FIG. **28** is an isometric view of the implant retainer.

FIG. **29** is a longitudinal cross sectional isometric view of the implant retainer.

FIG. **30**A is an isometric view of the sleeve.

FIG. **30**B is a longitudinal cross section of an embodiment of the sleeve having multiple sleeve portions.

FIG. **31** is an isometric view of a trocar, guidewire, drill, screwdriver, etc. for insertion through the lumen of the sleeve.

FIG. **32** is an isometric view of a second embodiment of a system for fusing a sacroiliac joint.

FIG. **33** is the same view as FIG. **32**, except the system is exploded to better illustrate its components.

FIG. **34** is a side elevation of the system embodiment of FIG. **32**.

As shown in FIG. **35** is a proximal isometric view of the implant arm of the embodiment of FIG. **32**.

FIG. **36** is an isometric view of the anchor arm.

FIGS. **37** and **38** are different isometric views of a third embodiment of the system.

FIG. **39** is the same view as FIG. **37**, except the system is shown exploded to better illustrate the components of the system.

FIG. **40** is a side elevation of the system of FIG. **37**, wherein the tool is attached to the implant assembly for delivery of the implant assembly to the sacroiliac joint.

FIGS. **41-44** are various isometric views of the implant of the third embodiment of the system.

FIGS. **45-46** are opposite plan views of the implant.

FIGS. **47-50** are various elevation views of the implant.

FIGS. **51-52** are, respectively, isometric and side elevation views of an implant having an anchor member receiving arm.

FIG. **53** is an enlarged view of the disk-shaped seat of the implant arm of FIG. **51**.

FIG. **54** is an isometric view of an implant with another type of anchor member locking mechanism.

FIG. **55** is an enlarged view of the free end of the anchor member locking mechanism of FIG. **54**.

FIGS. **56-61** are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of another embodiment of the implant.

FIGS. **62-67** are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of yet another embodiment of the implant.

FIGS. **68-73** are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of still another embodiment of the implant.

FIGS. **74-79** are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of yet another embodiment of the implant.

FIGS. **80-85** are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of still yet another embodiment of the implant.

FIG. **86** is an isometric view of the delivery tool.

FIGS. **87-88** are generally opposite isometric views of the delivery tool in an exploded state.

FIG. **89** is an isometric view of the handle.

FIG. **90** is an exploded isometric view of the retaining collar and handle shown in longitudinal cross section.

FIG. **91** is a longitudinal cross section of the delivery tool **20** when assembled as shown in FIG. **86**.

FIG. **92** is a side view of an implant retainer similar to that described with respect to FIGS. **86-91**, except having a modified distal end.

FIGS. **93-94** are, respectively, longitudinal and transverse cross sectional views of an implant with an engagement hole configured to complementarily engage with the T-shaped distal end of the retainer of FIG. **92**.

FIG. **95** is the same view as FIG. **93**, except with the retainer received in the hole.

FIG. **96**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. **96**B is an enlarged view of the hip region of FIG. **96**A.

FIG. **97**A is a lateral-posterior view of the hip region of the patient of FIG. **96**A, wherein the patient is lying prone and the soft tissue surrounding the skeletal structure of the patient is shown in dashed lines.

FIG. **97**B is an enlarged view of the hip region of FIG. **97**A.

FIG. **98**A is a posterior view of the hip region of the patient of FIG. **96**A, wherein the patient is lying prone and the soft tissue surrounding the skeletal structure of the patient is shown in dashed lines.

FIG. **98**B is an enlarged view of the hip region of FIG. **98**A.

FIGS. **99**A-**99**Q 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 **99-99** in FIG. **98**B.

FIG. **100**A is a posterior-lateral view of the hip region of the patient, illustrating the placement of a cannula alignment jig.

FIGS. **100**B-**100**C are different isometric views of the cannula alignment jig.

FIG. **101**A is a posterior-lateral view of the hip region of the patient, illustrating the placement of a drill jig.

FIG. **101**B is an isometric view of the drill jig.

FIG. **102**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. **102**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. **102**C is an enlarged view of the implant taken along the plane of the sacroiliac joint.

FIG. **102**D is a transverse cross section of the implant and joint plane taken along section line **102**D-**102**D of FIG. **102**C.

FIG. **103**A is generally the same view as FIG. **97**A, except illustrating the delivery tool being used to deliver the implant to the sacroiliac joint space.

FIG. **103**B is an enlarged view of the hip region of FIG. **103**A.

FIG. **104** is generally the same enlarged view as FIG. **96**B, except illustrating the delivery tool being used to deliver the implant to the sacroiliac joint space.

FIG. **105** is the same view as FIG. **104**, except the implant has now been fully inserted into the prepared space in the sacroiliac joint.

FIG. **106**A is the same view as FIG. **104**, except the sleeve is now received in the collar of the anchor arm.

FIG. **106**B is generally the same view as FIG. **106**A, 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.

FIG. **107**A is a posterior-inferior view of the hip region of the patient, wherein the soft tissue surrounding the skeletal hip bones is shown in dashed lines.

FIG. **107**B is an enlarged view of the implant region of FIG. **107**A.

FIGS. **108**A and **108**B are, respectively, posterior and posterior-lateral views of the implantation area and the implant assembly implanted there.

FIG. **109** is an isometric view of the system wherein the tool is attached to the implant for delivery of the implant to the sacroiliac joint.

FIG. **110** is a view of the system wherein the implant and anchor arm are shown in plan view.

FIG. **111**A is an inferior-posterior view of the patient's hip skeletal structure similar to the view depicted in FIG. **107**A.

FIG. **111**B is a lateral-superior-posterior view of the patient's hip skeletal structure.

FIG. **111**C is an inferior-posterior view of the patient's hip skeletal structure taken from a perspective laterally opposite the view depicted in FIG. **111**B.

FIG. **112**A is an inferior-posterior view of the patient's hip skeletal structure similar to the view depicted in FIG. **107**A.

FIG. **112**B is a side view of the patient's hip skeletal structure similar to the view depicted in FIG. **106**A.

FIG. **112**C is a view of the patient's hip skeletal structure similar to the view depicted in FIG. **103**A, except from an opposite lateral perspective.

FIG. **112**D is a superior view of the patient's hip skeletal structure.

FIG. **113** 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. **114** is the same transverse cross sectional view of the patient's hip as shown in FIGS. **99**A-**99**Q, 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. **115** is a posterior view of the patient's sacrum and illiums, 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. **116** is the same view as FIG. **117**, except having a different spanning member structure.

FIG. **117**A is a lateral-inferior-posterior view of the patient's hip skeletal structure similar to the view depicted in FIG. **111**C.

FIG. **117**B is an inferior-posterior view of the patient's hip skeletal structure similar to the view depicted in FIG. **111**A.

FIG. **117**C is the same view as FIG. **106**B, except showing the implant being implanted in the extra-articular space, as opposed to the sacroiliac joint articular region.

FIGS. **118**A-**118**C are, respectively, isometric and opposite plan views of an implant with a side-to-side deviated bore.

FIGS. **119**A-**119**E are, respectively, distal end isometric, side elevation, plan, distal end elevation, and proximal end elevation views of another embodiment of the implant.

FIGS. **120**A-**120**B are, respectively, distal end isometric and side elevation views of yet another embodiment of the implant.

FIGS. **121**A-**121**G are, respectively, distal end isometric, side elevation, plan, distal end elevation, proximal end elevation, proximal end isometric, and side elevation views of still another embodiment of the implant.

FIG. **121**H 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. **122** is a proximal end isometric view of another embodiment of the implant assembly.

FIGS. **123**A-**123**E are, respectively, distal end isometric, side elevation, plan, distal end elevation, and proximal end elevation views of yet another embodiment of the implant.

FIGS. **124**A and **124**B**1** are isometric views of another embodiment of the delivery tool coupled and decoupled with the implant, respectively.

FIG. **124**B**2** is a cross section view as taken along section line **124**B**2**-**124**B**2** in FIG. **124**B**1**.

FIG. **124**C is an isometric view of the delivery tool in an exploded state.

FIG. **124**D is an enlarged view of the distal end of the implant arm of the delivery tool.

FIGS. **124**E-**124**H are, respectively, distal end isometric, side elevation, plan, and opposite plan views of a version of the embodiment of the implant of FIGS. **123**A-**123**E, wherein the version includes a bore for receiving an anchor.

FIG. **125**A is an isometric view of another embodiment of the implant.

FIG. **125**B is a longitudinal cross section view of the implant of FIG. **125**A.

FIG. **126**A is an isometric view of another embodiment of the implant assembly.

FIG. **126**B is a longitudinal cross section view of the implant of FIG. **126**A.

FIG. **126**C is a longitudinal cross section of the proximal head of the anchor of FIG. **126**A.

FIG. **127** is an isometric view of an embodiment of a sleeve mounted on an implant arm of a delivery system similar to the delivery system of FIG. **88**, wherein the sleeve facilitates visualization of the trans screw and trajectory.

FIG. **128**A is an isometric view of another embodiment of the sleeve of FIG. **127**.

FIG. **128**B is an end view of sleeve of FIG. **127**.

FIG. **128**C is a posterior view of the hip region, wherein the sleeve of FIG. **127** is being employed.

FIGS. **129**A-**129**B show isometric views of another embodiment of the system, wherein the delivery tool has a series of interchangeable anchor arms that may be coupled to the implant arm to adjust the tool for the patient, but maintain the angular relationship between the components of system that allows the anchor member to be delivered into the implant bore and/or another location adjacent to the implant without adjustment to the delivery tool.

FIG. **129**C shows an enlarged view of the arm assembly of the delivery tool of FIGS. **129**A-**129**B.

FIGS. **129**D-**129**K are, respectively, distal end isometric, proximal end isometric, side elevation, opposite side elevation, plan, opposite plan, proximal end elevation, and distal end elevation views of an embodiment of the implant intended for use with the system of FIGS. **129**A-**129**C.

FIG. **129**L is an enlarged isometric view of the implant of FIGS. **129**D-**129**K mounted on the extreme distal end of the implant arm of the delivery tool of FIGS. **129**A-**129**C.

FIGS. **129**M and **129**N are side views of the distal regions of two alternative implant arms arrangements.

FIG. **129**O (not used)

FIG. **129**P is an exploded isometric view of the implant arm of FIG. **129**M.

FIGS. **130**A-**130**B show anterior views of the hip region with the system of FIGS. **129**A-**129**C, wherein the ilium is shown and hidden, respectively.

FIGS. **130**C-**130**G show anterior-superior-lateral, posterior, superior, lateral, and inferior views of the hip region with the system of FIGS. **129**A-**129**C.

FIGS. **130**H and **130**I show inferior and posterior-lateral views of a patient, wherein the system of FIGS. **129**A-**129**C is inserted through the soft tissue of the hip region.

FIGS. **131**A-**131**B show isometric views of another embodiment of the system.

FIG. **131**C shows an enlarged plan view of the arm assembly of the delivery tool of FIGS. **131**A-**131**B.

FIGS. **131**D-**131**E are isometric view of a version of the implant of FIGS. **129**D-**121**K adapted for use with the delivery system of FIGS. **131**A-**131**C.

FIG. **131**F is an isometric view of a version of the implant of FIGS. **129**D-**129**K, wherein the body of the implant is hollow and configured to work with a distal end of an implant arm configured to remove cartilage.

FIG. **131**G is an isometric view of the distal end of the implant arm configured to be received in the hollow body of the implant of FIG. **131**F, wherein the distal end of the implant arm is configured to remove cartilage.

FIG. **131**H is an isometric view of the implant arm distal end of FIG. **131**G received in the implant of FIG. **131**F.

FIG. **131**I is an isometric longitudinal cross section of the implant arm distal end and implant supported thereon as taken along section line **131**I-**131**I of FIG. **131**H.

FIG. **132**A is an isometric view of yet another embodiment of the system for fusing a sacroiliac joint.

FIG. **132**B is the same view as FIG. **132**A, except the system is exploded to better illustrate its components.

FIG. **133**A is an isometric view of yet another embodiment of the system for fusing a sacroiliac joint.

FIG. **133**B shows another isometric view of the system of FIG. **133**A.

FIG. **133**C shows the same view as FIG. **133**B, except the system is inserted through the soft tissue of the hip region of the patient.

FIG. **133**D is the same view as FIG. **133**C, except the soft tissue is hidden to show the patient bone structure.

FIG. **133**E shows a rear elevation view of the system of FIG. **133**A.

FIG. **133**F shows the same view as FIG. **133**E, except the system is inserted through the soft tissue of the hip region of the patient.

FIG. **133**G is the same view as FIG. **133**F, except the soft tissue is hidden to show the patient bone structure.

FIG. **134**A illustrates an embodiment of a system for extracting an implant.

FIGS. **134**B-**134**C show enlarged views of the distal end of the system of FIG. **134**A, wherein the distal end is decoupled and coupled to the implant, respectively.

FIG. **134**D is a longitudinal cross section as taken along section line **134**D-**134**D of FIG. **134**C.

FIG. **134**E is the same view as FIG. **134**A, except the system is exploded to better illustrate its components.

FIG. **134**F is an isometric view of the proximal end of the implant of FIGS. **134**B-**134**C.

FIGS. **135**A-**135**C are respectively a first isometric, a second isometric and a plan view of an implant embodiment having a shape that generally mimics or resembles that of a sacroiliac joint space as viewed from a substantially lateral view.

FIGS. **136**A-**136**D are generally opposite isometric views of an implant embodiment that is configured to transition from a generally linear, rectangular arrangement (shown in FIGS. **136**A-**136**B) to a boot or L-shaped configuration (shown in FIGS. **136**C-**136**D) that generally fills and/or mimics the shape of the sacroiliac joint space.

FIG. **136**E is an exploded isometric view of the implant of FIGS. **136**A-**136**D.

FIGS. **136**F and **136**G are, respectively, proximal and distal elevations of the implant of FIGS. **136**A-**136**D.

FIGS. **136**H and **136**I are, respectively, top and bottom plan views of the implant of FIGS. **136**A-**136**D.

FIG. **136**J is a longitudinal cross sectional elevation of the implant of FIGS. **136**A-**136**D as taken along section line **136**J-**136**J.

FIGS. **136**K and **136**L are respective enlarged views of the upper and lower cylinder regions of FIG. **136**J.

FIGS. **137**A and **137**B are generally opposite isometric views of an implant embodiment configured to essentially mimic at least a portion of the sacroiliac joint space.

FIGS. **137**C-**137**F are, respectively, a top plan view, a distal end elevation, a side elevation, and a proximal elevation of the implant of FIGS. **137**A and **137**B.

FIGS. **138**A and **138**B are generally opposite isometric views of an implant embodiment configured to essentially mimic at least a portion of the sacroiliac joint space.

FIGS. **138**C-**138**F are, respectively, a top plan view, a distal end elevation, a side elevation, and a proximal elevation of the implant of FIGS. **138**A and **138**B.

FIGS. **139-154** are various views of an embodiment of an implant assembly for fusing a sacroiliac joint.

FIG. **155** is an isometric view of an implant delivery tool for use with the implant assembly of FIGS. **139-154**.

FIGS. **156** and **157** are exploded views of the implant assembly of FIGS. **139-154**.

FIGS. **158-163** are various views of an implant delivery tool in accordance with an embodiment of the present invention.

FIGS. **164-168** are various views of an implant delivery tool in accordance with another embodiment of the present invention.

FIGS. **169-170** are front and rear perspective views of an implant for fusing a sacroiliac joint in accordance with another embodiment of the present invention.

FIGS. **171-173** are various views of an implant for fusing a sacroiliac joint in accordance with another embodiment of the present invention.

FIG. **174** includes various perspective views of an implant for fusing a sacroiliac joint in accordance with yet another embodiment of the present invention.

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 anchor **30**, is configured to fuse a sacroiliac joint once implanted at the joint. The tool **20** is configured such that the anchor **30** can be quickly, accurately and reliably delivered to a bore **40** of an implant **25** supported off of the tool distal end in a sacroiliac joint.

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

As can be understood from FIGS. **2A** and **2B**, 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 an anchor element **30** (e.g., a bone screw or other elongated 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. **2A**. 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** and while maintaining the alignment between components (e.g., anchor **30** aligned with bore **40**) 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 element **30** to extend through the ilium, sacrum and implant **25** generally transverse to the sacroiliac joint and implant **25**. The delivery tool **20** is then decoupled from the implanted implant assembly **15**, as can be understood from FIG. **2B**.

To begin a detailed discussion of components of an embodiment of the implant assembly **15**, reference is made to FIG. **4**, which is a side isometric view of the implant assembly **15**. As shown in FIG. **4**, the implant assembly **15** includes an implant **25** and an anchor element **30**. The anchor element **30** may be in the form of an elongated body such as, for example, a nail, rod, pin, threaded screw, expanding body, a cable (e.g., configured with a ball end), etc. The anchor element **30** is configured to be received in a bore **40** defined through the implant **25**. The bore **40** extends through the implant **25** and is sized such that the anchor element **30** can at least extend into or through the implant **25** as illustrated in FIG. **4**.

For a detailed discussion of the implant **25**, reference is made to FIGS. **5-17**. FIGS. **5-9** are various isometric views of the implant **25**. FIGS. **12** and **13** are opposite plan views of the implant **25**, and FIGS. **10**, **11**, **14** and **15** are various elevation views of the implant. FIGS. **16** and **17** are isometric longitudinal cross sections of the implant **25** as taken along corresponding section lines in FIGS. **11** and **13**, respectively.

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**, a bore **40** extending through the body, and keels, fins or planar members **50**, **55** that radially extend outwardly away from the body **45**. In one embodiment, the radially extending planar members **50**, **55** may be grouped into pairs of planar members **50**, **55** that are generally coplanar with each other. For example, planar members **50** that are opposite the body **45** from each other generally exist in the same plane. More specifically, as best understood from FIGS. **14** and **15**, the planar faces **60** of a first planar member **50** are generally coplanar with the planar faces **60** of a second planar member **50** opposite the body **45** from the first planar member **50**. Likewise, the planar faces **65** of a third planar member **55** are generally coplanar with the planar faces **65** of a fourth planar member **55** opposite the body **45** from the third planar member **55**.

As best understood from FIGS. **14** and **15**, one set of planar members **50** (i.e., the large planar members **50**) may extend radially a greater distance D_1 than the distance D_2 extended radially by the other set of planar members **55** (i.e., the small planar members **55**). Also, the width W_1 of a large planar member **50** from its outer edge to its intersection with the body **45** may be greater than the width W_2 of a small planar member **55** from its outer edge to its intersection with the body **45**. Also, the thickness T_1 of the large planar members **50** may be greater than the thickness T_2 of the small planar members **55**. Thus, one set of planar members **50** may be both wider and thicker than the other set of planar members **55**. In other words, one set of planar members **50** may be larger than the other set of planar members **55**.

In one embodiment, the distance D_1 spanned by the large planar members **50** is between approximately 5 mm and approximately 30 mm, with one embodiment having a distance D_1 of approximately 20 mm, and the distance D_2 spanned by the small planar members **55** is between approximately 5 mm and approximately 20 mm, with one embodiment having a distance D_2 of approximately 14 mm. The width W_1 of a large planar member **50** is between approximately 2.5 mm and approximately 15 mm, with one embodiment having a width W_1 of approximately 5 mm, and the width W_2 of a small planar member **55** is between approximately 1 mm and approximately 10 mm, with one embodiment having a width W_2 of approximately 3 mm. The thickness T_1 of a large planar member **50** is between approximately 2 mm and approximately 20 mm, with one embodiment having a thickness T_1 of approximately 4 mm, and the thickness T_2 of a small planar member **55** is between approximately 1 mm and approximately 10 mm, with one embodiment having a thickness T_2 of approximately 2 mm.

As indicated in FIGS. **5-15**, the first set of planar members **50** are generally perpendicular with the second set of planar members **55**. Since the sets of planar members **50**, **55** are perpendicular to each other, in one embodiment; the intersection of the planar members **50**, **55** at a central longitudinal axis of the implant **25** may form the body **45** of the implant **25**.

In other embodiments, and as illustrated in FIGS. **5-14**, the body **45** may be of a distinct shape so as to have, for example, a cylindrical or other configuration. In one embodiment, as indicated in FIG. **14**, the cylindrical body **45** has a radius R_1 of between approximately 1 mm and approximately 20 mm, with one embodiment having a radius R_1 of approximately 10 mm.

As illustrated in FIG. **12**, in one embodiment, the implant **25** has a length L_1 of between approximately 5 mm and approximately 70 mm, with one embodiment having a length L_1 of approximately 45 mm.

As indicated in FIGS. **5** and **9-14**, the implant distal end **42** may have a bulletnose or otherwise rounded configuration, wherein the rounded configuration extends outward away from the distal extremity of the body **45** and along the distal or leading edges of the planar members **50**, **55**. Thus, as can be understood from FIGS. **5** and **9-13**, the leading or distal edges **57** of the planar members **50**, **55** may be rounded in the radially extending length of the lead or distal edges and/or in a direction transverse to the radially extending length of the lead or distal edges. In one embodiment, the leading edges **57** of the planar members **50**, **55** each have a radius R_2 of between approximately 1 mm and approximately 15 mm, with one embodiment having a radius R_2 of approximately 10 mm. In one embodiment, the leading end **42** of the implant body **45** and the leading edges **57** of the planar members **50**, **55** have a generally conical point configuration.

As indicated in FIGS. **6-8**, **10-13**, and **15**, the implant proximal end **43** has a generally planar face that is generally perpendicular to a longitudinal center axis CA of the implant **25**. A center attachment bore **70** and two lateral attachment bores **75** on opposite sides of the center bore **70** are defined in the implant proximal end **43**. The center bore **70** is centered about the longitudinal center axis CA, and the lateral attachment bores **75** are near outer ends of the long planar members **50**, generally centered in the thickness of the larger planar members **50**. Alternatively, in particular embodiments, the implant proximal end **43** can be configured to have a face similarly configured to the implant distal end **42** (i.e. rounded, bullet nosed, etc.) to allow for a simplified removal of implant **25** during a revision surgery.

As indicated in FIGS. **16** and **17**, the center bore **70** may be a blind hole in that it only has a single opening. Alternatively, the center bore **70** may be configured as a hole that communicates between the implant proximal end **43** and implant bore **40**. A center bore so configured may be able to receive a fastener to permit interference with the anchor member **30** extending through the bore **40** after implantation to resist migration of said anchor member.

As illustrated in FIG. **16**, the lateral bores **75** are also blind holes and can be configured to not extend nearly as far into the body **45** as the center hole **70** and can be configured to be not nearly as great in diameter as the center hole **70**. 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. In one embodiment, the lateral attachment bores **75** can each have a diameter of between approximately 0.5 mm and approximately 3 mm, with one embodiment having a diameter of approximately 1.5 mm.

As can be understood from FIG. **17**, the implant bore **40**, which is configured to receive the anchor member **30**, has a longitudinal center axis BA that is generally transverse to the longitudinal center axis CA of the implant **25**. In one embodiment, the implant bore longitudinal center axis BA forms an angle $A_{BA\text{-}CA}$ with the implant longitudinal center axis CA. For example, the angle $A_{BA\text{-}CA}$ may be between approximately 15 degrees and approximately 135 degrees, with one embodiment being approximately 45 degrees.

As shown in FIGS. **4-17**, the bore **40** is generally located within a plane with which the small radial planar members **55** are located. That the bore **40** is located in the same plane as occupied by the small radial planar members **55** is also the case where the bore **40** angularly deviates from being perpendicular with the longitudinal axis of the implant body **45**.

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. **4-17**, except the bore **40** of the implant **25** may be angled side-to-side relative to the longitudinal axis of the implant body **45** such that the bore **40** is not contained in the plane occupied by the small radial planar members **55**. For example, as shown in FIGS. **118**A-**118**C, which are, respectively, isometric and opposite plan views of an implant **25** with such a side-to-side deviated bore **40**, the bore daylights in the body **45** and large radial planar members **50**. In doing so, the bore **40** deviates side-to-side from the plane in which the small planar members **55** are located. Since the bore daylights in the body **45** and large planar members **50**, the bore **40** of FIGS. **118**A-**118**C differs from that of FIGS. **4-17**, wherein the bore **40** daylights in the small radial members **55**.

Just like delivery tool **20** of FIG. **2**A has an as-manufactured configuration that allows the anchor arm **115** to deliver the anchor element **30** to the bore **40** of the implant **25** of FIGS. **4-17** without necessitating modification of the delivery tool **20** configuration subsequent to the tool **20** leaving its manufacturing facility, a delivery tool **20** can be configured to similarly interact with the bore **40** of the implant **25** of FIGS. **118**A-**118**C.

In some embodiments, the implant **25** may be substantially as described above with respect to FIGS. **4-17**, except the implant **25** may further include an anchor member receiving arm **300**. For example, as shown in FIGS. **51-52**, which are, respectively, isometric and side elevation views of an implant **25** having an anchor member receiving arm **300**, the arm **300** may be generally cantilevered off of the proximal end **43** of the implant **25**. The arm **300** includes a free end **305** with a disk-shaped seat **310** having a center hole **315** with a center axis that is coaxially aligned with the center axis BA of the bore **40**.

In one embodiment, the arm **300** is rigidly fixed to the implant proximal end **43**. In other embodiments, the arm **300** may be in a pivotable or hinged configuration with the implant proximal end **43** to allow movement between the implant **25** and arm **300**. Such a hinged arm configuration may be further configured to have a free end **305** which may have a hole **315** (or slot). Due to the hinged configuration of the arm, the arm may be pivoted relative to the rest of the implant such that the center axis of hole **315** may be directed to avoid placing an anchor in a bore **40** or hit the implant **25**. In other words, because of the hinged configuration, the arm may be oriented relative to the rest of the implant such that the axis of hole **315** directs an anchor **40** around an implant **25** (i.e., the axis of hole **315** will avoid intersecting the implant **25**).

As illustrated in FIG. **53**, which is an enlarged view of the disk-shaped seat **310**, 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 arms 300 may have an anchor member locking mechanism with a different configuration. For example, as illustrated in FIG. 54, which is an isometric view of an implant 25 with another type of anchor member locking mechanism, the arm 300 may be generally cantilevered off of the proximal end 43 of the implant 25. The arm 300 includes a free end 305 with a center hole 315 with a center axis that is coaxially aligned with the center axis BA of the bore 40. As illustrated in FIG. 55, which is an enlarged view of the free end 305, the hole 315 has a cantilevered abutment arm 335 defined in the body of the arm 300 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 hole 315 such that when the anchor member 30 is extended through the hole 315, the face 345 abuts against the anchor member 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.

While in the implant embodiment discussed with respect to FIGS. 4-17 may have a cylindrical body 45 at which the planar members 50, 55 intersect, in other embodiments the body 45 of the implant 25 may simply be the region 45 of the implant 25 where the planar members 50, 55 intersect. For example, as shown in FIGS. 56-61, which are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of an implant 25, the body 45 of the implant 25 is simply the region 45 of the implant 25 where the planar members 50, 55 intersect. Although not shown in FIGS. 56-61, in one embodiment, the implant 25 has the bore 40 and holes 70, 75 substantially as depicted and discussed with respect to the implant of FIGS. 4-17. Also, the rest of the features of the implant 25 of FIGS. 56-61 are substantially as discussed with respect to the implant 25 of FIGS. 4-17, a main difference being the lack of the cylindrical body 45 and the edges of adjacent intersecting surfaces of the implant 25 of FIGS. 56-61 being rounded or arcuate as opposed to sharp or well-defined edges, as is the case between adjacent intersecting surfaces of the implant embodiment of FIGS. 4-17.

Depending on the embodiment, the implant 25 may have surface features or texture designed to prevent migration of the implant once implanted in the joint space. For example, as shown in FIGS. 62-67, which are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of an implant 25 with anti-migration surface features 355, the body 45 of the implant 25 is simply the region 45 of the implant 25 where the planar members 50, 55 intersect. Although not shown in FIGS. 62-67, in one embodiment, the implant 25 has the bore 40 and holes 70, 75 substantially as depicted and discussed with respect to the implant of FIGS. 4-17. Also, the rest of the features of the implant 25 of FIGS. 62-67 are substantially as discussed with respect to the implant 25 of FIGS. 56-61, a main difference being the edges of adjacent intersecting surfaces the implant 25 of FIGS. 56-61 being sharp or well defined edges as opposed to round or arcuate edges, as is the case between adjacent intersecting surfaces of the implant embodiment of FIGS. 56-61.

As to particular embodiments as shown in FIGS. 56-61, 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 of the implant 20, to evaluate particular embodiments of an implant as described herein that would be best suited to a particular patient, application or implant receiving space.

As shown in FIGS. 62-67, the anti-migration features 355 are generally evenly distributed along the planar surfaces 60, 65 of the planar members 50, 55 in a rows and columns arrangement. The anti-migration features 355 are generally similarly distributed along the planar surfaces of the edges of the planar members 55. The anti-migration features 355 may be in the form of trapezoids, squares, rectangles, etc. As indicated in FIG. 66, the anti-migration features 355 may have a rectangular cross sectional elevation with a thickness FT of between approximately 0.2 mm and approximately 5 mm, with one embodiment having a thickness FT of approximately 1 mm.

As another example, as shown in FIGS. 68-73, which are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of an implant 25 with another type of anti-migration surface features 355, the body 45 of the implant 25 is simply the region 45 of the implant 25 where the planar members 50, 55 intersect. Although not shown in FIGS. 68-73, in one embodiment, the implant 25 has the bore 40 and holes 70, 75 substantially as depicted and discussed with respect to the implant of FIGS. 4-17. Also, the rest of the features of the implant 25 of FIGS. 68-73 are substantially as discussed with respect to the implant 25 of FIGS. 62-67, including the sharp or well defined edges between adjacent intersecting surfaces of the implant 25.

As shown in FIGS. 68-73, the anti-migration features 355 are in the form of unidirectional serrated teeth or ridges 355, wherein the ridges 355 have a triangular cross sectional elevation best understood from FIGS. 70 and 71, wherein the rearward or trailing end of the features 355 are the truncated or vertical end of the triangle cross sectional elevation, and the front or leading end of the features 355 are the point end of the triangle cross sectional elevation. As indicated in FIG. 71, the anti-migration features 355 with the triangular cross sectional elevations have a thickness FT of between approximately 0.2 mm and approximately 5 mm, with one embodiment having a thickness FT of approximately 1 mm, and a length FL of between approximately 0.5 mm and approximately 15 mm, with one embodiment having a thickness FT of approximately 2.5 mm. The triangular ridges 355 are generally evenly distributed along the planar surfaces 60, 65 of the planar members 50, 55 in ridges that run transverse to the length of the implant 25. The anti-migration features 355 are generally similarly distributed along the planar surfaces of the edges of the planar members 55.

In continuing reference to FIGS. 68-73, although the anti-migration features 355 are depicted in the form of unidirec-

tional serrated teeth or ridges **355** on each of the textured surfaces of the implant, the invention is not so limited and, as to particular embodiments, can be configured to have said features **355** 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 **355** 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**.

Depending on the embodiment, the implant **25** may have an edge configuration of the planar members **55** designed to prevent migration of the implant once implanted in the joint space. For example, as shown in FIGS. **74-79** which are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of an implant **25** with anti-migration edges or ends **360**, the body **45** of the implant **25** is simply the region **45** of the implant **25** where the planar members **50**, **55** intersect. Although not shown in FIGS. **74-79**, in one embodiment, the implant **25** has the bore **40** and holes **70**, **75** substantially as depicted and discussed with respect to the implant of FIGS. **4-17**. Also, the rest of the features of the implant **25** of FIGS. **74-79** are substantially as discussed with respect to the implant **25** of FIGS. **56-61**, with the exception of the anti-migration edges **360** of the implant embodiment of FIGS. **74-79**.

As shown in FIGS. **74-79**, the anti-migration edges **360** of the planar members **55** are in the form of notches **365** generally evenly distributed along longitudinally extending free edges or ends of the planar members **55**. As indicated in FIG. **77**, the notches **365** may have parallel sides **370** inwardly terminating as an arcuate end **375**. The orientation of each notch **365** may be such that the center line NL of the notch **365** forms an angle NA with the center axis CA of the implant **25** that is between approximately 90 degrees and approximately 15 degrees, with one embodiment having an angle NA of approximately 45 degrees. As indicated in FIG. **77**, each notch **365** may have a length LN between the extreme point on the arcuate end **375** and the outer edge boundary of the notch of between approximately 0.2 mm and approximately 10 mm, with one embodiment having a length LN of approximately 3 mm. Each notch **365** may have a width WN of between approximately 0.5 mm and approximately 20 mm, with one embodiment having a width WN of approximately 2 mm.

As another example, as shown in FIGS. **80-85**, which are, respectively, front isometric, rear isometric, side elevation, plan, front elevation, and rear elevation views of an implant **25** with another type of anti-migration edges or ends **360**, the body **45** of the implant **25** is simply the region **45** of the implant **25** where the planar members **50**, **55** intersect. Although not shown in FIGS. **80-85**, in one embodiment, the implant **25** has the bore **40** and holes **70**, **75** substantially as depicted and discussed with respect to the implant of FIGS. **4-17**. Also, with the exception of its anti-migration edges **360** and its more arcuate distal or leading end **42**, the rest of the features of the implant **25** of FIGS. **80-85** are substantially as discussed with respect to the implant **25** of FIGS. **62-67**, including the sharp or well defined edges between adjacent intersecting surfaces of the implant **25**.

As shown in FIGS. **80-85**, the anti-migration edges **360** are flared longitudinally extending free edges or ends of the planar members **55**. The edges **360** include a series of ridges **370** that are generally evenly distributed along the length of the edges **360** and oriented transverse to the length of the edges **360**.

As indicated in FIG. **83**, the ridges **370** have triangular cross sectional elevations with an overall height RA of between approximately 0.2 mm and approximately 8 mm, with one embodiment having a width RA of approximately 1 mm. As illustrated in FIG. **85**, the flared longitudinally extending free edges or ends of the planar members **55** have rim edges **380** defining the top and bottom edges of the anti-migration edges **360** of the planar members **55**, wherein the rim edges **380** have slopes **385** transitioning between the planar surfaces **65** of the planar members **55** and the rim edges **380**.

The edges **360** have a height EH between the edges **380** of between approximately 0.5 mm and approximately 15 mm, with one embodiment having a height EH of approximately 4 mm. The width EW of the flared edge **360** from the beginning of the sloped transition **385** to the face of the edge **360** is between approximately 0.2 mm and approximately 9 mm, with one embodiment having a width EW of approximately 1 mm.

In particular embodiments, the implants with features as described above with respect to FIGS. **62-83** can alternatively be configured to function as a broach or other surgical site preparation tool that can assist in the removal of certain tissues, for example, cartilage or bone, during certain steps of a procedure.

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 implant assembly **15** components **25**, **30**, 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 an arm assembly **85**, a handle **90**, an implant retainer **95**, a sleeve **100** and a trocar or guidewire **105**. As shown in FIG. **18**, which is a proximal isometric view of the arm assembly **85**, the arm assembly **85** includes an implant arm **110** and an anchor arm **115** supported off of the implant arm **110**. The implant arm **110** includes a distal end **120**, a proximal end **125** and a proximal cylindrical opening **130** of a cylindrical bore **132**. The proximal end **125** includes a squared outer surface configuration **135** that facilitates a mechanical engagement arrangement with the handle **90** such as the mechanical arrangement that exists between a wrench and nut.

As shown in FIG. **19**, which is a distal isometric view of the arm assembly **85**, the distal end **120** includes cylindrical opening **137** of a cylindrical bore **132**, large planar members, keels, or fins **140** and small planar members, keels, or fins **145**, pins **150**, and a planar extreme distal face **152**. As depicted in FIG. **20**, which is a longitudinal cross section of the implant arm **110** as taken along section line **20-20** in FIG. **18**, the cylindrical bore **132** extends the full length of the implant arm **110** between the proximal opening **135** and the distal opening **137**.

For a detailed discussion of the interaction between the features of the implant arm distal end **120** and the proximal end **43** of the implant **25**, reference is now made to FIGS. **2A** and **21A** and **22-24**. FIG. **21A** is a side elevation of the system **10** wherein the tool **20** is attached to the implant assembly **15** for delivery of the implant assembly **15** to the sacroiliac joint. FIG. **22** is the same view as FIG. **21A**, except shown as a longitudinal cross section. FIG. **23** is an enlarged view of the distal region of the system **10** circled in FIG. **22**. FIG. **24** is an enlarged cross sectional plan view taken in a plane 90 degrees from the section plane of FIG. **23**.

As can be understood from FIGS. **2**A and **21**A and **22**-**24**, when the system **10** is assembled for the delivery of the implant assembly **15** to the sacroiliac joint, the proximal end **43** of the implant **25** (see FIG. **6**) is supported off of the implant arm distal end **120** (see FIG. **19**). As can be understood from a comparison of FIGS. **6** and **19** and more clearly depicted in FIGS. **23** and **24**, the cylindrical body **45**, and planar members **50**, **55** of the implant **25** and the cylindrical implant arm **110** and planar members **140**, **145** of the implant arm **110** respectively correspond with respect to both shape and size such that when the implant **25** is supported off of the implant arm distal end **120** as depicted in FIGS. **2**A and **21**A and **22**-**24**, the respective outer surfaces of the implant **25** and implant arm distal end **120** transition smoothly moving from the implant **25** to the implant arm distal end **120**, and vice versa. Also, as shown in FIGS. **23** and **24**, when the system **10** is assembled for the delivery of the implant assembly **15** to the sacroiliac joint, the planar extreme proximal face **43** of the implant **25** abuts against the planar extreme distal face **152** of the implant arm distal end **120**, the pins **150** being received in a recessed fashion in the lateral bores **75**. The pins **150** being received in the lateral bores **75** prevents the implant **25** from pivoting relative to the implant arm **110**. The pins **150** can be configured to have a rectangular, circular or any other cross section and the corresponding lateral bores **75** can also be configured to have corresponding shapes in cross section.

Alternatively, in order to further restrict undesirable movement between components of a system **10**, namely between that of a delivery tool **20** and an implant **25**, the distal face **152** of the implant arm distal end **120** can be configured to rap around, and can also be recessed into or grappled to, the exterior surface of the elongate body **45**, or planar members **50**, or **55** of the implant **25** a distance DE, from about 0.2 mm to about 20 mm (e.g., 10 mm), in the direction of implant distal end **42**. According to particular embodiments, a recess can extend a distance DA from said exterior surfaces in the general direction of implant longitudinal axis CA, from about 0.25 mm to 5 mm (e.g., 1.25 mm). In a non-limiting example of a particular embodiment, the distal face **152** of the implant arm distal end **120** can be further configured to wrap completely or only a portion of the periphery of an implant by occupying only a portion, CAR, as defined by a number of degrees around implant longitudinal axis CA, from about 1 degree to about 180 degrees (e.g., 30 degrees). In particular embodiments, said features can be configured to be located in the area between the planar members **50** and **55**.

As shown in FIGS. **18** and **19**, the anchor arm **115** is supported off of the implant arm **110** at an angle and includes a proximal end **155** and a distal end **160** distally terminating in a sleeve or collar **165** having a longitudinal center axis LCA_1 that is generally transverse to the longitudinal axis of the anchor arm **115**. Collar **165** has a length of between approximately 10 mm and approximately 60 mm (e.g., 20 mm) disposed between collar ends **166** and **167** configured to permit and maintain accurate alignment of the first sleeve **100** along LCA_1 during the course of the procedure. The anchor arm proximal end **155** intersects the implant arm **110** at a location between the proximal and distal ends of the implant arm.

As indicated in FIGS. **18** and **19**, the implant arm **110** also includes a longitudinal center axis LCA_2. As shown in FIG. **21**A, when the system **10** is assembled such that the implant **25** is mounted on the distal end of the implant arm **110**, the longitudinal center axis CA of the implant **25** is coaxially aligned with the longitudinal center axis LCA_2 of the implant arm **110**, and the longitudinal center axis BA of the implant bore **40** is coaxially aligned with the longitudinal center axis LCA_1 of the anchor arm collar **165**. Thus, the longitudinal center axis CA of the implant **25** and the longitudinal center axis LCA_2 of the implant arm **110** exist on a first common longitudinally extending axis, and the longitudinal center axis BA of the implant bore **40** and the longitudinal center axis LCA_1 of the anchor arm collar **165** exist on a second common longitudinally extending axis.

In one embodiment, the longitudinal center axis LCA_1 of the anchor arm collar **165** forms an angle $A_{LCA1\text{-}LCA2}$ with the longitudinal center axis LCA_2 of the implant arm **110**. For example, the angle $A_{LCA1\text{-}LCA2}$ may be between approximately 15 degrees and approximately 135 degrees, with one embodiment being approximately 45 degrees.

As can be understood from FIG. **21**A, when the system **10** is assembled such that the implant **25** is mounted on the distal end of the implant arm **110**, the longitudinal center axis LCA_2 of the implant arm **110** is coaxial with the longitudinal center axis CA of the implant **25** and the longitudinal center axis of the handle **90**. Thus, the line of action for the insertion of the implant **25** into the sacroiliac joint is coaxial with the longitudinal center axes of the implant **25**, implant arm **110** and handle **90**.

As can be understood from the preceding discussion, in one embodiment, when the system **10** is assembled such that the implant **25** is mounted on the distal end of the implant arm **110**, the angle $A_{BA\text{-}CA}$ may be substantially the same as the angle $A_{LCA1\text{-}LCA2}$. Also, the longitudinal center axis BA of the implant bore **40** is coaxially aligned with the longitudinal center axis LCA_1 of the anchor arm collar **165**. Thus, as will be described in detail below, the anchor arm collar **165** is oriented so as to guide drills and other tools in creating a channel through tissue and bone leading to the implant bore **40** when the implant **25** is positioned in the sacroiliac joint while the implant **25** is still attached to the distal end of the implant arm **110**, as shown in FIG. **21**. Additionally, the anchor arm collar **165** is oriented so as to guide the anchor member **30** into the implant bore **40** when the implant **25** is positioned in the sacroiliac joint while the implant **25** is still attached to the distal end of the implant arm **110**, as shown in FIG. **21**A.

As can be understood from FIG. **21**A, in one embodiment, the above-described coaxial and angular relationships are rigidly maintained due to the anchor arm **115** and its collar **165** being in a fixed, non-adjustable configuration, and the interconnection between the proximal end of the anchor arm **115** and the implant arm **110** being a fixed, non-adjustable configuration at least with respect to the angle $A_{LCA1\text{-}LCA2}$ between the longitudinal center axis LCA_1 of the anchor arm collar **165** and the longitudinal center axis LCA_2 of the implant arm **110**. Thus, in one embodiment, the delivery tool **20** comes from the manufacture to the physician in a fixed, non-adjustable configuration having the coaxial and angular relationships articulated above with respect to FIG. **21**A.

FIG. **21**B is the same view as FIG. **21**A, except of another embodiment of the delivery tool **20** wherein the tool **20** includes multiple anchor arms **115**A-**115**D that can be coupled to specific respective locations **168**A-**168**D on the implant arm **110** to account for different patient sizes, yet still maintain the coaxial and angular relationships set out above. As shown in FIG. **21**B, the delivery tool **20** may include two or more, for example, four, anchor arms **115**A-**115**D, each anchor arm having a different overall length. Despite having different overall lengths, because each anchor arm **115**A-**115**D is configured to couple to a specific respective location **168**A-**168**D on the implant arm **110**, the longitudinal center axis LCA_1 of each anchor arm collar **165**A-**165**D is still coaxially aligned with the longitudinal center axis BA of the

implant bore **40** when each anchor arm is mounted at its correct respective location **168**A-**168**D on the implant arm **110**. Thus, although the embodiment depicted in FIG. **21**B is adjustable with respect to patient size via the interchangeable anchor arms **115**A-**115**D, the above-described coaxial and angular relationships are rigidly maintained due to the anchor arms **115**A-**115**D and their collars **165** being in a fixed, non-adjustable configuration, and the interconnection between the proximal end of the anchor arms **115**A-**115**D and the implant arm **110** being, a fixed, non-adjustable configuration at least with respect to the angle $A_{LCA1\text{-}LCA2}$ between the longitudinal center axis LCA_1 of the anchor arm collar **165** and the longitudinal center axis LCA_2 of the implant arm **110**. Thus, although the embodiment depicted in FIG. **21**B is adjustable with respect to the patient size via the interchangeable anchor arms **115**A-**115**D, the delivery tool **20** comes from the manufacture to the physician in a fixed, non-adjustable configuration with respect to the coaxial and angular relationships articulated above with respect to FIG. **21**A.

Although not shown in FIG. **21**B, in some embodiments, multiple sleeves **100** may be provided with the system **10**. For example, the system **10** may include four anchor arms **165**A-**165**D of different lengths and the system may also include four sleeves **100** of different lengths, each sleeve **100** being configured for use with a specific anchor arm. For example, since anchor arm **165**D is the longest anchor arm, its corresponding sleeve **100** may be the longest of the sleeves. Similarly, since anchor arm **165**A is the shortest anchor arm, its corresponding sleeve **100** may be the shortest of the sleeves.

Because of the multiple interchangeable anchor arms **165**A-**165**D that are each configured for attachment to a specific respective location **168**A-**168**D on the implant arm **110**, the delivery tool **20** may be adjusted to accommodate patients of different sizes and still maintain the angular relationships between the components of system **10** that allows the anchor member **30** to be delivered into the implant bore **40** without any further adjustment to the delivery tool. Because the angular relationships are rigidly maintained between the arms **110**, **115**, the collar **165**, and the implant bore **40** despite the anchor arms **115**A-**115**B being interchangeable, the anchoring of the implant **25** in the sacroiliac joint via the anchor member **30** may be achieved quickly and safely. In other words, because the tool does not need to be adjusted with respect to angular relationships, the surgery is simplified, reduced in duration, and reduces the risk of the anchor member **30** being driven through a nerve, artery or vein.

In some embodiments, the system **10** may be provided with two or more tools **20**, each tool having a configuration for a specific size of patient. For example, the tool **20** depicted in FIG. **21**A may be provided for smaller patients in that there is reduced distance between the anchor arm collar **165** and the implant **25**. As depicted in FIG. **21**C, which is the same view of FIG. **21**A, except illustrating a version of the same tool **20** configured to accommodate larger patients, the distance between anchor arm collar **165** and implant **25** is greater due to the anchor arm **165** being more proximally located on the implant arm **110** as compared to the configuration depicted in FIG. **21**A. It should be noted that, although the version depicted in FIG. **21**C is configured to accommodate larger patients, the coaxial and angular relationships discussed above with respect to FIG. **21**A are the same for the version depicted in FIG. **21**C. For the version depicted in FIG. **21**C, the sleeve **100** is substantially elongated as compared to the sleeve **100** of FIG. **21**A. Depending on the size of the patient, the physician may select or be provided with one of the tool configurations shown in FIG. **21**A or **21**C.

Additionally, the sleeve **100** of FIG. **21**C can be prevented from undesired migration within the anchor arm collar **165** during a procedure by utilizing a locking mechanism **163** in close proximity to the collar **165**. As a non-limiting example, a locking mechanism can be configured as a fastener **163**, which, in certain embodiments, can be threaded and rotatably advanced into the collar **165** to cause a greater amount of friction upon the sleeve **100**.

As shown in FIGS. **25-27**, which are various isometric views of the handle **90**, the handle **90** includes a gripping portion **170**, a neck portion **175**, a proximal end **180**, a distal end **185**, a proximal opening **190**, a distal opening **195** and a bore **200** extending longitudinally through the handle **90** between the openings **190**, **195**. The proximal opening **190** is defined in the proximal end **180**, which forms the extreme proximal portion of the gripping portion **170**. The distal opening **195** is defined in the distal end **185**, which forms the extreme distal portion of the neck portion **175**. The neck portion **175** has multiple regions having different diameters, thereby forming a collared configuration. The gripping portion **170** may have a generally spherical or oval hemispheric shape.

As shown in FIG. **27**, a squared inner surface configuration **205** is defined in a segment of the bore **195** located in the neck portion **175**, the rest of the bore **195** having a cylindrical configuration. Thus, as can be understood from FIGS. **1**, **21**A and **22**, when the implant arm distal end **125** is received in the handle bore **200**, the squared inner surface configuration **205** facilitates a mechanical engagement arrangement with the squared outer surface configuration **135** of the implant arm distal end **125**. As a result, grasping the handle so as to cause the handle to pivot about its longitudinal center axis causes the implant arm to similarly pivot about its longitudinal center axis, which is generally coaxial with the longitudinal center axis of the handle. The fit between the squared surface configurations **135**, **205** may be such as to form an interference fit, thereby preventing the handle from being pulled off of the implant arm distal end without the intentional application of substantial separating force.

As illustrated in FIGS. **28** and **29**, which are full isometric and longitudinal cross sectional isometric views of the implant retainer **95**, the implant retainer **95** includes a longitudinal cylindrical member **210**, T-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 FIGS. **2**A and **21**A and **22-24**, when the system **10** is assembled for the delivery of the implant assembly **15** to the sacroiliac joint, the longitudinal cylindrical member **210** extending through the handle bore **200** (see FIG. **27**) and implant arm bore **132** (FIG. **20**) such that a distal side of the T-handle **215** abuts or nearly abuts with the handle proximal face or end **180** (FIG. **25**) and the implant engagement feature **220** is received in the implant center bore **70** (FIG. **6**). 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 against the implant arm distal face and the pins in the lateral bores, as depicted in FIGS. **22-24**. In other embodiments, the implant engagement feature **220** and the center bore **70** are configured so as to form an interference fit between the two such that an intentional separating force is required to remove the implant engagement feature from within the center bore and allow the release of the implant from the distal end of the implant arm, as indicated in FIG. **2**B.

FIG. **30**A is an isometric view of a sleeve **100** that is configured to be received in the anchor arm collar **165**, as can be understood from FIGS. **2**A, **21**A, and **22-23**. The sleeve **100** may have a tubular portion **225** that extends from a plate **230** and defines a lumen **226** extending the length of the tubular portion **225**. As indicated in FIG. **30**B, which is a longitudinal cross section of one embodiment of the sleeve **100**, the sleeve **100** is formed of multiple sleeve portions **100**A-**100**C nested together such that the tubular portions **225**A-**225**B are concentrically arranged and the plates **230**A-**230**B are stacked. As each sleeve portion **100**A-**100**C has a tubular portion **225**A-**225**B with a different diameter, the sleeve portions **100**A-**100**C can be employed as needed to dilate an incision opening or guide different diameter guidewires, trocars, drills, etc. in the direction of the implant bore **40**.

FIG. **31** is an isometric view of a trocar, guidewire, drill, screwdriver, etc. that may be inserted through the lumen **226** of the tubular portion **225** in gaining access to, or driving the anchor member **30** into, the implant bore **40** when the implant **25** is positioned in the sacroiliac joint via the distal end of the implant arm **110**.

To begin a detailed discussion of a second embodiment of the system **10**, reference is made to FIGS. **32-33**. FIG. **32** is an isometric view of the system **10**, and FIG. **33** is the same view as FIG. **32**, except the system **10** is shown exploded to better illustrate the components of the system **10**.

As can be understood from FIGS. **32** and **33**, 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. **33**, the implant assembly **15** includes an implant **25** and an anchor element **30** (e.g., a bone screw or other elongated body). In one embodiment, the implant assembly **15** is the same as that described above with respect to FIGS. **4-17**. 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. **32**. 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 element **30** to extend through the ilium, sacrum and implant **25** generally transverse to the sacroiliac joint and implant **25**. The delivery tool **20** is then decoupled from the implanted implant assembly **15**.

As shown in FIG. **32**, the delivery tool **20** includes a distal end **35** and a proximal end **80**. The distal end **35** supports the implant assembly **15** components **25**, **30**, 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. **33**, the delivery tool **20** further includes an arm assembly **85**, a handle **90**, an implant retainer **95**, and a trocar or guidewire **105**. As shown in FIG. **33** and also in FIG. **34**, which is a side elevation of the system **10**, the arm assembly **85** includes an implant arm **110** and an anchor arm **115**.

As shown in FIG. **35**, which is a proximal isometric view of the implant arm **110**, the implant arm **110** includes a distal end **120**, a proximal end **125** and a proximal cylindrical opening **130** of a cylindrical bore **132**. The proximal end **125** includes a squared outer surface configuration **135** that facilitates a mechanical engagement arrangement with the handle **90** such as the mechanical arrangement that exists between a wrench and nut. As the handle **90** is the same as described above with respect to FIGS. **25-27**, the handle **90** receives and mechanically interlocks with the distal region of the implant arm **110** as described above with respect to FIG. **22**.

As with the implant arm **110** discussed above with respect to FIG. **19** and as can be understood from FIG. **34**, the distal end **120** of the implant arm **110** includes a cylindrical opening **137** (see FIG. **19**) of a cylindrical bore **132**, large planar members, keels, or fins **140** and small planar members, keels, or fins **145**, pins **150**, and a planar extreme distal face **152** (see FIG. **19**). Just as explained with respect to FIG. **20** above, the cylindrical bore **132** of the embodiment depicted in FIG. **34** extends the full length of the implant arm **110** between the proximal opening **135** and the distal opening **137**.

As the retaining member **95** of the embodiment of FIG. **33** is the same as described above with respect to FIGS. **28-29**, the retainer member **95** extends through the handle **90** and implant arm **110** to mechanically interlock with the implant center bore **70** as described above with respect to FIGS. **22-24**. Also, the configuration of the distal end **120** of the implant arm **110** of FIG. **35** is the same as the configuration of the distal end **120** of the implant arm **110** of FIG. **19**. Accordingly, the distal end **120** of the implant arm **110** of FIG. **35** interacts with the proximal end of the implant **25** as describe above with respect to FIGS. **22-24**.

As indicated in FIG. **35**, the implant arm **110** includes pivot pins **235** on opposite sides of the implant arm **110**, the pivot pins **235** having a pivot axis PA that is perpendicular to the plane in which the implant bore **40** passes through the implant **25**. In other words, the pivot axis PA is perpendicular to the longitudinal center axis LCA_2 of the implant arm **110** and contained within the same plane as the longitudinal center axis LCA_2 of the implant arm **110**. The pivot pins **235** are located on the implant arm **110** near the distal end of the handle **90**.

As illustrated in FIG. **36**, which is an isometric view of the anchor arm **115**, the anchor arm **115** includes a proximal end **155** and a distal end **160** distally terminating in a sleeve or collar **165** that is arcuate and substantially extended as compared to the collar **165** of the embodiment depicted in FIG. **18**. The arcuate and extended collar **165** has an arcuate longitudinal center axis LCA_1 that is generally transverse to the longitudinal axis of the anchor arm **115**. A lumen **236** extends the length of the collar **165** to daylight in openings at both ends of the collar **165**.

As shown in FIG. **36**, the anchor arm proximal end **155** includes notches **240**, which, as can be understood from FIGS. **32** and **34**, receive the respective pivot pins **235**. As a result, the anchor arm **115** is pivotally supported off of the implant arm **110** via the notches **240** at the anchor arm proximal end **155** pivotally receiving the pivot pins **235** of the implant arm **110**.

As can be understood from FIGS. **32-34**, an arcuate member **105** can be inserted in the lumen **236** of the arcuate extended collar **165**. The curvature of the arcuate member **105** matches the curvature of the lumen **236** of the arcuate collar **165**. The arcuate member **105** may be a trocar, guidewire, drill, screwdriver, etc. that may be inserted through the lumen **236** of the collar **165** in gaining access to, or driving the anchor member **30** into, the implant bore **40** when the implant **25** is positioned in the sacroiliac joint via the distal end of the implant arm **110**. As indicated by the arrow A in FIG. **34**, the arcuate member **105** is slideably displaceable through the arcuate length of the collar **165**. Also, as indicated by arrow B, the anchor arm **110** is pivotal about the pivot pins **235**.

As indicated in FIG. **35**, the implant arm **110** includes a longitudinal center axis LCA_2. As shown in FIG. **34**, when the system **10** is assembled such that the implant **25** is mounted on the distal end of the implant arm **110**, the longitudinal

center axis CA of the implant **25** is coaxially aligned with the longitudinal center axis LCA_2 of the implant arm **110**, and the longitudinal center axis BA of the implant bore **40** is coaxially aligned with the longitudinal center axis LCA_1 of the anchor arm collar **165**. In other words, in the context of the embodiment of FIG. **34**, the arcuate longitudinal center axis LCA_1 extends to be coaxially aligned with the longitudinal center axis BA of the implant bore **40**. In one embodiment, as indicated in FIG. **34**, the longitudinal center axis LCA_1 of the anchor arm collar **165** has an arm radius R_{ARM} that extends into coaxial alignment with the longitudinal center axis BA of the implant bore **40**. For example, the arm radius R_{ARM} may be between approximately 50 mm and approximately 300 mm, with one embodiment being approximately 160 mm.

As can be understood from FIG. **34**, when the system **10** is assembled such that the implant **25** is mounted on the distal end of the implant arm **110**, the longitudinal center axis LCA_2 of the implant arm **110** is coaxial with the longitudinal center axis CA of the implant **25** and the longitudinal center axis of the handle **90**. Thus, the line of action for the insertion of the implant **25** into the sacroiliac joint is coaxial with the longitudinal center axes of the implant **25**, implant arm **110** and handle **90**. Thus, as will be described in detail below, the anchor arm collar **165** is oriented so as to guide drills and other tools in creating a channel through tissue and bone leading to the implant bore **40** when the implant **25** is positioned in the sacroiliac joint while the implant **25** is still attached to the distal end of the implant arm **110**, as shown in FIG. **34**. Additionally, the anchor arm collar **165** is oriented so as to guide the anchor member **30** into the implant bore **40** when the implant **25** is positioned in the sacroiliac joint while the implant **25** is still attached to the distal end of the implant arm **110**, as shown in FIG. **32**.

Because the tool embodiment depicted in FIG. **32** has an anchor arm **115** that is pivotally supported off of the implant arm **110** and the anchor arm collar **165** is arcuate and slideably receives an arcuate trocar, etc. **105**, the tool **20** is able to account for different patient sizes, yet still maintain the coaxial and angular relationships set out above. In other words, regardless of whether the anchor arm **115** is pivoted so as to move the anchor arm distal end **160** closer to or further away from the implant bore **40** to accommodate a smaller or larger patient, the trocar **105** can be withdrawn from or extended towards the implant bore **40** as needed to deliver the anchor **30** to the implant bore **40**, the trocar **105** being maintained in the necessary coaxial alignment of the longitudinal axis LCA_1 of the collar **165** with the longitudinal axis BA of the implant bore **40**.

Because the angular relationships are rigidly maintained between the trocar **105** and the implant bore **40** despite the anchor arm **115** being pivotal relative to the implant arm, the anchoring of the implant **25** in the sacroiliac joint via the anchor member **30** may be achieved quickly and safely. In other words, because the tool does not need to be adjusted with respect to angular relationships, the surgery is simplified, reduced in duration, and reduces the risk of the anchor member **30** being driven through a nerve, artery or vein.

To begin a detailed discussion of a third embodiment of the system **10**, reference is made to FIGS. **37-40**. FIGS. **37** and **38** are different isometric views of the system **10**. FIG. **39** is the same view as FIG. **37**, except the system **10** is shown exploded to better illustrate the components of the system **10**. FIG. **40** is a side elevation of the system wherein the tool is attached to the implant assembly for delivery of the implant assembly to the sacroiliac joint.

As can be understood from FIGS. **37-40**, 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. **39**, the implant assembly **15** includes an implant **25** and an anchor element **30** (e.g., a bone screw or other elongated body).

As can be understood from a comparison of FIGS. **2A-3** to FIGS. **37-40**, the delivery tool **20** of FIGS. **2A-3** is the same as the delivery tool **20** of FIGS. **37-40**. Thus, for a complete description of the delivery tool **20** of FIGS. **37-40** and its components, namely, the arm assembly **85**, handle **90**, implant retainer **95**, a trocar or guidewire **105**, and multiple nested sleeves **100**, refer back to the corresponding discussion given above with respect to FIGS. **2A-3** and **18-31**.

As indicated in FIGS. **37-40**, the system **10** includes an implant assembly **15** with an implant **25** similar the implant **25** discussed above with respect to FIGS. **4-18**, except the implant **25** of FIGS. **37-40** also includes a guide arm **265**. To begin a detailed discussion of components of the embodiment of the implant **25** of FIGS. **37-40**, reference is made to FIGS. **41-50**. FIGS. **41-44** are various isometric views of the implant **25**. FIGS. **45-46** are opposite plan views of the implant **25**, and FIGS. **47-50** are various elevation views of the implant.

A comparison of FIGS. **41-50** to FIGS. **5-18** reveals that the two implant embodiments are the same, except the implant embodiment of FIGS. **41-50** has a guide arm **265**. Thus, for a complete description of the features of the implant **25** other than the guide arm **265**, which is discussed below, refer back to the corresponding discussion given above with respect to FIGS. **5-18**.

As shown in FIGS. **41-45** and **46-50**, the guide arm **265** includes a longitudinally extending member **270** and a guide portion **275**. The guide arm **265** is cantilevered off of a side of the implant near the proximal or trailing end **43** of the implant **25**. Thus, the guide arm **265** includes an attached end **280**, which is attached to, or extends from, the implant proximal end **43**, and a free end **285**, which defines the guide portion **275**.

The longitudinally extending member **270** may be in the form of a planar member or other shaped member. As illustrated in FIG. **45**, the longitudinal axis LA of the member **270** is generally coplanar with the longitudinal axis CA of the implant body **45**. However, as indicated in FIG. **48**, the longitudinal axis LA of the member **270** forms an angle A_{LA-CA} with the longitudinal axis CA of the implant body **45**. For example, the angle A_{LA-CA} may be between approximately 5 degrees and approximately 60 degrees, with one embodiment being approximately 40 degrees.

As illustrated in FIGS. **41-45** and **47-50**, the guide portion **275** is in the form of a collar defining a central hole **290**. As indicated in FIG. **47**, the member **270** has an overall length AD from its intersection with the rest of the implant to the tip of the free end **285** of between approximately 5 mm and approximately 60 mm, with one embodiment being approximately 20 mm. Also, the center axis GA of the hole **290** is coaxially aligned with the center axis BA of the bore **40**. The overall length AE from the intersection of the member **270** with the rest of the implant to the center axis GA is between approximately 2 mm and approximately 58 mm, with one embodiment being approximately 17 mm.

Since the center axis GA of the hole **290** is coaxially aligned with the center axis BA of the bore **40**, when the system **10** is assembled such that the implant **25** is mounted on the distal end of the implant arm **110** with the longitudinal center axis LCA_2 of the implant arm **110** coaxial with the longitudinal center axis CA of the implant **25**, the respective longitudinal axes LCA_1, BA and GA of the anchor arm collar **165**, the bore **40** and the guide hole **290** are coaxially aligned,

as can be understood from FIG. **40**. Thus, when the implant body **45** is located in the sacroiliac joint and the guide collar **275** of the implant **25** is located near or against bone adjacent to the sacroiliac joint, the anchor member **30** may be accurately driven through the guide hole **290**, through the bone and through the implant bore **40** to anchor the implant at the sacroiliac joint in such a manner to allow the implant to fuse the joint.

In one embodiment, the implant **25** may be machined, molded, formed, or otherwise manufactured from stainless steel, titanium, ceramic, polymer, composite or other biocompatible materials. The anchor member **30** may be machined, molded, formed or otherwise manufactured from similar biocompatible materials. As an example, implant **25**, anchor **30** or delivery tool **20** may be manufactured by laser or electron beam additive manufacturing with, for example, EOSINT P 800 or EOSINT M 280 (available from EOS GmbH, Electro Optical Systems, Robert-Stirling-Ring 1, D-82152 Krailling/Munich), or Arcam A1 (available from Arcam AB (publ.), Krokslätts Fabriker 27A, SE-431 37 Molndal Sweden)

For the delivery tools **20** depicted in FIGS. **2**A, **21**A, **21**C, **32**, **37**, and **40**, the handle **90** and arm assembly **85** are coupled together so as to not allow rotational movement relative to each other, and the implant retainer **95** is rotationally displaceable within the handle **90** and arm assembly **85**. In other embodiments of the tool **20**, the handle **90** and implant retainer **95** are coupled together so as to rotate as a unit relative to the arm assembly **85**. An example of such an embodiment is illustrated in FIG. **86**, which is an isometric view of the delivery tool **20**.

As shown in FIG. **86**, the delivery tool **20** includes a distal end **35** and a proximal end **80**. As shown in FIGS. **87-88**, which are generally opposite isometric views of the delivery tool **20** in an exploded state, the tool **20** further includes an arm assembly **85**, a handle **90**, an implant retainer **95**, and a collar assembly **400**. The tool **20** may also include a sleeve **100** and a trocar or guidewire **105** as discussed above with respect to the embodiment of FIG. **3**.

As can be understood from FIGS. **86-88**, the arm assembly **85** includes an implant arm **110** and an anchor arm **115** supported off of the implant arm **110**. The implant arm **110** has a two-piece construction of an inner sleeve **110**A and an outer sleeve **110**B. The implant arm inner sleeve **110**A includes a distal end **120**, a proximal end **125**, a proximal cylindrical opening **130** of a cylindrical bore **132**, and a distal cylindrical opening **137** of the bore **132**. The cylindrical bore **132** extends the full length of the implant arm inner portion **110**A between the proximal opening **135** and the distal opening **137**. Longitudinally extending raised ribs **405** are radially distributed about the outer circumferential surface of the implant arm inner portion **110**A. The longitudinal ribs **405** distally terminate by intersecting a raised circumferential ring **410** on the outer circumferential surface of the inner implant arm portion **110**A. A groove **415** is circumferentially extends about the outer circumference of the implant arms inner portion **110**A. The distal end **120** of the implant arm inner portion **110**A also includes large planar members, keels, or fins **140** and small planar members, keels, or fins **145**, pins **150**, and a planar extreme distal face **152** similar to that discussed above with respect to the embodiment of FIG. **2**A.

As illustrated in FIGS. **87-88**, the implant arm outer portion **110**B includes a distal end **420**, a proximal end **425**, a proximal cylindrical opening **430** of a cylindrical bore **432**, and a distal cylindrical opening **437** of the bore **432**. The cylindrical bore **432** extends the full length of the implant arm outer portion **110**B between the proximal opening **435** and the distal opening **437**. Longitudinally extending grooves **440** are radially distributed about the inner circumferential surface of the bore **432** in an arrangement that matches the longitudinal raised ribs **405** of the implant arm inner portion **110**A such that the ribs **405** are received in the grooves **440** in a mated arrangement when the inner portion **110**A is received in the bore **432** of the outer portion **110**B. The anchor arm **115** extends off the implant arm outer portion **110**B at an angle as described above with respect to the previously discussed embodiments. The anchor arm **115** terminates at its free end in a collar **165** similar to those already discussed above.

As shown in FIGS. **87** and **88**, the implant retainer **95** includes a proximal end **215**, a distal end **220**, and a lumen **445** extending the full length of the implant retainer **95**. The proximal end **215** includes a squared, pentagonal or hexagonal outer surface configuration **450** that facilitates a mechanical engagement arrangement with the handle **90** such as the mechanical arrangement that exists between a wrench and nut. A ring **451** radial extends from the retainer **95** at the distal edge of the squared, pentagonal or hexagonal configuration **450**. The distal end **220** may be threaded or otherwise configured to engage a proximal end of anyone of the implants **25** disclosed herein.

As illustrated in FIGS. **87** and **88**, the collar assembly **400** includes a helical spring **455**, rings **460**A and **460**B, washer **460**C, retainer balls **461**, and a retaining collar **465**. As shown in FIG. **89**, which is an isometric view of the handle **90**, a cylindrical neck portion **470** of the handle **90** includes a shoulder **476** which slopes down to a circumferential groove **475** and a pair of holes **480** defined in the outer circumferential surface of the neck **470**.

As indicated in FIG. **90**, which is an exploded isometric view of the retaining collar **465** and handle **90** shown in longitudinal cross section, the holes **480** extend through the cylindrical wall **485** that defines the neck **470** and a cylindrical void **487** within the neck. A squared, pentagonal or hexagonal inner surface configuration **490** is defined in the handle **90** distal the cylindrical void **487** to receive in a mating arrangement the complementarily shaped outer configuration **450** of the proximal end of the implant retainer **95**. A lumen **495** extends from a proximal end of the handle to open into the squared, pentagonal or hexagonal inner surface configuration **490**.

As shown in FIG. **90**, the retaining collar **465** includes a proximal end **500**, a distal end **505**, an outer circumferential surface **510** and an inner circumferential surface **515** that defines the hollow interior of the collar **517**. The outer circumferential surface **510** extends radially outward to form a rim **520** near the proximal end **500**. The inner circumferential surface **515** has a stepped and ramped configuration. Specifically, working distal to proximal, the inner circumferential surface **515** includes a proximal inner ring **525** separated from an intermediate inner ring **530** by a proximal large diameter region **535** separated from a small diameter region **540** by a ramped surface **545**. Proximal the intermediate inner ring **530** is another large diameter region **550** bordered on its proximal boundary by a groove **555**.

As can be understood from FIG. **91**, which is a longitudinal cross section of the delivery tool **20** when assembled as shown in FIG. **86**, the implant arm inner portion **110**A is received in the implant arm outer portion **110**B such that the ribs **405** are matingly received in the corresponding slots **440** and the ring **410** abuts against the distal end **420** of the outer portion **110**B. The implant retainer **95** extends through the inner portion **110**A such that the distal end **220** of the implant retainer distally extends from the distal end **120** of the inner portion **110**A and the ring **451** abuts against the proximal end **125** of the inner portion **110**A. The proximal ends of the inner por-

tion **110**A and retainer **95** are received in the volume **487** (see FIG. **90**) of the neck **470**, the squared, pentagonal, or hexagonal portion **450** of the retainer **95** matingly received in the complementarily shaped volume **490** of the neck such that the ring **451** abuts against the step in the neck between the volume **490** of the neck and the rest of the volume of the neck distal thereto. The distal end of the neck **470** abuts against the proximal end **425** of the outer portion **110**B.

As illustrated in FIG. **91**, a first lock ring **460**A is received in the groove **555** in the collar **465**. A second lock ring **460**B is received in the circumferential groove **475**. A washer **460**C is received on the neck **470** and abuts shoulder **476**, which prevents washer **460**C from advancing proximally beyond shoulder **476**, and washer **460**C is held in place distally by second lock ring **460**B. Helical spring **455** circumferentially extends about the neck **470** between the washer **460**C and the intermediate inner ring **530** of the collar **465**. Thus, the spring biases the collar **465** distally on the neck **470**. First lock ring **460**A prevents collar **465** from distal disengagement from neck **470**; the ring **460**A, due to the forces exerted by a compressed spring **455** abuts washer **460**C under normal conditions until manipulation by a medical person acting to move collar **465** proximally which in turn moves first lock ring **460**A proximally thereby creating a further distance between first lock ring **460**A and washer **460**C.

As depicted in FIG. **91**, neck holes **480** can be configured to have a sufficient diameter to allow the retaining balls **461** to enter from the opening nearest the outer circumferential surface of the neck **470** and to be seated within holes **480**, the configuration further allowing a portion of the retaining balls **461** to extend into the cylindrical void **487** such to allow sufficient engagement with groove **415** as further described below. The neck holes **480** can be further configured, as depicted in FIG. **91**, to have a slight reduction in their diameter, the reduction of diameter occupying a small portion of the holes **480** nearest the cylindrical void **487**, thereby allowing for a configuration between neck **470**, neck holes **480** and retaining balls **461** such that the retaining balls **461** are resistant to completely entering cylindrical void **487** after the removal of inner portion of the implant retainer **95** and implant arm inner portion **110**A. The balls **461** are each held in their respective holes **480** in the neck **470** by the balls **461** being trapped between the neck holes **480** and inner circumferential surface of the collar **465**. Therefore, when the collar **465** is biased distally on the neck, the balls **461** are inwardly forced by the reduced diameter region **540** to lock into the groove **415** of the inner portion **110**A, retaining the proximal end of the anchor arm **110** in the handle/collar assembly. When the collar **465** is pulled proximally by a medical person using the tool **20**, the balls **461** are exposed to the large diameter region **535**, allowing the balls **461** sufficient play to radially outwardly move in the holes **480** to allow the balls to escape the groove **415**, thereby allowing the proximal end of the anchor arm **110** to be removed from the handle/collar assembly.

As shown in FIG. **91**, the lumens **495** and **445** are aligned to make one continuous lumen through the assembled tool **20**. Thus, the tool **20** can be fed over a guidewire, stylet, needle or etc., or such implements can be fed through the lumen. Also, a bone paste, in situ curable biocompatible material, or similar material can be fed through the lumen to an implant **25** positioned in the joint via the tool.

As can be understood from FIGS. **86-91**, the collar assembly **400** retains the proximal end of the implant arm **110** in the neck of the handle **90**. The collar assembly **400** can be displaced proximally on the neck of the handle **90** to allow the proximal end of the implant arm **110** to be removed from the neck of the handle. When the implant arm **110** is coupled to the handle **90**, the portions **110**A and **110**B of the implant arm **110** are locked together and prevented from displacing relative to each other, but the handle **90** and retainer **95** can be caused to rotate as a unit relative to the implant arm **110** to cause the distal end **220** of the retainer **95** engage or disengage the implant **25** as desired. Accordingly, the configuration allows for the removal of a handle **90** during the course of a procedure while allowing the retainer **95** to maintain engagement with implant **25** as desired.

Additionally, as a non-limiting example, according to particular embodiments, a reversible locking ratcheting mechanism can be employed to prevent undesired rotation of the handle and other components which could loosen the connection between implant **25** and retainer **95**.

As illustrated in FIG. **92**, which is a side view of an implant retainer **95** similar to that described with respect to FIGS. **86-91**, except having a modified distal end **220**. Specifically, the embodiment of FIG. **92** has T-shaped distal end **220**. In one embodiment, the T-shaped distal end **220** includes a cylindrical center portion **220**A and ears or tabs **220**B oppositely positioned on the center portion **220**A from each other.

FIGS. **93-94** are, respectively, longitudinal and transverse cross sectional views of an implant **25** with an engagement hole **70** configured to complementarily engage with the T-shaped distal end **220** of the retainer **95** of FIG. **92**. As illustrated in FIGS. **93-94**, the hole **70** includes a cylindrical longitudinally extending center portion **70**A with longitudinally extending grooves **70**B located oppositely from each other. Inner radially extending grooves **70**C intersect the distal ends of the grooves **70**B.

As shown in FIG. **95**, which is the same view as FIG. **93**, except with the retainer **95** received in the hole **70**, the cylindrical retainer portion **220**A is received in the cylindrical hole portion **70**A, and the retainer tab portions **220**B are received in the hole grooves **70**B. Once the distal end **220** of the retainer **95** is sufficiently received in the hole **70** such that the retainer tab portions **220**B are aligned with the associated radially extending grooves **70**C as illustrated in FIG. **95**, the retainer **95** can be rotated within the hole **70** to cause the tab portions **220**B to move into the radially extending grooves **70**C, thereby locking the distal end **220** of the retainer **95** in the hole **70** of the implant **25**. Grooves **70**C can be configured such as to form an interference fit, thereby preventing retainer **95** from being separated from the implant **25** without the intentional application of substantial rotational separating force. Reversing the rotation of the retainer can cause the tab portions **220**B to exit the radial grooves **70**C, thereby unlocking the retainer distal end from the implant hole. Alternatively, according to particular embodiments, as a non-limiting example, radially extending grooves **70**C can be configured to have at least one ramped surface, which upon rotation of retainer **95** into the grooves **70**C, urges the distal end **220** a distance further in the direction of distal end **42** of implant **25** thereby creating increased friction between ring **45** of retainer **95** and proximal end **125** of **110**A thereby preventing undesirable reverse rotation of the retainer without the intentional application of substantial rotational separating force, which otherwise could lead to an unlocking of the retainer distal end from the implant hole.

As illustrated in FIG. **93**, in one embodiment, the implant **25** may include a lumen **600** extending the length of the implant through the anchor hole **40** and the retainer engagement hole **70**. Such a lumen **600** may serve to receive a guidewire or stylet there through. Such a lumen **600** may serve to receive an injection of bone paste material, or other biocompatible material.

To begin a detailed discussion of a fourth embodiment of the system **10**, reference is made to FIGS. **109** and **110**. FIG. **109** is an isometric view of the system **10** wherein the tool **20** is attached to the implant **25** for delivery of the implant to the sacroiliac joint. FIG. **110** is a view of the system **10** wherein the implant **25** and anchor arm **115** are shown in plan view.

As can be understood from FIGS. **109-110**, the system **10** includes a delivery tool **20** and an implant **25** for implanting at the sacroiliac joint via the delivery tool **20**, the implant **25** being for fusing the sacroiliac joint. As can be understood from a comparison of FIGS. **109** and **86**, the tool embodiment of FIG. **109** is substantially similar to the tool embodiment of FIG. **86**, except the tool embodiment of FIG. **109** has an anchor arm **115** that distally ends in multiple anchor collars **165***a*-**165***d*.

As can be understood from a comparison of FIGS. **109** and **7**, the implant embodiment of FIG. **109** is substantially similar to the implant embodiment of FIG. **7**, except the implant embodiment of FIG. **109** has multiple bores **40***a*-**40***b*.

As illustrated in FIGS. **109-110**, the anchor collars **165** may include two linearly aligned center collars **165***a* and **165***b*, and a lateral anchor collar **165***c* and **165***d* may be located on either side of the most proximal center collar **165***b*. As indicated in FIG. **110**, the two center collars **165***a* and **165***b* may be axially aligned with the respective bores **40***a* and **40***b* of the implant **25** when the implant **25** is supported off of the distal end of the implant arm **110** of the tool **20**. As a result, an anchor member **30** (see, for example, FIG. **4**) may be delivered into each of the bores **40***a* and **40***b* via the respective anchor collars **165***a* and **165***b*. The lateral anchor collars **165***c* and **165***d* may be employed to deliver yet additional anchor members **30** to additional anchor member receiving features (e.g., bores, etc.) existing on, or extending from the sides of, the implant **25**, where such additional anchor member receiving features are present on the implant **25**. Alternatively, lateral collars **165***c* and **165***d* can be configured to deliver additional anchor members **30** into the bone of the ilium and sacrum while not passing through a bore **40** (i.e., preconfigured to place anchor members **30** immediately adjacent the longitudinal side edges of the implant **25**.

To begin a discussion regarding 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**, reference is first made to FIGS. **96**A-**98**B to identify the bone landmarks adjacent, and defining, the sacroiliac joint **1000**. FIG. **96**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. **96**B is an enlarged view of the hip region **1002** of FIG. **96**A. As illustrated in FIGS. **96**A and **96**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. **97**A is a lateral-posterior view of the hip region **1002** of the patient **1001** of FIG. **96**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. **97**B is an enlarged view of the hip region **1002** of FIG. **97**A. As shown in FIGS. **97**A and **97**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. **96**A and **96**B, except from another vantage point. The vantage point provided via FIGS. **97**A and **97**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. **98**A is a posterior view of the hip region **1002** of the patient **1001** of FIG. **96**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. **98**B is, an enlarged view of the hip region **1002** of FIG. **98**A. As shown in FIGS. **98**A and **98**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. **96**A and **96**B, except from yet another vantage point. The vantage point provided via FIGS. **98**A and **98**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. **96**A-**98**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. **99**A-**99**P, 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 **99-99** in FIG. **98**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. **99**A-**99**P are simplified for illustrative purposes and do not show these features to scale. Now referring primarily to FIG. **99**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. **99**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 a 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. **99**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. **99**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. **99**B) of the sacroiliac joint **1000**. More specifically, as can be understood from FIGS. **96**A-**98**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. **99**D, a passage from the incision **1053** (see FIG. **99**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. **96**A-**98**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. **100**A-**100**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**.

Now referring to FIGS. **101**A and **101**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. **99**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. **106**B) and the interarticular region **1044** which, for example, has been highlighted by contrast material as above described.

Now referring to FIG. **99**E, a cannulated drill bit **1070** can be advanced over the probe body **1054** and within a drill guide hole **1068** (see FIGS. **101**A and **101**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/YAG (yttrium-aluminum-garnet), argon, and ruby), electrosurgical equipment employing electromagnetic energy (the cutting 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 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. **99**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. **99**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. **99**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 a first radial member **50**, or an elongate body **45** having a first and second radial members **50** 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**, an elongate body **45** and at least one radial member **50** adapted for non-transverse placement between the articular surfaces **1016** or at least one radial member **55** adapted to extend into the bone of the sacrum **1004** or the ilium **1005**.

As a non-limiting example, FIG. **99**G shows a broach **1078** configured to remove a portion of the sacroiliac joint **1000** to produce a implant receiving space **1029** (shown in FIG. **99**H) to receive embodiments of the sacroiliac joint implant **25** having an elongate body **45** to which a first radial member **50** and a second radial member **50** extend along the longitudinal axis CA of the elongate body **45** in substantially opposed relation adapted to locate between the articular surfaces **1016** of the sacroiliac joint **1000** and further having a third radial member **55** and a fourth radial member **55** which extend along the longitudinal axis CA of the elongate body **45** in substantially opposed relation adapted to correspondingly extend correspondingly into the bone of the sacrum **1004** and the ilium **1005**.

Now referring primarily to FIGS. **102**A-**102**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**. While certain embodiments of the sacroiliac joint implant **25** may only provide an elongate body **45** which locates within a correspondingly configured implant receiving space **1029** to engage at least a portion of the bone of the ilium **1005** or sacrum **1004**, the invention is not so limited, and can further include at least a first radial member or a first and a second radial member at least a portion of the external surface of the first radial member **50** engaging 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 have a third radial member **55** and a fourth radial member **55**, the implant receiving space **1029** can further include one or more radial member receiving channels **1074**, which correspondingly allow the third and fourth radial members **55**, **55** 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 **1074** can forcibly urge the radial members **55**, **55** into the bone **1073** of the sacrum **1004** and the ilium **1005**. An anchor member **30** (such as treaded members) can be inserted through the bore **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, now U.S. Pat. No. 8,979,928, which is incorporated herein by reference, in some embodiments, the implant **25** may be implanted non-transversely in the cranial portion **1087** (see FIG. **102**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, now U.S. Pat. No. 8,979,928.

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. **99**I, **103**A, **103**B and **104**. FIG. **103**A is generally the same view as FIG. **97**A, and FIG. **103**B is an enlarged view of the hip region of FIG. **103**A. FIG. **104** is generally the same enlarged view as FIG. **96**B. As shown in FIGS. FIGS. **99**I, **103**A, **103**B and **104**, once the implant receiving space **1029** has been created as discussed above with respect to FIGS. **99**A-**99**H, the implant **25** can be supported off of the distal end **120** of the implant arm **110** 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. **96**A-**98**B. As can be understood from FIGS. **103**A-**104**, in entering the sacroiliac joint space, the implant **25** is oriented such that its wide planar members **50** are oriented generally parallel to, and aligned with, the sacroiliac joint line **2019** (i.e., the wide planar members **50** are generally located within the joint plane **1030**), and the implant's narrow planar members **55** are generally transverse to the joint plane **1030** (see, e.g., FIGS. **102**C and **102**D). The longitudinal axis LCA_2 of the implant arm **110** 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 LCA_2 of the implant arm **110** 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 implant arm **110** can be said to be at least one of generally superior or cephald the sciatic notch.

FIG. **105** is the same view as FIG. **104**, except the implant **25** has now been fully inserted into the prepared space **1029** in the sacroiliac joint **1000**. As illustrated in FIGS. **99**J and **105**,

the implant **25** is fully received in the prepared sacroiliac space **1029** such that the wide planar members **50** are oriented generally parallel to, and aligned with, the sacroiliac joint line **2019** (i.e., the wide planar members **50** are generally located within the joint plane **1030**), and the implant's narrow planar members **55** are generally transverse to the joint plane **1030** and, in some embodiments, have even entered the bone material forming the sacrum and ilium articular surfaces of the sacroiliac joint (see, e.g., FIGS. **102**C and **102**D). As can be understood from FIG. **99**J, the longitudinal axis of the implant **25** and the longitudinal axis of the implant arm **110** may be coaxially aligned with each other and generally located in the sacroiliac joint plane **1030**.

FIG. **106**A is the same view as FIG. **104**, except the sleeve **100** is now received in the collar **165** of the anchor arm **115**. As can be understood from FIGS. **99**K and **106**A, the distal end of the sleeve **100** may extend through an incision in the patient's soft tissue such that the distal end of the sleeve **100** is positioned generally against the lateral surface of the ilium **1005**. The longitudinal axis of the sleeve and collar of the anchor arm can be understood to be generally coaxially aligned with the longitudinal axis of the bore **40** of the implant **25**.

FIG. **106**B is generally the same view as FIG. **106**A, 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. **106**B, 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. **106**B, the implant **25** is inserted via the implant arm **110** of the delivery tool **20** into the caudal region **1086** of the sacroiliac joint articular region **1044**. As shown via the implant **25** and implant arm **110** 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 implant arm **110** and wide planar members **50** are in the joint plane **1030** (see, for example, FIGS. **99**I-**99**J) and the longitudinally extending edge **3050** of the wide planar member **50** 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. **106**B via the implant **25** and implant arm **110** 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 implant arm **110** and wide planar members **50** are in the joint plane **1030** (see, for example, FIGS. **99**I-**99**J) and the longitudinally extending edge **3050** of the wide planar member **50** 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. **106**B) 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. **106**B 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. **106**B 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**.

FIG. **107**A is a posterior-inferior view of the hip region **1002** of the patient **1001**, wherein the soft tissue **1003** surrounding the skeletal hip bones is shown in dashed lines. FIG. **107**B is an enlarged view of the implant region of FIG. **107**A. As can be understood from FIGS. **99**L, **107**A and **107**B, the anchor member **30** is positioned in the lumen of the sleeve **100**. A driving tool **105** (e.g., screw driver) is extended through the lumen of the sleeve **100** so the distal end of the tool **105** is engaged with a proximal end of the anchor member **30** (e.g., screw). As shown in FIG. **99**M, the tool **105** is used to drive the anchor member **30** distally through the bone of the ilium **1005** and into the bore **40** of the implant **25** generally transverse to the joint line plane **1030**. As a result, as indicated in FIG. **99**N, the implant assembly formed of the implant **25** and anchor member **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 member **30** extends through the bone of the ilium **1005** and into the implant bore **40** generally transverse to the joint space plane **1030**. The tool **105** and sleeve **100** can be removed from the anchor arm collar **165**, and the incision associated with the sleeve **100** can be closed. Additionally, tool **105** can be a cutting tool **105** (e.g., drill bit, hole punch, or etc) which can used in similar steps as above describe to remove bone or other tissues in the path where anchor member **30** is to be placed.

As indicated in FIG. **99**O, the distal end of the implant arm is decoupled from the proximal end of the implant **25** and removed. The incision associated with the implant arm can be

closed. In some embodiments, the anchor member **30** will only be long enough to span bone of the ilium **1005** and enter the implant bore **40**. In other embodiments, as illustrated in FIG. **99**P, the anchor member **30** will be sufficiently long to extend through the bone of the ilium, completely through the implant bore **40**, and into the bone of the sacrum **1004**. As illustrated in FIG. **99**Q, in certain embodiments, implant **25** can be configured to have more than one implant bore **40** which can also receive an anchor member **30**. The anchor member **30** prevents migration of the implant **25** within the joint space. The anchor member **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. Where the anchor member extends through the implant bore and into the bone of both the sacrum and ilium, the anchor member **30** can 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 can be understood from FIGS. **108**A and **108**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 member **30** into the implant bore **40** 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 longitudinal axis LCA_1 of the anchor arm collar **165** being coaxially aligned with the longitudinal axis BA of the implant bore **40** when the proximal end **43** of the implant **25** is supported off of the implant arm **115** of the delivery tool **20** makes it possible to safely drive the anchor member **30** through the ilium **1005** bone and into the implant bore **40** when the implant is hidden in the joint space on account of being delivered to the joint space via the delivery tool **20**.

To begin a detailed discussion of another method of employing the system **10** to fuse the sacroiliac joint, reference is made to FIGS. **111**A-**111**C. FIG. **111**A is an inferior-posterior view of the patient's hip skeletal structure similar to the view depicted in FIG. **107**A. FIG. **111**B is a lateral-superior-posterior view of the patient's hip skeletal structure. FIG. **111**C is an inferior-posterior view of the patient's hip skeletal structure taken from a perspective laterally opposite the view depicted in FIG. **111**B. The S1 through S4 foramina can be seen at the respective indicators S1, S2, S3 and S4 in FIGS. **111**A-**111**C.

As can be understood from a comparison of FIGS. **111**A to **107**A, the delivery tool **20** has been reversed such that the anchor collar **165** is oriented so as to deliver the anchor member **30** through the sacrum **1004** first and then into the bore **40** of the implant **25** and optionally further into the ilium **1005**. In other words, unlike the method depicted in FIG. **107**A, wherein the anchor member **30** is driven lateral to medial through the ilium **1005** first and then into the implant followed by the sacrum **1004** (optional), the method depicted in FIG. **111**A shows the anchor member **30** being driven medial to lateral through the sacrum **1004** first and then into the implant followed by the ilium **1005** (optional). As can be understood from a comparison of FIGS. **111**A to **107**A, the implant **25** of FIG. **111**A is located in the sacroiliac joint with its wide radial members **50**, narrow radial members **55** and body **45** oriented as explained above with respect to FIGS. **102**A-**107**B, the only difference being the direction the bore **40** is oriented and the way the anchor member **30** penetrates the surrounding bone structures.

In the embodiment of FIG. **111**A, the anchor member **30** may be an S2 alar iliac (S2AI) screw. Such a screw may penetrate the sacrum **1004** just lateral the lateral edge of the S1 foramen and, in some instances, generally superiorly-inferiorly even with the superior edge of the S1 foramen so as to mimic an S2 alar iliac pelvic fixation. Alternatively, according to particular embodiments, for example, as shown in FIG. **111**A, such a screw may penetrate the sacrum **1004** just lateral the lateral edge of the S2 foramen and, in some instances, generally superiorly-inferiorly even with the superior edge of the S2 foramen.

To begin a detailed discussion of another method of employing the system **10** to fuse the sacroiliac joint, reference is made to FIGS. **112**A-**112**D. FIG. **112**A is an inferior-posterior view of the patient's hip skeletal structure similar to the view depicted in FIG. **107**A. FIG. **112**B is a side view of the patient's hip skeletal structure similar to the view depicted in FIG. **106**A. FIG. **112**C is a view of the patient's hip skeletal structure similar to the view depicted in FIG. **103**A, except from an opposite lateral perspective.

FIG. **112**D is a superior view of the patient's hip skeletal structure.

As can be understood from a comparison of FIGS. **112**A and **112**B to FIGS. **107**A and **106**A, respectively, in the embodiment depicted in FIGS. **112**A-**112**D, the delivery tool **20** has a trajectory that is generally superior-to-inferior as opposed to posterior-to-anterior. Further, unlike the embodiments described above wherein the implant **25** gains access to the sacroiliac joint space **1044** via the caudal access **2016** to be implanted in the caudal region **1086** of the sacroiliac joint space **1044** (see, for example, FIG. **106**B and related figures and discussion), the embodiment of FIGS. **112**A-**112**D gains access to gains access to the sacroiliac joint space **1044** via the cranial access **2017** (e.g., at the superior border **3006** shown in FIG. **106**B) to be implanted in the cranial region **1087** of the sacroiliac joint space **1044** (see, for example, FIG. **112**C-**112**D).

As indicated in FIGS. **112**A-**112**D, the delivery tool **20** is oriented such that the anchor collar **165** is positioned so as to deliver the anchor member **30** through the ilium **1005** first and then into the bore **40** of the implant **25** and optionally further into the sacrum **1004**. In other words, the method depicted in FIGS. **112**A-**112**D shows the anchor member **30** being driven lateral to medial through the ilium **1005** first and then into the implant followed by the sacrum **1004** (optional). Other than being delivered via a different trajectory and access location and being implanted in a different region of the sacroiliac joint, the implant **25** of FIGS. **112**C-**112**D is located in the sacroiliac joint with its wide radial members **50**, narrow radial members **55** and body **45** oriented as explained above with respect to FIGS. **102**A-**102**D, the only difference being the implant **25** being accessed via, and implanted in, the cranial region **1087** as opposed to the caudal region **1086**.

To begin a detailed discussion of another method of employing the system **10** to fuse the sacroiliac joint, reference is made to FIGS. **117**A-**117**C. FIG. **117**A is a lateral-inferior-posterior view of the patient's hip skeletal structure similar to the view depicted in FIG. **111**C. FIG. **117**B is an inferior-posterior view of the patient's hip skeletal structure similar to the view depicted in FIG. **111**A. FIG. **117**C is the same view as FIG. **106**B, except showing the implant **25** being implanted

in the extra-articular space **3007**, as opposed to the sacroiliac joint articular region **1044**, and accessing the extra-articular space **3007** via an extra-articular recess access region **6000**. The S1 through S4 foramina can be seen at the respective indicators S1, S2, S3 and S4 in FIGS. **117**A-**117**B.

As can be understood from a comparison of FIGS. **117**A to **107**A, the delivery tool **20** has been reversed such that the anchor collar **165** is oriented so as to deliver the anchor member **30** through the sacrum **1004** first and then into the bore **40** of the implant **25** and optionally further into the ilium **1005**. In other words, unlike the method depicted in FIG. **107**A, wherein the anchor member **30** is driven lateral to medial through the ilium **1005** first and then into the implant followed by the sacrum **1004** (optional), the method depicted in FIG. **117**A shows the anchor member **30** being driven medial to lateral through the sacrum **1004** first and then into the implant followed by the ilium **1005** (optional). In the embodiment of FIG. **117**A, the anchor member **30** may be a bone screw the same as or similar to an S2 alar iliac (S2AI) screw. Such a screw may penetrate the sacrum **1004** just lateral the lateral edge of the S1 foramen and just superior the superior edge of the S1 foramen. Thus, the anchor element **30** can enter the bone of sacrum near the first sacral foramen (S2AI trajectory) then into or through implant bore **40** and can further enter the bone of the ilium. The implant **25**, as with any of the implantation locations and implants **25** discussed herein can optionally be employed to be configured to serve as an attachment point for structural components of a spinal support system with a spanning element as discussed below with respect to FIGS. **115** and **116** or with a coupling element as discussed below with respect to FIG. **114**.

As can be understood from a comparison of FIGS. **117**A to **107**A, FIGS. **117**B to **111**C, and FIGS. **117**C to **106**B, the implant **25** of FIG. **117**C is located in the extra-articular region **3007** as opposed to the sacroiliac joint articular region **1044**. Further, the implant **25** of FIGS. **117**A-C has entered the extra-articular region **3007** via an extra-articular recess access region **6000**, which, is on the opposite side of the posterior inferior overhang **2020** of the posterior superior iliac spine **2004** from the caudal portion **1086** of the sacroiliac joint articular region **1014** and posterior inferior access region **2016** leading to the sacroiliac joint articular region **1044** employed to implant the implant **25** in the caudal portion **1086** of the sacroiliac joint articular region **1044**, as discussed above with respect to FIGS. **103**A-**108**B or FIGS. **111**A-**111**C.

As can be understood from FIG. **117**C, the implant **25** is oriented in the extra-articular region **3007** with its wide radial members **50** generally coplanar with the plane of the extra-articular region **3007** and the narrow radial members **55** extending into the sacrum and ilium bone defining each side of the extra-articular region **3007**.

As illustrated in FIG. **117**C, in some embodiments, the implant **25** is oriented within the extra-articular region **3007** such that the longitudinal axis of the body **45** is generally perpendicular to the posterior boundary segment **3008** of the boundary **3000** of the sacroiliac joint articular region **1014**. Also, the distal end **42** of the implant **25**, when implanted in the extra-articular region **3007**, points towards the anterior-inferior corner **3010** of the boundary **3000** of the sacroiliac joint articular region **1014**. The distal end **42** of the implant **25** may extend across the posterior boundary segment **3008** of the boundary **3000** of the sacroiliac joint articular region **1014** and into the sacroiliac joint articular region **1014**. Thus, when implanting the implant **25** via the extra-articular recess access region **6000**, the general direction of travel for the implant distal end **42** is towards the anterior-inferior corner **3010**, and the implant **25** can be positioned substantially within the extra-articular region **3007** or, alternatively, the implant **25** can be further advanced to also occupy a portion of the sacroiliac joint articular region **1044**.

As discussed above with respect to FIGS. **117**A-**117**B, in implanting the implant **25** in the extra-articular region **3007**, the delivery tool **20** is configured to drive the anchor element **30** medial to lateral through the sacrum **1004** into the implant bore **40** and, optionally, further into the ilium **1005**. However, in some embodiments, the delivery tool **20** and implant bore **40** may have as-manufactured configurations that allow the anchor element **30** to be driven lateral to medial through the ilium **1005** into the implant bore **40** and, optionally, further into the sacrum **1004**.

In some embodiments, the system **10** may be provided in the form of a kit **4999**. Such a kit **4999** is shown in FIG. **113**. 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 member **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 member **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 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 bore **40** to provide various desirable trajectories for an anchor member **30** and multiple delivery systems **20** with as-manufactured angular relations corresponding to the different angles of the bore. 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. **114**, which is the same transverse cross sectional view of the patient's hip as shown in FIGS. **99**A-**99**Q, once the implant **25** and anchor(s) **30** are secured at the sacroiliac joint **1000** in any of the manners depicted in FIGS. **99**O-**99**Q, 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. **115** is a posterior view of the patient's sacrum **1004** and illiums **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. **115**, in one embodiment, each of a pair of sacroiliac joints **1000** can receive an embodiment of the sacroiliac joint implants **25**, above-described, 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. **116** is the same view as FIG. **117**, except having a different spanning member structure. As illustrated in FIG. **116**, a first coupling element **2087** can be joined to the first end **2011** of an embodiment of a sacroiliac joint implant **25** as above described 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. Additionally, spanning element **2090** can be coupled to an implant **25** similar to FIGS. **41**-**54**, or configured similarly but with the spanning element coupled to one of the planar members (e.g., planar member **50** and with spanning element extending radially away from the longitudinal axis of an implant **25** and at least partially existing in the plane of a sacroiliac joint before contouring to the posterior surface of a sacrum and terminating at an opposed end **2095**.)

As can be understood from FIG. **116** and with continuing reference to FIGS. **111**A-C and **117**A-C, according to particular embodiments, the spanning element **2090** can be configured to receive an S2AI screw positioned and directed in a trajectory as substantially shown in FIGS. **111**A-C or **117**A-C. As a non-limiting example, an S2AI screw or other elongate fixation body can pass through an aperture **2096**, which can be located on an opposed end **2095** of the spanning element **2090** and can be disposed directly into the bone of the sacrum **1004**, pass through or engage the bore **40** of an implant **25**, and into the bone of the ilium **1005**. According to certain embodiments, an engagement between an S2AI screw and the bore **40** can be configured, for example, as having a bore **40** which can have threads or other surface that are generally complementary to those of a fastener **2088**. Said complementary surfaces can be configured to provide a virtual cold weld between components to further resist undesirable movement.

As shown in FIGS. **119**A-**119**E, which are, respectively, distal end isometric, side elevation, plan, distal end elevation, and proximal end elevation views of another embodiment of an implant **25**, the features of the implant **25** of FIGS. **119**A-**119**E are substantially similar to the features of the implant **25** as described herein, for example with respect to FIGS. **4**-**17**. The main differences between the implant **25** described with respect to FIGS. **119**A-**119**E and the implant **25** described with respect to FIGS. **4**-**17** are the lack of the cylindrical body **45** and the edges of adjacent intersecting surfaces of the implant **25** of FIGS. **119**A-**119**E are generally rounded or arcuate as opposed to sharp or well-defined edges, as is the case between adjacent intersecting surfaces of the implant embodiment of FIGS. **4**-**17**. Further, the planar members **50** may taper distally and be relatively thicker as compared to the planar members **55** of the implant embodiment of FIGS. **119**A-**119**E. For example, the taper may extend the entire length of the implant **25** with the thickness of planar member **50** near implant distal end **42** being about 3-5 mm and the thickness of the planar member **50** near the implant proximal end **43** being about 6-7 mm. Finally, the leading or distal edges **57** of the planar members **50** may be one or more tapered surfaces, as shown in FIGS. **119**A-**119**E.

FIGS. **120**A-**120**B are, respectively, distal end isometric and side elevation views of yet another embodiment of the implant **25**. As can be understood from FIGS. **120**A-**120**B, the features of the implant **25** are substantially similar to the features of the implant **25** described with respect to FIGS. **119**A-**119**E, a main difference being that the leading or distal edges **57** of the planar members **55** are generally sharp, well-defined angled edges, as opposed to the generally rounded or arcuate edges of the implant embodiment of FIGS. **119**A-**119**E.

In one embodiment, as can be understood from the dashed lines in FIG. **120**B, the planar members **50** may be non linear between distal end **42***b* and proximal end **43** such that there is a radius R between implant ends (or between distal end **42***b* and a point, for example, midway along the longitudinal axis). The radius R may be about 100 mm to about 200 mm with one embodiment being approximately 150 mm. Accordingly, as indicated by the dashed lines in FIG. **120**B, planar members **50***b* may terminate with a distal end **42***b*. Addition-

ally, but not shown in the figures, planar members **55** may be similarly curved so as to substantially follow along or be aligned with curved planar members **50***b*. Such a configuration may more anatomically conform to the curvature of a sacroiliac joint while allowing planar members **50***b* to generally remain within a curved plane of a sacroiliac joint.

As shown in FIGS. **121**A-**121**E, which are, respectively, distal end isometric, side elevation, plan, distal end elevation, proximal end elevation, proximal end isometric, and side elevation views of another embodiment of an implant **25**, the planar members **50**, **55** may have surface features or texture designed to prevent migration of the implant once implanted in the joint space. For example, the implant **25** may include anti-migration surface features **355**, which are waved, undulating, or spiral ridges extending longitudinally along the planar members **50**, **55**. Alternatively, anti-migration surface features **355** may be configured to extend perpendicular to the longitudinal axis of planar members **50**, **55**.

It will be appreciated that the features of the implant **25** of FIGS. **121**A-**121**G are substantially as discussed herein, for example, with respect to the implant **25** of FIGS. **62**-**67**, a main difference being the implant **25** is hollow and the surfaces **60** include a plurality of voids **6500**, which are generally triangular in shape. The voids **6500** of the implant **25** may be filled with a biological material (e.g., a protein, demineralized bone matrix, or lattice structure containing or substantially comprised of stem cells) via an access opening **6502** leading to the hollow interior of the implant. The biological material is designed to improve growth of bone around the implant **25** and to strength the integration of the implant **25** to the bone. The voids **6500** improve integration of the implant **25** to the bone. Further, the leading or distal edges **57** of the planar members **50** and the implant distal end **42** of FIGS. **121**A-**121**G may be relatively thicker as compared to the implant embodiment of FIGS. **62**-**67**. Additionally, as can be best understood from FIG. **121**C, the leading or distal edges **57** of the planar members **50** may differ in length and general shape. For example, as can be understood from FIGS. **121**B-**121**C, a first leading or distal edge **57** may be generally round and arcuate and relatively longer as compared to a second leading or distal edge **57** that is generally flat and relatively shorter. Further, as shown in FIGS. **121**D, **121**F and **121**G, the planar member **50** may include an access opening **6502** leading to the hollow interior of the implant.

With an opening **6502** on one side of the implant and not on the opposite side of the implant, the implant is configured to allow and promote boney growth, or expansion of biological material inserted within, toward, for example, certain areas within the sacroiliac joint and away or not toward certain other areas of the sacroiliac joint when the implant is implanted in the sacroiliac joint. For example, when the implant **25** of FIGS. **121**A-**121**G is inserted into the sacroiliac joint similar to the manner indicated in FIG. **106**B, wherein the opening **6502** of the implant **25** is oriented towards the posterior boundary segment **3008**, boney growth or the expansion of biological material contained in the implant will extend through the implant opening **6502** in the direction of the posterior boundary segment **3008** and be specifically directed away from inferior boundary **3002**, anterior-inferior boundary **3010** and anterior boundary segment **3004** to limit potential bone growth, or seepage of biologically active agents near the neurovascular structures which are present beyond said boundaries.

Additionally, as can be best understood from FIGS. **121**A and **121**C, and with continuing reference to FIGS. **106**B and **117**C, as indicated by arrow F in FIGS. **121**A and **121**C, one of the leading distal edges **57** (e.g., the edge located opposite the side with opening **6502**) of the planar member **50** of the implant may be curved and of a substantially greater radius as compared to the distal edge **57** of the opposite planar member **50**. Such a curved section (indicated by arrow F) on the distal edge **57** of planar member **50** may be configured to anatomically generally mimic and even substantially conform to a anterior-inferior corner **3010** (see, e.g., FIGS. **117**C and **106**B) in order to more fully occupy this region of the joint nearest neurological and vascular structures which are present anterior to and inferior to corner **3010**.

The curved section (indicated by arrow F) (or according to particular embodiments located anywhere in implant **25**) can additionally be configured to include an inlayed radiopaque marker, for example tantalum, to assist the surgeon with navigation while using fluoroscopy. Further, according to particular embodiments, the curved section (arrow F) can 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 implant arm **110** 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 milliampers (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. **121**H, 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, gastroc-

nemius, 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.

As can be understood from FIGS. **121**A-**121**G, in one embodiment, the joint implant **25** includes a longitudinal axis and a bore **40** extending non-parallel to the longitudinal axis. The joint implant **25** also includes a hollow interior and an exterior surface having a plurality of openings **6500** defined therein that extend into the hollow interior. Prior to implantation of the implant into the joint space, the hollow interior can be filled with a biological material via the access opening **6502** that leads into the hollow interior of the implant.

The implant of FIGS. **121**A-**121**G also includes a distal end **42**, a proximal end **43**, and a body extending between the proximal and distal ends. The bore **40** extends non-parallel to the hollow interior. A first pair of planar members **50** radially extend from the body of the joint implant **25**. Depending on the embodiment, the body may be similar to the body **45** depicted in FIGS. **5**-**15** or the body may simply be an intersecting or intermediate region of the first pair of planar members **50**, as can be understood from FIGS. **121**A-**121**G.

As shown in FIGS. **121**A-**121**G, the hollow interior extends within the confines of the first pair of planar members **50**. Also, the exterior surface in which the plurality of openings **6500** is defined includes exterior planar surfaces **60** of the first pair of planar members **50**. A second pair of planar members **55** radially extend from the body of the joint implant **25** generally perpendicular to the first pair of planar members **50**. As can be understood from FIG. **121**F, in some embodiments, the hollow interior is limited to within the confines of the first pair of planar members **50** while the second pair of planar members **55** are solid such that the hollow interior does not enter the confines of the second pair of planar members. In other embodiments, the hollow interior is limited to the confines of the second pair of planar members or the hollow interior may extend into the confines of both pairs of planar members. As indicated in FIG. **121**E, in one embodiment, the first pair of planar members **50** extend over a wider radial extent than the second pair of planar members **55**.

FIG. **122** is a proximal end isometric view of another embodiment of the implant assembly **15**. As can be understood from FIG. **122**, the features of the implant assembly **15** are substantially the features described herein, for example, with respect to FIG. **3**, a main difference being that a distal end **6510** of the anchor element **30** includes an opening **6506** and edges **6508** in the form of serrated teeth or notches with parallel sides inwardly terminating as an arcuate end. The opening **6508** creates a generally "clothes-pin" like shape of the anchor element distal end **6510**. In one embodiment, the edges **6508** may be triangular, trapezoidal, rectangular, or another angular cross-sectional elevation and generally evenly distributed along the surface of the anchor element distal end **6510**. The edges **6508** help drive the implant assembly **15** into the joint and prevent migration of the implant assembly **15** once in place.

In one embodiment, opening **6506** is defined by arms **6507**. The opening **6506** and arms **6507** are configured such that, after passing through a channel created in a first bone and after passing through bore **40** and then subjected to impaction into a second bone, for example that of the ilium, bone of the second bone can be received into opening **6506** to urge the "clothes pin" arms **6507** apart from one another thereby further embedding the edges **6508** into bone for enhanced fixation. Alternatively, in other embodiments, anchor **30** may be configured in part or completely of shape memory biomaterials (e.g., Nitinol or PEEK ALTERA, available from MedShape, Inc. located at 1575 Northside Drive, NW, Suite 440, Atlanta, Ga. 30318 USA), which are capable of changing shape in response to temperature, light and/or mechanical forces. An anchor **30** configured with a shape memory biomaterial can be configured, for example, immediately prior to insertion as substantially shown in FIG. **122** with "clothes-pins" arms **6507** in general parallel relation. Upon final placement in the ilium or other second bone, the "clothes-pins" arms **6507** (in response to temperature, light and/or mechanical force) can separate away from one another and in certain embodiments "curl" outwardly and back toward the proximal end of anchor **30** in order to further resist undesirable movement of implant assembly **15**. Another main difference between the implant assembly embodiment of FIG. **122** and of FIG. **3** is that a washer **6504** is coupled to the anchor element **30**. The washer **6504** and the shape and texture of the anchor member distal end **6510** secure the implant assembly **15** in the sacroiliac joint. The washer can be (pivotably) coupled to the anchor such that when inserted or explanted the washer remains coupled to the anchor and need not be removed separately.

FIGS. **123**A-**123**E are, respectively, distal end isometric, side elevation, plan, distal end elevation, and proximal end elevation views of yet another embodiment of the implant **25**. As can be understood from FIGS. **123**A-**123**E, many of the features of the implant **25** are substantially the features of the implant **25** described herein, for example, with respect to FIGS. **119**A-**119**E, a main difference being that the planar

members **50**, **55** are generally round or arcuate and the implant distal end **42** is generally rounded. Specifically, the leading or distal edges **57** of the implant embodiment of FIGS. **119**A-**119**E are not separate features in the embodiment of FIGS. **123**A-**123**E and instead are generally incorporated in the rounded or arcuate surfaces of the planar members **50**, **55**, which intersect at the implant distal tip **42**. Additionally, the implant proximal end **43** is generally flat with round edges, and relatively wider than the implant embodiment of FIGS. **119**A-**119**E. The planar members **50** may each include a channel **6514** extending longitudinally and opening into the implant proximal end **43** adapted for receiving a distal end of the delivery device as described herein.

Further, another main difference is that the implant **25** shown in FIGS. **123**A-**123**E includes wings **6516**, which are separated from the planar members **50**, **55** by a gap **6512**. In other words, the gap **6512** extends longitudinally between the planar members **55** and the wings **6516** until the implant proximal end **43**. The wings **6516** allow the implant **25** to be driven into the joint region with the wings existing in a plane transverse to the joint plane such that one of the wings **6516** is delivered into the sacrum and the other wing **6516** into the illium. The wings **6516** may include anti-migration surface features **355** in the form of notches or ribs extending inwardly in the gaps **6512** that are generally evenly distributed longitudinally along the wings **6516** parallel to the planar members **55** and oriented transversely to the longitudinal axis of the respective wing. The anti-migration surface features **355** and the wings **6516** prevent migration of the implant **25** once placed, as described herein. As can be understood from FIGS. **124**E-**124**H, the implant of FIGS. **123**A-**123**E may additionally includes a bore **40** extending through the implant **25** to receive an anchor **30** delivered via an anchor arm **115** of the system **10** as described herein. Such a bore **40** may extend through the implant so as to extend in generally the same plane in which the wings **6516** exist.

In some embodiments, for example, the relative location and angles between wings **6516** and planar members **50**, **55** can remain substantially the same before and after implantation. Alternatively, in some embodiments, the wings **6516** can be configured to deflect a distance away from planar members **50**, **55** upon insertion and contact with bone. In other words, the gaps **6512** may enlarge upon placement and, to facilitate such enlargement of the gaps **6512**, anti-migration features **355**, or distal ends **6516**A of wings **6516**, may be configured with a sloping surface to urge wings **6516** a distance away from planar members **50**, **55**. Upon final placement, the deflected wings **6516** urge bone or joint surfaces against the implant **25** in order to enhance bone contact with the implant **25** by compression to enhance bone fusion and to enhance fixation of the bones or bone fragments by potential energy stored in the deflected wings **6516**. Alternatively, according to particular embodiments, the implant **25**, or only the wings **6516**, may be manufactured from a shape memory biomaterial. In such embodiments, the position of the wings **6516** before implantation may be such that their distal ends **6516**A are a further distance from planar members **50**, **55** than shown in FIG. **123**A-E. After final placement of the implant in the sacroiliac joint, an angle Φ of the gap **6512** can decrease and the distance between distal ends **6516**A of wings **6516** and planar members **50**, **55** can decrease by the shape memory biomaterial biasing or shaping to appear substantially as shown in FIGS. **123**A-E. As a result, the wings **6516** provide compression of the bone in gap **6512** against the surfaces of the implant **25**.

Alternatively, proximal ends **6516**B of wings **6516** can be configured with a hinge between the proximal ends **6516**B and the proximal end **43** of implant **25** to allow wings **6516** to deflect away from planar members **50**, **55** upon implantation. Additionally, the proximal ends **6516**B can extend a distance proximally further than the proximal end **43** of implant **25**. Also, an end cap can be secured to the proximal end **43** of implant **25**. Advancing the end cap distally can bias the extended proximal ends **6516**B away from the longitudinal axis of implant **25** by causing rotation of the wings about the hinges. Such rotation causes the portion of the wings **6516** distal said hinges to rotate an opposite complementary angular distance toward the longitudinal axis of the implant **25**, resulting in compression of bone against implant **25** for enhanced fusion and fixation.

Alternatively, proximal ends **6516**B of wings **6516** may be attached to proximal end **43** of implant **25** by slidable interlocking elements. Upon implantation the wings **6516** may be located a maximum distance away from implant **25** as allowed by the slidable interlocking elements and, after final placement of implant **25**, the wings may be drawn toward the implant **25** by various methods. For example, the slidable interlocking elements may be configured with sloped elements which prevent movement in the direction away from the longitudinal axis of implant **25** yet allow a compressive force, for example from a surgeon employing hemostats on the surfaces of wings **6516** facing opposite implant **25**, to irreversibly draw the wings **6516** toward implant **25**. As a second example, a gear can be located on the proximal end **43** of implant **25**, which when driven by rotational forces, by, for example, a screw driver or hex wrench, can force wings **6516** to draw toward implant **25** while sliding along the slidable interlocking elements.

FIGS. **124**A and **124**B**1** are isometric views of another embodiment of the delivery tool **20** coupled and decoupled with the implant **25**, respectively. FIG. **124**C is an isometric view of the delivery tool **20** in an exploded state. FIG. **124**D is an enlarged view of the distal end **120** of the implant arm **110** of the delivery tool **20**. As can be understood from a comparison of FIGS. **124**A-**124**D and FIGS. **86**-**88**, the delivery tool embodiment of FIGS. **124**A-**124**D is substantially similar to the delivery tool embodiment of FIGS. **86**-**88**, a main difference being the distal end **120** of the implant arm **110**, as shown in FIG. **124**D is adapted to engage the channels **6514** of the implant **25** described with respect to FIGS. **123**A-**123**E. For example. The large planar members, keels, or fins **140** and the small planar members, keels, or fins **145**, as described herein, for example, with respect to FIG. **19**, may match the relative shape and size of the channels **6514** of the implant **25**. Accordingly, the delivery tool embodiment of FIGS. **124**A-**124**D is adapted to deliver the implant **25** into the joint region with the wings extending in a plane that is generally transverse to the joint plane such that each wing is received into a respective bone (e.g., sacrum or iliac) bordering the joint, as described with respect to FIGS. **123**A-**123**E.

As can be understood from FIGS. **124**E and **124**G, in some embodiments, the implant has a bore **40** that has a non-circular (e.g., oblong) cross section as taken along a cross section plane that is generally perpendicular to the length of the bore **40** extending through the implant. The delivery tool **20** of FIGS. **124**A-D can be configured to align a non-circular anchor **30** through the non-circular bore **40** of implant **25**. For example, as shown in FIG. **124**B**2**, a guide sleeve **100** is concentrically contained in a collar **165** of the anchor arm **115**. The sleeve **100** has a guide hole **2444** that has a non-circular (e.g., oblong) transverse cross section that prevents rotational movement of the oblong anchor when distally dis-

placed through the guide hole **2444**. The sleeve **100** may have a groove **2333** extending along a portion of its exterior surface length that mechanically interfaces with a complementary feature defined in the collar, thereby preventing rotation of the sleeve within the collar. Since the non-circular (e.g., oblong) cross sectioned anchor **30** is prevented from rotation within the complementarily shaped guide hole **2444** and the sleeve **100** is prevented from rotation within the collar **165** due to the structural impediment presented by the groove **2333**, the non-circular anchor **30** can be accurately and reliably delivered into the non-circular bore **40** of the implant **25** of FIGS. **124**E and **124**G. The delivery tool **20** can also be configured to be able to deliver a non-circular anchor **30** adjacent implant **25**. Further, another difference between the embodiment of FIGS. **124**A-**124**D and FIGS. **86-88** is that the anchor arm **115** as shown in FIGS. **124**A-**124**C is contoured to permit the transverse delivery of the transfixing anchor screw **30** (e.g., see FIG. **3**) through and/or adjacent the implant **25** and across the sacroiliac joint space.

As can be understood from FIGS. **124**E-**124**H, in one embodiment, a joint implant **25** includes a longitudinal axis, a body **25**, a distal end **42**, a proximal end **43**, a first wing **6516**, a second wing **6516** and a bore **40** extending non-parallel to the longitudinal axis. The proximal end is opposite the distal end. The first wing is connected to the body near the proximal end and extends distally in an offset manner from a first lateral side of the body. The second wing is connected to the body near the proximal end and extends distally in an offset manner from a second lateral side of the body opposite the first lateral side of the body. The body of the implant tapers extending proximal to distal.

As shown in FIGS. **124**E-**124**H, the joint implant also includes a first pair of planar members **55** radially extending from the body of the joint implant. The first pair of planar members **55** forms at least a portion of the first and second lateral sides of the body from which the first and second wings **6514** are offset. The implant may also include a second pair of planar members **50** radially extending from the body of the joint implant generally perpendicular to the first pair of planar members **55**. The second pair of planar members may have a thickness greater than a thickness of the first pair of planar members. As already stated, the first and second wings extend distally in an offset manner from the respective first and second lateral sides, thereby defining first and second respective gaps or slots **6512** between the wings and the respective lateral sides. The bore and the first and second wings reside in generally the same plane.

As can be understood from FIG. **125**A, which is an isometric view of another embodiment of the implant **25**, the longitudinally extending body **45** may include helical spiral threads **6524** rather than keels, fins or planar members **50**, **55** that radially extend outwardly away from the body **45**, as described herein. The helical spiral threads **6524** engage with the bone in the joint region to prevent migration of the implant **25**. Additionally, in the embodiment shown in FIG. **125**A, the body **45** is generally cylindrical with anti-migration surface features **355** in the form of ridges or ribs extending longitudinally along the body **45**. Further, in addition to the bore **40**, the body **45** may include anchor member receiving features **6520** and **6522**, which are substantially similar to the bore **40**, to provide a choice of a plurality of locations to transfix the anchor member **30**, as described herein. Additionally, bores **40** can allow bone to grow into the hollow interior of the implant as discussed below. For example, as shown in FIG. **125**A, the body **45** may include three bores, **40**, **6520**, and **6522** positioned relative to one another along the same longitudinal surface of the body **45**. The implant **25** may be delivered into the joint region with an embodiment of the delivery tool **20** that includes three collars supported off of the anchor arm **115** similar to the embodiment of FIG. **110**, except having at least three longitudinally oriented holes similar to holes **165***a* and **165***b*, which are at pre-set locations corresponding to the bores **40**, **6520**, and **6522**. The rest of the features shown in the implant embodiment of FIG. **125**A may be substantially similar to the features of implant embodiments described herein.

As shown in FIG. **125**B, which is a longitudinal cross section view of the implant **25** of FIG. **125**A, the longitudinal body of implant **25** may be substantially hollow with a distal end **42** configured with an aperture opening to the hollow interior. The hollow interior may be filled with a biological material for promoting bone growth into the hollow interior, as discussed above. Additionally, helical threads **6524** may be "T-shaped" in cross section in order to hold bone to resist a first bone from moving relative to a second bone.

As shown in FIG. **126**A, which is an isometric view of another embodiment of the implant assembly **15**, the implant **25** of FIG. **126**A is substantially the implant **25** of FIG. **125**A, a main difference being that the additional bores **6520** and **6522** are not included on the body **45**. Further, features of the anchor element **30** are substantially similar to the features of the anchor element **30** described herein, for example, with respect to FIG. **3**. However, the anchor element **30** as shown in FIG. **126**A includes helical spiral threads **6528** at the anchor element distal end **6529**. The helical spiral threads **6528** of the anchor element **30** are rotationally driven and secured into the bone. For example, the anchor element proximal end **6531** may be adapted to engage an Allen wrench, hex key, or other tool with a hexagonal cross section to deliver the anchor element **30** through the bore **40** and into the bone. Additionally, anchor **30**, when configured as a screw can be self-tapping.

As illustrated in FIG. **126**C, which is a longitudinal cross section of the proximal head of the anchor **30** of FIG. **126**A, in one embodiment, the hex key can be cannulated and configured to receive an anchor retainer rod with a threaded end that engages complementary threads **6537** located on the anchor element proximal end **6531** set below the hex key engagement cutout.

As illustrated in FIGS. **126**A and **126**B, the anchor **30** may have flutes **6533** extending longitudinally down a portion of the shaft configured to engage a setscrew **6534**, as discussed below, in order to prevent rotation of anchor **30** within the bore **40**. Alternatively, anchor **30** can be configured with spiral flutes. Alternatively, anchor **30**, whether configured as a screw with threads or as a nail, may be further configured with flutes which extend circumferentially in order for a setscrew **6534**, as discussed below, to engage said flutes and thereby prevent axial movement of anchor **30** within the bore **40**.

As shown in FIG. **126**B, which is a longitudinal cross section view of the implant assembly **15** of FIG. **126**A, the proximal end **43** of the longitudinal body of implant **25** may be configured to receive a setscrew **6534**, or pair of setscrews positioned in longitudinal series in the setscrew hole to lock the setscrews in place against each other in the set screw hole. The setscrew **6534** (or the most distal setscrew of a pair of setscrews in longitudinal series) can threadably advance distally in the setscrew hole such that a distal end of the setscrew enters the bore **40** to be received in a groove **6533** and abut against the anchor **30** to resist movement between the anchor **30** and implant **25**.

As can be understood from FIGS. **125**A-**126**B, in one embodiment, a joint implant **25** includes a longitudinal axis,

a proximal end **43**, a distal end **42**, a body **45**, a bore **40** extending non-parallel to the longitudinal axis, and a helical thread **6524** extending around the body between the proximal and distal ends. The implant body may be substantially cylindrical, and the bore may be a single bore **40** (see FIG. **126**A) or multiple bores **40**.

As can be understood from FIGS. **127**-**128**A, the implant arm **110** may include a handle at a proximal end of the implant arm, wherein the handle includes an elongated handle member **6532** that has a length perpendicular to a longitudinal axis of the implant arm. A radiopaque elongated member **6534** extends through the elongated handle member parallel to the length of the elongated handle member. The radiopaque elongated member is contained in a non-radiopaque portion of the elongated handle member. As indicated in FIG. **128**A, the radiopaque elongated member may be two such members **6534**, **6536** spaced apart from each other in the elongated handle member **6532** and residing in a plane at least parallel with, if not including, a longitudinal axis of the implant arm **110**.

As can be understood from FIGS. **126**A-**126**B, the joint implant may also include a setscrew **6534** with a distal end that is configured to enter the first bore **40** to abut against the anchor element **30** so as to limit movement of the anchor element in the first bore. For example, in abutting against the anchor element, the distal end of the setscrew engages a flute **6533** defined in the anchor element.

FIG. **127** is an isometric view of an embodiment of a sleeve **6550** mounted on an implant arm **110** of a delivery device **20** similar to that of FIG. **88**, wherein the sleeve facilitates visualization of trans screw trajectory. When delivering the implant **25**, the arm assembly **85** is decoupled from the implant arm **110** and the sleeve **6550** is coupled to the implant arm **110**. The handle members **6532** may be rotated to cause implant arm **110** to rotate, thereby causing the helical spiral threads **6526** to threadably engage the bone and advancing the implant **25** into the joint region. In one embodiment, the sleeve **6550**, which may be formed of a radiotranslucent material such as PEEK or carbon fiber, includes a tantalum inlay **6534** for transcrew trajectory visualization. In other words, the handles **6532** may include a cylindrical member **6534**, which is a radiopaque marker to aid in alignment, for example, using fluoroscopy with the x-ray beam aligned generally in parallel relation to the joint. The marker **6534** runs within the handle **6532** parallel to a longitudinal center axis of the handle. Once the implant **25** is implanted in the joint space as desired, the sleeve **6550** can be removed from the implant arm **110** and the arm assembly **85** with its anchor arm **115** can be coupled to the implant arm **110** in order to allow for the guided delivery of the anchor **30** into the bore **40** of the implant **25** as described herein. As can be understood from FIG. **128**A, which is an isometric view of another embodiment of the sleeve **6550** of FIG. **127**, the features of the sleeve of FIG. **127** are substantially the features of the sleeve embodiment of FIG. **128**A, a main difference being that the handle members **6532** of the embodiment of FIG. **128** include another cylindrical member **6536**, which may be another radiopaque marker for alignment visualization. Both markers **6534** and **6536** run within the handle **6532** parallel to a longitudinal center axis of the handle.

FIG. **128**B is an end view of sleeve **6550** of FIG. **128**A showing overlapping radiopaque markers **6534** and **6536**, which are configured with terminal circle shaped markers **6555**. FIG. **128**C is a posterior view of the hip region, wherein the sleeve **6550** is being employed. As can be understood from FIGS. **128**A-**128**C, the configuration of the sleeve **6550** permits the operator (e.g. surgeon, computer controlled navigation system, or surgical robot) to visualize and adjust with rotational force the trajectory, relative to anatomic structures, of an anchor **30** which can pass through a bore **40** or pass adjacent to implant **25** in order to avoid violating neurovascular structures or other implants which may already be present or are anticipated to be implanted in proximity to implant assembly **15**.

As can be understood from FIGS. **128**A-**128**C, when the implant **25** is coupled to the implant arm **110**, a longitudinal axis of the implant **25**, a longitudinal axis of the bore **40**, and the longitudinal axes of the radiopaque elongated members **6534**, **6536** exist in a common plane. In other words, when the implant **25** is coupled to the implant arm **110**, the two radiopaque elongated members **6534**, **6536**, which are spaced apart from each other in the elongated handle member **6532**, reside in a plane at least parallel with, if not including, a longitudinal axis of the implant arm **110** and/or a longitudinal axis of the bore **40**. As a result, as can be understood from FIGS. **128**A-**128**C, the radiopaque members can be used to ascertain the location and orientation of the bore when the implant is located within the joint space, thereby helping the physician to understand if the anchor to be delivered to or near the implant will adversely impact neurovascular structures.

Referring to FIG. **128**B, it can be seen that the two radiopaque markers **6534**, **6536** form a single line when viewed along the plane in which both radiopaque markers reside. This single line indicates to the physician the orientation of the bore **40** and a trajectory of an anchor that would be received in the bore **40**. Other radiopaque markers may be located on the handle **6550** to convey other information to the physician. For example, additional radiopaque markers similar to markers **6534**, **6536** may be located parallel to, and offset from, markers **6534**, **6536** so as to convey to the physician a trajectory of an anchor intended to not pass through the bore, but to instead pass adjacent to a side of the implant.

FIGS. **129**A-**129**B show isometric views of another embodiment of the system **10**, wherein the delivery tool **20** has a header **6539** with a series of collars **165** and associated sleeves **100** having a variety of pre-defined angular alignments to guide one or more transfixing anchor members **30** into place, thereby providing a choice of delivery angles that are complementary to the implant **25**. According to particular embodiments, a sleeve or collar **165** of the header **6539** depicted in FIGS. **129**A-**129**B may have a longitudinal center axis LCA_1 similar to the longitudinal center axis LCA_1 depicted in FIG. **18**, the a longitudinal center axis LCA_1 being aligned with a trajectory which either passes into or through a bore **40** of the implant **25** or passes near an implant **25** to further locate an anchor **30** into the bone of a sacrum within certain desirable areas to avoid neurovascular elements and to place the anchor within sacral bone with a higher bone density. For example, depending on the trajectory of the implant **25** and the location of the bore **40** when LCA_1 is aligned with said bore versus placing an anchor near an implant and not through a bore, an anchor can terminate generally within the sacral ala, or terminate in the body of the first sacral vertebra while avoiding the first sacral foramina, or terminate in a S2 vertebral body between the first and second sacral foramina, or terminate into the apex of the sacral promontory, or terminate through or within an anterior sacral cortex, or terminate through or near an S1 endplate.

The system **10** includes a delivery tool **20** and an implant **25** for implanting at the sacroiliac joint via the delivery tool **20**, the implant **25** being for fusing the sacroiliac joint. As shown in FIGS. **129**A and **129**B, the delivery tool **20** includes an implant arm **110** and an anchor arm **115**. As described herein, the implant arm **110** is configured to releasably couple to the

implant **25**, and the anchor arm **115** is coupled to the implant arm **110** and configured to deliver the anchor element **30** to the bore **40** of the implant **25**. An impactor arm **6546** of the impactor assembly **6550** is removably coupled to handle members **6538** of the arm assembly **85**. Additionally, the impactor arm **6546** is removably coupled to the implant arm **110**. When the impactor assembly **6550** is coupled to the handle members **6538** as shown in FIG. **129**B, impacting an impactor handle **6547** of the impactor assembly **6550** distally causes the implant arm **110**, and the rest of the assembly **10** as whole, to displace distally and deliver the implant **25** into the sacroiliac joint space. The delivery tool **20** further includes a retaining member **6548** configured to couple the arm assembly **85** to the implant arm **110** and to engage the implant **25**. The other features of the retaining member **6548** may be substantially similar to the retaining member **95** as described above with respect to FIGS. **28-29**. Specifically, the retainer member **6548** extends through the implant arm **110** to mechanically interlock with a bore (e.g., center bore **70**) of the implant **25** as described herein. During delivery of the implant **25**, the arm assembly **85** may be decoupled from the delivery tool **20** for easier delivery of the implant **25** into the joint region. Additionally, the markers **6534** and **6536** can be removable.

As discussed below in greater detail, during the implantation of the implant assembly **15** at the sacroiliac joint, the implant **25** is supported by the implant arm **110** and the arm assembly **85** with its collar header **6539** may be coupled to the implant arm **110** to guide and support one or more anchor elements **30** (not shown). The handle members **6538** may be used to position or guide the implant as it is being distally driven into the sacroiliac joint via impacts delivered to the impactor handle **6547**. In some embodiments, the handle **6538** may be constructed of a radiolucent material and may include radiopaque markers **6534** and **6536** similar to those shown in FIGS. **127** and **128** for positioning the implant in the plane of the joint under fluoroscopy.

As described below, the delivery tool **20** is then used to cause the one or more anchor elements **30** to extend through the ilium, the sacrum and the implant **25** generally transverse to the sacroiliac joint and implant **25**. The delivery tool **20** is then decoupled from the implanted implant assembly **15**, as described herein.

The arm assembly **85** includes the anchor arm **115** with a collar header **6539** extending from the anchor arm. The collar header includes a series of arm members **6540**, **6542**, and **6544** in which a series of collars **165** are defined at different horizontal and vertical angles. The anchor arm **115** is coupled to the implant arm **110** via the handle members **6538**. Depending on the embodiment, the horizontal linear arm member **6540** may include five collars **165***e*, **165***f*, **165***g*, **165***h*, and **165***i*, each providing different alignment angles, the horizontal linear arm member **6542** may include two collars **165***k* and **165***j*, each providing different alignment angles. The vertical arcuate arm member **6544** may include one additional collar **165***l* plus already mentioned collar **165***f*, each providing different alignment angles. It will be appreciated that the collar positions and alignments shown in the embodiment of FIGS. **129**A-C are for illustrative purposes only and that other positions and alignments are contemplated.

In one embodiment, as shown in FIGS. **124**A-**124**C, the anchor arm **115** is contoured having an arcuate shape. The anchor arm **115** is received in a vertically extending arm member **6544** of the header **6539**. The vertically extending arm member **6544** has an arcuate configuration over its vertical extension that is generally the same as the arcuate configuration of the anchor arm **115** with respect to degree of curvature. Thus, the vertical arcuate arm member **6544** extends from the anchor arm **115** following the same general arcuate path. The arcuate arm member **6544** may be thicker relative to the anchor arm **115** to provide stability during the delivery of the one or more anchor members **30** and sufficient width to accommodate the collars **165***f* and **165***l* defined therein as shown in FIG. **129**C. The collars **165***f* and **165***l* are defined in the generally planar surface of the vertical arcuate arm member **6544**.

The collar header **6539** may further include horizontal linear arm members **6540** and **6542**, which extend perpendicularly from the vertical arcuate arm **6544**. Members **6540** and **6542** may be manufactured in a fixed configuration or removable configuration with fixed attachment points located along collar header **6539**. The horizontal linear arm members **6540** and **6542** have a relative thickness similar to the vertical arcuate arm member **6544** and are generally linear. The horizontal linear arm members **6540** and **6542** include one or more collars **165***e*-**165***i* and **165***k*-**165***j* defined on a generally planar surface of each of the horizontal linear arm members **6540** and **6542**. The generally planar surfaces of the horizontal linear arm members **6540** and **6542** intersect with the general planar surface of the vertical arcuate arm member **6544** to form a substantially single generally planar surface, as shown best in FIG. **129**C. Accordingly, one or more of the collars **165***f* may be positioned on an intersecting surface of the arcuate arm member **6544** and one of the linear arm members **6540** or **6542**.

Each of the collars **165** are configured to receive a sleeve **100** to cause the one or more anchor elements **30** to extend through the ilium, the sacrum and the implant **25** (and/or immediately adjacent to the implant) generally transverse to the sacroiliac joint and implant **25**, as described herein. Some collars **165**, such as collars **165***f*, **165***i* and **165***l*, may be axially aligned with respective bores of the implant **25** when the implant **25** is supported off of the distal end of the implant arm **110** of the tool **20**. As a result, an anchor member **30** may be delivered into each of the bores via the respective anchor collars **165**. Collars **165***f*, **165***i* and **165***l* are each indicated to be directed to the bore **40** by a marker **6543** showing two concentric circles. As discussed below and can be understood from FIG. **129**C, collar **165***l* has a zero degree horizontal offset by virtue of being on the vertical arm **6544**, which is in parallel alignment to the plane occupied by the implant arm **110** and anchor arm **115**. However, collar **165***l* has a 90 degree vertical offset to the longitudinal axis of the implant arm **110** and the implant **25** mounted thereon such that a sleeve **100** extending through the collar **165***l* extends in the plane occupied by the implant arm and anchor arm and further extends perpendicular to the longitudinal axis of the implant arm and implant. Because collar **165***l* is aligned with the bore **40**, the anchor delivered to the bore by the sleeve extending through collar **165***l* will orient the anchor in the bore in a plane occupied by the implant arm and anchor arm, but perpendicular to the longitudinal axis of the implant. Collar **165***l* may include three overlapping bores that provide a 90 degree alignment angle (or slight angular variations greater than or less than 90 degrees), thereby allowing placement of an anchor **30** (or multiple anchors in general parallel relation), for example through a slot or multiple bores **40** in implant **25**, at varied distances between implant ends.

As can be understood from FIG. **129**C, collar **165***f* has a zero degree horizontal offset by virtue of being on the vertical arm **6544**, which is in parallel alignment to the plane occupied by the implant arm **110** and anchor arm **115**. However, collar **165***f* has a 45 degree vertical offset to the longitudinal axis of

the implant arm **110** and the implant **25** mounted thereon such that a sleeve **100** extending through the collar **165***l* extends in the plane occupied by the implant arm and anchor arm and further extends at a 45 degree angle to the longitudinal axis of the implant arm and implant. Because collar **165***f* is aligned with the bore **40**, the anchor delivered to the bore by the sleeve extending through collar **165***f* will orient the anchor in the bore in a plane occupied by the implant arm and anchor arm, but at 45 degrees to the longitudinal axis of the implant.

As can be understood from FIG. **129**C, collar **165***i* has a 30 degree horizontal offset by virtue of being on horizontal arm **6540** at a 30 degree location. In other words, a sleeve **100** extending through collar **165***i* will approach the implant at an angle that is 30 degrees right of the plane occupied by the implant arm **110** and anchor arm **115**. Further, because horizontal arm **6540** is centered horizontally on collar **165***f*, which has a 45 degree vertical offset to the longitudinal axis of the implant arm **110** and the implant **25** mounted thereon, collar **165***i* will have a 45 degree vertical offset as described with respect to collar **165***f*. Thus, a sleeve **100** extending through collar **165***i* extends at a 30 degree horizontal offset angle to the plane occupied by the implant arm and anchor arm and further extends at a 45 degree offset angle to the longitudinal axis of the implant arm and implant. Because collar **165***i* is aligned with the bore **40**, the anchor delivered to the bore by the sleeve extending through collar **165***i* will orient the anchor in the bore 30 degrees offset from the plane occupied by the implant arm and anchor arm and at 45 degrees to the longitudinal axis of the implant.

The collars **165***e*, **165***g*, **165***h*, **165***j* and **165***k* may be employed to deliver anchor members **30** into the bone of the ilium and sacrum while not passing through a bore **40** of the implant **25** (i.e., according to particular embodiments, preconfigured to place anchor members **30** immediately adjacent the longitudinal side edges of the implant **25**). Such offset placement collars **165***e*, **165***g*, **165***h*, **165***j* and **165***k* are each indicated as such by a marker **6547** showing a circle tangent to a rectangle, as illustrated in FIG. **129**C.

As can be understood from FIG. **129**C, collar **165***h* has a 30 degree horizontal offset by virtue of being on horizontal arm **6540** at a 30 degree location. In other words, a sleeve **100** extending through collar **165***i* will approach the implant at an angle that is 30 degrees right of the plane occupied by the implant arm **110** and anchor arm **115** and, because the adjacent marker **6547** indicates that the anchor **30** will be delivered adjacent to the implant **25** and not through its bore **40**, the anchor will be delivered at the 30 degree angle to the left of the implant. Further, because horizontal arm **6540** is centered horizontally on collar **165***f*, which has a 45 degree vertical offset to the longitudinal axis of the implant arm **110** and the implant **25** mounted thereon, collar **165***h* will have a 45 degree vertical offset as described with respect to collar **165***f*. Thus, a sleeve **100** extending through collar **165***h* extends at a 30 degree horizontal offset angle to the plane occupied by the implant arm and anchor arm and further extends at a 45 degree offset angle to the longitudinal axis of the implant arm and implant. Because collar **165***h* is not aligned with the bore **40**, the anchor will be adjacent the implant (i.e., not in the bore **40**). Also, the anchor **30** delivered by the sleeve extending through collar **165***h* will orient the anchor adjacent the implant 30 degrees offset from the plane occupied by the implant arm and anchor arm and at 45 degrees to the longitudinal axis of the implant.

As can be understood from FIG. **129**C, collar **165***j* has a 20 degree horizontal offset by virtue of being on horizontal arm **6542** at a 20 degree location. In other words, a sleeve **100** extending through collar **165***j* will approach the implant at an angle that is 20 degrees right of the plane occupied by the implant arm **110** and anchor arm **115** and, because the adjacent marker **6547** indicates that the anchor **30** will be delivered adjacent to the implant **25** and not through its bore **40**, the anchor will be delivered at the 20 degree angle to the left of the implant. Further, because horizontal arm **6542** is centered horizontally at a 70 degree vertical offset to the longitudinal axis of the implant arm **110** and the implant **25** mounted thereon, collar **165***j* will have a 70 degree vertical offset. Thus, a sleeve **100** extending through collar **165***j* extends at a 20 degree horizontal offset angle to the plane occupied by the implant arm and anchor arm and further extends at a 70 degree offset angle to the longitudinal axis of the implant arm and implant. Because collar **165***j* is not aligned with the bore **40**, the anchor will be adjacent the implant (i.e., not in the bore **40**). Also, the anchor **30** delivered by the sleeve extending through collar **165***j* will orient the anchor adjacent the implant 20 degrees offset from the plane occupied by the implant arm and anchor arm and at 70 degrees to the longitudinal axis of the implant.

As can be understood from FIG. **129**C, collar **165***e* has a leftward parallel offset by virtue of being on horizontal arm **6540** at a leftward parallel offset location. In other words, a sleeve **100** extending through collar **165***e* will approach the implant leftward offset from, and parallel to, the plane occupied by the implant arm **110** and anchor arm **115** and, because the adjacent marker **6547** indicates that the anchor **30** will be delivered adjacent to the implant **25** and not through its bore **40**, the anchor will be delivered at such a parallel arrangement and to the left of the implant. Further, because horizontal arm **6540** is centered horizontally on collar **165***f*, which has a 45 degree vertical offset to the longitudinal axis of the implant arm **110** and the implant **25** mounted thereon, collar **165***e* will have a 45 degree vertical offset as described with respect to collar **165***f*. Thus, a sleeve **100** extending through collar **165***e* extends at a leftward parallel offset to the plane occupied by the implant arm and anchor arm and further extends at a 45 degree offset angle to the longitudinal axis of the implant arm and implant. Because collar **165***e* is not aligned with the bore **40**, the anchor will be adjacent the implant (i.e., not in the bore **40**). Also, the anchor **30** delivered by the sleeve extending through collar **165***h* will orient the anchor adjacent the implant at the leftward parallel offset from the plane occupied by the implant arm and anchor arm and at 45 degrees to the longitudinal axis of the implant.

As can be understood from FIG. **129**C, collar **165***k* has a leftward parallel offset by virtue of being on horizontal arm **6542** at a leftward parallel offset location. In other words, a sleeve **100** extending through collar **165***k* will approach the implant leftward offset from, and parallel to, the plane occupied by the implant arm **110** and anchor arm **115** and, because the adjacent marker **6547** indicates that the anchor **30** will be delivered adjacent to the implant **25** and not through its bore **40**, the anchor will be delivered at such a parallel arrangement and to the left of the implant. Further, because horizontal arm **6542** is centered horizontally at a 70 degree vertical offset to the longitudinal axis of the implant arm **110** and the implant **25** mounted thereon, collar **165***k* will have a 70 degree vertical offset. Thus, a sleeve **100** extending through collar **165***k* extends at a leftward parallel offset to the plane occupied by the implant arm and anchor arm and further extends at a 70 degree offset angle to the longitudinal axis of the implant arm and implant. Because collar **165***k* is not aligned with the bore **40**, the anchor will be adjacent the implant (i.e., not in the bore **40**). Also, the anchor **30** delivered by the sleeve extending through collar **165***j* will orient the anchor adjacent the implant

at the leftward parallel offset from the plane occupied by the implant arm and anchor arm and at 70 degrees to the longitudinal axis of the implant.

Because of the multiple collars **165**, the delivery tool **20** may be adjusted to accommodate patients of different sizes and still maintain the angular relationships between the components of system **10** that allows one or more anchor members **30** to be delivered into a bore of the implant **25** and/or into the bone of the ilium and sacrum immediately adjacent the implant, or around the implant with anchor **30** passing through regions **3007** or **1044**, without any further adjustment to the delivery tool **20**. Because the angular relationships are rigidly maintained between the arms **110**, **115**, the arm members **6540**, **6542**, and **6544**, the collars **165** of the header **6539**, and the implant **25**, the anchoring of the implant **25** in the sacroiliac joint via one or more anchor members **30** may be achieved quickly and safely. In other words, because the delivery tool **20**, via the multi-angle collar options of the header **6539**, provides multiple angular alignments for deploying one or more anchor members **30** and does not need to be adjusted with respect to angular relationships, the surgery is simplified, reduced in duration, and reduces the risk of an anchor member **30** being driven through a nerve, artery or vein. Additionally, collars may be color coded to correspond with particular implants of the same color, which indicates a complementary configuration. Furthermore, sleeves **100** may encounter interference elements within the collars to restrict or reduce axial movement of the sleeve during the course of the procedure (e.g., see discussion above with respect to FIG. **124**B2).

While any one or more of the implant embodiments disclosed herein could be employed with the delivery device discussed with respect to FIGS. **129**A-**129**C, one version of the implant as now discussed with respect to FIGS. **129**D-**129**L may be especially advantageous. FIGS. **129**D-**129**K are various views of the implant **25**, and FIG. **129**L is an enlarged isometric view of the implant **25** of FIGS. **129**D-**129**K mounted on the extreme distal end of the implant arm **110** of the delivery tool **20** of FIGS. **129**A-**129**C.

As shown in FIGS. **129**D-**129**K, the implant **25** includes a distal end **42** and a proximal end **43**. The implant also includes a middle planar member **6579** in which a central bore slot **40** is defined so as to extend through the middle planar member **6579**. The bore slot **40** may be an elongated oval shape that has a longitudinal axis that is parallel with the longitudinal axis of the implant **25**. The elongated shape allows for an anchor **30** to be delivered through the bore slot **40** at a variety of angles via the collars **165***f*, **165***i*, and **165***l* discussed above with respect to FIG. **129**C.

The distal end **42** of the middle planar member **6579** has a truncated shape with chamfered edges transition between the planar sides of the planar member and the blunt planar distal face of the distal end of the middle planar member. A small planar wing **6580** forms a T-shaped perpendicular intersection with a first lateral edge of the middle planar member **6579**, and a large planar wing **6581** forms a T-shaped perpendicular intersection with a second lateral edge of the middle planar member **6579** opposite the first lateral edge of the middle planar member. Accordingly, as can be understood from FIGS. **129**J and **129**K, the implant has an I-shaped cross section as viewed from either the distal or proximal ends, the large wing **6581** having a substantially larger (e.g., nearly double) width than the small wing **6580**. Additionally, as illustrated in FIGS. **129**J and **129**K, the implant **25** may include one or more bore shafts **10020** extending between, and daylighting at, the implant distal end **42** and implant proximal end **43**. Such shafts **10020** are configured to receive or pass over, for example, guide pins placed in the plane of a sacroiliac joint.

As illustrated in FIG. **129**D, like the distal end **42** of the middle planar member **6579**, the distal ends of the wings **6580** and **6581** also have truncated shapes with chamfered edges transitioning between the planar sides of the wings and the blunt planar distal faces of the distal ends of the wings. While the planar surfaces of the small wing **6580** may be generally smooth, the planar surfaces of the large wing **6581** may have longitudinally extending evenly spaced apart grooves **6582** defined therein. Alternatively, grooves **6582** may extend perpendicular to length of the implant.

As shown in FIG. **129**E, the proximal end **43** of the implant **25** has a groove **6514** that extends from wing to wing across the blunt proximal end **43** of the implant, the groove even extending into the outermost planar surfaces of the wings **6580** and **6581**. As can be understood from FIG. **129**L, when the implant **25** is mounted on the extreme distal end of the implant arm **110**, members **140** similar to those already described herein with respect to FIG. **124**D are received in the groove **6514**, and the central cylindrical member **220** of the retaining member **95** is received in the proximal opening **70** to retain the implant securely on the distal end of the implant arm **110**.

As indicated in FIGS. **129**E and **129**L, the implant **25** may have similar alignment marks **6583** that help a user to properly mount the implant on the implant arm distal end in a correct orientation relative to each other.

While all the various embodiments of the implant arm **110** discussed above are illustrated in their associated figures as having an arrangement that results in the implant **25** being supported off of the distal end **120** of the implant arm **110** such that the longitudinal axis of the implant arm is essentially axially aligned with the longitudinal axis of the implant arm, in other embodiments, as mentioned above, the implant can be supported off of the distal end of the implant arm in other manners. For example, as can be understood from FIG. **129**M, the distal end **120** of the implant arm **110**, which forms a distal end **35** of the overall delivery device **20**, may be oriented so as to support the implant **25** such that the longitudinal axis of the implant is offset from, but substantially parallel to the longitudinal axis of the implant arm **110**. Alternatively, as can be understood from FIG. **129**N, the distal end **120** of the implant arm **110** may be oriented so as to support the implant **25** such that the longitudinal axis of the implant is substantially non-parallel to the longitudinal axis of the implant arm **110**. For example, the longitudinal axis of the implant may form an acute angle (e.g., 45 degree) angle with the longitudinal axis of the implant arm. Alternatively, the implant arm and sleeve can be arcuate. Regardless of whether the longitudinal axis of the implant is axially aligned with, parallel with, or at an acute angle with the longitudinal axis of the implant arm, the overall delivery device with be so configured such that an anchor **30** can be delivered via the implant arm **115** to a bore **40** in the implant **25** and/or a predetermined location immediately adjacent the implant without having to adjust an angular relationship between the implant arm and the anchor arm.

As shown in FIG. **129**P, the implant arm **110** of FIGS. **129**M and **129**N may be 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, as illustrated in FIGS. **129**M and **129**N.

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. **129**P,

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. **129**P, the sleeve **110**Z includes a distal end **10040**, a proximal end **10042**, 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 FIGS. **129**M, **129**N and **129**P, 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. 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 said implant as can be understood from FIGS. **129**L, **131**G and **131**H. 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. 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.

To illustrate the methodology associated with employing the delivery tool **20** of FIGS. **129**A-**129**C in implanting any of the above-described implants **25** in the sacroiliac joint **1000** of a patient **1001**, reference is made to FIGS. **130**A-**130**I. Specifically, FIGS. **130**A-**130**B show anterior views of the hip region with the system of FIGS. **129**A-**129**C, wherein the ilium is shown and hidden, respectively. FIGS. **130**C-**130**G show anterior-superior-lateral, posterior, superior, lateral, and inferior views of the hip region with the system of FIGS. **129**A-**129**C. FIGS. **130**H and **130**I show inferior and posterior-lateral views of a patient, wherein the system of FIGS. **129**A-**129**C is inserted through the soft tissue of the hip region. As can be understood from FIGS. **130**A-**130**I, the curvature of the anchor arm **115** and the arm members **6540**, **6542**, and **6544** mirror the shape of the hip region **1002** to simplify surgery and increase reliability of alignment. Also, the implant **25** may be inserted into the sacroiliac joint via the implant arm **110** via the approach discussed in detail with respect to FIGS. **103**A-**108**A, the main difference being that the multi-collar header **6539** facilitating the delivery of the one or more anchors **30** into or around implant at a variety of locations and angled approaches.

A tool similar to that of FIGS. **129**A-**129**C can be configured to be employed for the approaches illustrated in FIGS. **111**-**112**. For example, for an approach similar to FIG. **111**, a tool similar to FIGS. **129**A-**129**C may be configured without collars **165***e*, **165***g*-**165***h*, **165***j* and **165***k*, because these omitted collars if used for a procedure as shown in FIG. **111** could undesirably direct an anchor anterior of the sacrum or ilium and outside a safe and desirable anchor trajectory. Additionally, collar **165***i* may be employed to direct an anchor **30** which passes through an ilium and into and terminating in a bore **40** of an implant **25** as to not pass into the bone of the sacrum.

As another example, a tool similar to FIGS. **129**A-**129**C may be configured, with **6540** and **6542** being mirrored over **6544** as to generally direct an anchor through a bore **40** of an implant **25** with a trajectory that is more anterior to posterior or which directs an anchor generally posterior to an implant **25** when the anchor is being positioned adjacent to an implant **25**.

According to particular embodiments, for example, for an approach similar to FIG. **112**, a tool similar to FIGS. **129**A-**129**C may be configured without collars **165***e*, **165***g*-*h*, **165***j* and **165***k*, because these omitted collars if used for a procedure as shown in FIG. **112** could undesirably direct an anchor inferior to the sciatic notch and outside a safe and desirable anchor trajectory. As an example, a collar or series of collars could be configured to align with a bore **40** or aligned to pass an anchor **30** above or superior to an adjacent implant **25** with, for example, collars with a 45-70 degree vertical offset to the longitudinal axis of the implant arm **110** (and the implant **25** mounted thereon), and 0-45 degree horizontal offset (with 0 degrees being parallel alignment to the plane occupied by the implant arm **110** and anchor arm **115**).

As can be understood from FIGS. **131**A-**131**B, which show isometric views of another embodiment of the system **10**, the delivery tool **20** of FIGS. **131**A-**131**B is substantially the delivery tool of FIGS. **129**A-**129**C, a main difference being that the collar header **6539** does not include the second horizontal linear arm member **6542** extending from the vertical arcuate arm member **6544** and that the arm members **6540** and **6544** include fewer collars **165**, as described below with respect to FIG. **131**C. Specifically, the first horizontal linear arm member **6540** and the vertical arm **6544** of the embodiment of FIGS. **131**A-**131**C include the same collar locations, angular arrangements and markers as is the case of the arms **6540** and **6544** of the embodiment of FIGS. **129**A-**129**C. FIGS. **131**A-**131**C show the impactor assembly **6550** decoupled from the implant arm **110** and the handle members **6538**. However it will be understood that the impactor assembly **6550** may be coupled to the implant arm **110** and the handle members **6538**, as described with respect to FIGS. **129**A-**129**C.

For a detailed discussion of the angular alignments of the collars **165**, reference is made to FIG. **131**C, which shows an enlarged view of the arm assembly **85** with the collar header **6539**. As discussed with respect to FIG. **129**C, the horizontal linear arm member **6540** intersects with the vertical arcuate arm member **6544** such that one or more of the collars **165** may be positioned on both the arcuate arm member **6544** and the linear arm member **6540**. As shown in FIG. **131**C, the arcuate arm member **6544** may include two linearly aligned collars **165***p* and **165***q* providing different alignment angles that are respectively the same as collars **165***f* and **165***l* of the embodiment discussed with respect to FIG. **129**C. For example, the collar **165***p* may provide a 45 degree alignment angle and the collar **165***q* may include three overlapping bores that provide a 90 degree alignment angle. The linear arm member **6540** may include four collars **165***p*, **165***o*, **165***n*, and **165***m* that are respectively the same as collars **165***f*, **165***g*, **165***h* and **165***i* of the embodiment discussed with respect to FIG. **129**C. For example, the collar **165***o* may provide a 15 degree alignment angle and the collars **165***n* and **165***m* may each provide a 30 degree alignment angle from different locations on the linear arm member **6540**. It will be appreciated that the collar positions and alignments shown in the embodiment of FIGS. **131**A-C are for illustrative purposes only and that other positions and alignments are contemplated.

FIGS. **131**D-**131**E are isometric view of a version of the implant of FIGS. **129**D-**121**K adapted for use with the delivery system of FIGS. **131**A-**131**C. As can be understood from a comparison of implant embodiment shown in FIGS. **131**D-

131E to the implant embodiment illustrated in FIGS. 129D-129E, the main difference between the two versions of the implant is that the elongated single bore slot 40 has changed to two circular bores 40. Polyethylene bushings may define a portion of the bore holes 40 of FIGS. 131D-131E.

In one embodiment, the implant 25 and a distal extension 5777 of the distal end of the implant arm 110 can be configured to receive and remove cartilage from the sacroiliac joint. For example, as shown in FIG. 131F, which is an isometric view of a version of the implant of FIGS. 129D-129K, the body 45 of the implant 25 is hollow along its longitudinal length and daylights at its proximal end 43 and distal end 42 in the form of proximal opening 5778 and distal opening 5779. The side walls of the body 45 extending between the large wing 6581 and small wing 6580 may include openings 5780 that extend into the hollow interior of the body 45. The openings may have a triangular or other shape.

As illustrated in FIG. 131G, which is an isometric view of the distal extension 5777 of the distal end of the implant arm 110, the distal extension 5777 is a hollow rectangular box having generally smooth outer wall surfaces. As can be understood from FIG. 131H, which is an isometric view of the implant arm distal extension 5777 received in the hollow body of the implant 25, the distal extension 5777 is configured to be received in a mating fashion that substantially matches and fills the hollow body of the implant 25 when the implant is supported off of the distal end of the implant arm 110. The matching arrangement between the distal extension 5777 and the hollow interior of the body 45 of the implant 25 is readily understandable from FIG. 131I, which is an isometric longitudinal cross section of the implant arm distal extension and implant supported thereon as taken along section line 131I-131I of FIG. 131H. As indicated in FIG. 131I, the interior wall surfaces of the implant arm distal extension 5777 includes raised teeth-like ridges 5781 that are oriented proximally to prevent cartilage contained in the hollow interior of the extension 5777 from distally exiting the extension 5777.

In use, the implant 25 is supported on the extension 5777 as depicted in FIGS. 131H and 131I and driven into the sacroiliac joint, thereby causing cartilage to be sliced by the leading distal rectangular edges 5782 of the extension 5777 and received in the confines of the hollow interior of the extension 5777. Once the implant 25 is positioned as desired in the sacroiliac joint and then decoupled from the distal end of the implant arm 110, the implant arm 110 can be proximally withdrawn, thereby causing the extension 5777 to proximally exit the confines of the hollow interior of the implant body 45. As the extension 5777 proximally withdraws, the teeth 5781 engage the cartilage located in the confines of the hollow extension 5777, causing the cartilage to be maintained in the confines of the hollow extension as it is proximally withdrawn from the sacroiliac joint, thereby extracting the cartilage from the sacroiliac joint. The void resulting from the withdrawal of the cartilage, which happens to be the hollow interior of the implant body 45, can then be filled with a metal or polymer structure to support the walls of the implant body 45 or, alternatively, the void can be filled with a bone growth promoting material to cause bone to infill the body of the implanted implant.

In one embodiment, the hollow extension 5777 is not part of the distal end of the implant arm 110, but is instead simply an insert 5777 portion of the implant 25. Thus, the insert 5777 is placed in the implant 25 and both are then supported off of the distal end of the implant arm 110. The implant and insert 5777 are then driven into the sacroiliac joint. The implant and insert 5777 are then decoupled from the distal end of the implant arm 110 and left in the sacroiliac joint as the implant arm 110 is proximally withdrawn from the patient. The extractor 6583 described below with respect to FIGS. 134A-134E can then be employed to extract the cartilage filled insert 5777 from the confines of the implant 25, which remains behind in the sacroiliac joint.

FIG. 132A is an isometric view of yet another embodiment of the system 10 for fusing a sacroiliac joint. The system 10 includes an impactor assembly 6550, an impactor arm 110, and a retainer 6548, which is substantially the impactor assembly, impactor arm, and retainer described with respect to FIGS. 129A-129C. The system 10 further includes an arm assembly 85 having handle members 6528, which have substantially the same features as the handle members 6538 described with respect to FIGS. 129A-129C, a main difference being that the handle members 6538 of FIGS. 132A-132B are generally cylindrical, as opposed to the generally rectangular shape of the handle members 6538 of FIGS. 129A-129C.

As shown in FIG. 132B, which is the same view as FIG. 132A, except the system is exploded to better illustrate its components, the anchor arm 115 is contoured and curves along an arcuate path to provide axial alignment between a collar 165 and a bore or other anchor member receiving features on the implant 25. The collar 165 is configured to receive a sleeve 100 to cause the one or more anchor elements 30 to extend through the ilium, the sacrum and the implant 25 generally transverse to the sacroiliac joint and implant 25, as described herein.

The anchor arm 115 is coupled to the implant arm 110 with a locking member 6556. Specifically, as can be best understood from FIG. 132B, the anchor arm 115 includes an engaging member 6568 configured to slidably couple with a channel 6566 of the implant arm 110. The coupling arrangement may be achieved via a dovetail arrangement of the channel and pins received in holes of the coupling arrangement. Once the anchor arm 115 is coupled to the implant arm 110, a distal end 6572 of the locking member 6556 is introduced through an opening 6570 to secure the anchor arm 115 to the implant arm 110. To engage the implant 25, the retaining member 6548 is introduced through an opening 6564 in the implant arm 110 such that a distal end 6562 of the retaining member 6548 may engage the implant 25, as described herein. Finally, a distal end 6558 of the impactor assembly 6550 may be introduced into an opening 6560 on the implant arm 110 to couple the impactor assembly 6550 to the implant arm 110 such that displacing the impactor assembly 6550 causes the implant arm 110 to deliver the implant 25 to the joint region, as described herein. The handles 6538 are removable from the rest of the assembly.

For a detailed discussion of yet another of the system 10 for fusing a sacroiliac joint, reference is made to FIGS. 133A-133G. As can be understood from FIGS. 133A, 133B, and 133E, an implant assembly includes the implant arm 110, an elbow 6581, and a linear implant member 6580. The implant arm 110 has generally the same features as the implant arm 110 described above and have an implant removably coupled to a distal end of the implant arm via any of the above described configurations, including a retainer member 6548 (see FIG. 132B) extending through the implant arm. As shown in FIGS. 133A, 133B, and 133E, the implant arm 110 is coupled to the linear implant member 6580 via the elbow 6581. Specifically, the linear implant member 6580 and the implant arm 110 intersect at the elbow 6581 such that the implant arm 110 and the linear implant member 6580 are positioned at an angle relative to each other. The elbow 6581 may serve as an impactor area for being impacted by an impactor in driving the implant supported on the end of the

implant arm into the joint. The linear implant member **6580** is removably coupled to the arm assembly **85** at the anchor arm **115**. In other words, the linear implant member **6580** is inserted into or otherwise couple to the anchor arm **115** and secured with the locking member **6556**.

The anchor arm **115** is coupled to a linear arm member **6578**, which is coupled to an arcuate arm member **6576**. In one embodiment, the linear arm member **6578** is generally parallel with the linear implant member **6580** and the arcuate arm member is generally parallel with the anchor arm **115**. The arcuate arm member **6576** is contoured and curves along an arcuate path to provide axial alignment between collars **165** and a bore or other anchor member receiving features on the implant **25**. The collars **165** are each configured to receive a sleeve **100** to cause the one or more anchor elements **30** to extend through the ilium, the sacrum and the implant **25** generally transverse to the sacroiliac joint and implant **25**, as described herein.

As indicated in FIG. **133**A by dimension line R, the arcuate arm member **6576** may have a curvature with a radius of between approximately 120 mm and approximately 180 mm with an arcuate length between the arrow ends of dimension line R of between approximately 200 mm and approximately 400 mm. As shown in FIG. **133**B, the U-shaped linear arm member **6578** of the anchor arm **115** extending from the proximal end of the arcuate arm member **6576** and leading to the proximal end of the implant arm **110** has a distal linear segment with a length L**1** of approximately 145 mm, a middle linear segment with a with a length L**2** of between approximately 50 mm and approximately 80 mm, and a proximal linear segment with a length L**3** of between approximately 95 mm and approximately 145 mm.

To illustrate the methodology associated with employing the delivery tool **20** of FIGS. **133**A, **133**B, and **133**E in implanting any of the above-described implants **25** in the sacroiliac joint **1000** of a patient **1001**, reference is made to FIGS. **133**C, **133**D, **133**F and **133**G. Specifically, FIGS. **133**C and **133**F show the same tool orientations as FIGS. **133**B and **133**E, respectively, except the system **10** is inserted through the soft tissue **1003** of the hip region **1002** of the patient **1001**. FIG. **133**D is the same view as FIG. **133**C, except the soft tissue is hidden to show the patient bone structure. FIG. **133**G is the same view as FIG. **133**F, except the soft tissue is hidden to show the patient bone structure.

As can be understood from FIGS. **133**C and **133**F, the curvature and relative positions of the features of the implant assembly and the arm assembly mirror the shape of the hip region **1002** to simplify surgery and increase reliability of alignment. Further, the system **10** is relatively compact such that it does not hinder movement during an operation. Also, the implant **25** may be inserted into the sacroiliac joint via the implant arm **110** via the approach discussed in detail with respect to FIGS. **103**A-**108**A, the main difference being that the arcuate arm member **6576** is contoured and curves along an arcuate path to provide axial alignment between multiple collars **165** and a bore or other anchor member receiving features on the implant **25**.

The embodiment of FIGS. **133**A-**133**G can be used for other surgical approaches such as, for example, the approaches illustrated in FIGS. **111**A-**112**C. For example, for the approach shown in FIGS. **111**A-**111**C, it may be preferred to employ the 45 degree collar of the anchor arm **115**, while for the approach depicted FIGS. **112**A-**112**D, it may be preferred to employ the 90 degree collar of the anchor arm **115** (i.e., the sleeve **100** that is generally perpendicular to the longitudinal axis of the implant arm **110** and the implant **25** supported off of the implant arm.

The embodiment depicted in FIGS. **133**A-**133**G offers a number of advantages. First, this embodiment provides more grasping area for the medical professional employing the device and allows for the hand and other body parts of the medical professional to be further from the x-ray beam of the fluoroscope. Also, the embodiment provides for increased visualization of the surgical site by the medical professional. Portions of the device, for example, **6578** are out of the area being x-rayed for fluro visualization, increasing the visualization possible via fluoroscopy. Finally, clamps can be employed on the device that can be used to secure the device to a surgical table out of the way of the x-ray beam or the imaging equipment.

For a detailed discussion of an embodiment of a system **6583** for extracting an implant, reference is made to FIGS. **134**A-**134**E. As can be understood from FIG. **134**A, the system **6583** includes a handle **90** and an implant retainer **95**, which have features substantially similar to the handle **90** and implant retainer **95** described herein, for example, with respect to FIG. **3**. Further, the system **6583** includes a distal end **6584** having a hook **6586**, which is adapted to engage with an engaging portion **6588** of the implant **25**.

In one embodiment, as can be understood from FIGS. **129**A-**129**C (and in a similar fashion from FIGS. **131**A-**131**C, and **133**A, **133**B and **133**E for other embodiments), a sacroiliac joint fusion system **10** includes a joint implant **25**, an anchor element **30** and a delivery tool **20**. The joint implant includes a distal end **42** and a proximal end **43** opposite the distal end. The anchor element comprising a distal end and a proximal end. The delivery tool includes an implant arm **110** and an anchor arm **115**. The implant arm includes a proximal end and a distal end. The implant arm distal end is configured to releasably couple to the proximal end of the joint implant. The anchor arm includes a proximal end, a distal end, a header **6539** and a member **100**. The proximal end of the anchor arm is coupled to the implant arm, and the header is supported on the anchor arm near the distal end of the anchor arm. The header includes at least first and second guide holes (e.g., any two or more of guide holes **165***e*-**165***l*). The first guide hole (e.g., anyone of guide holes **165***e*-**165***l*) is configured to orient the member **100** when received in the first guide hole in a first approach aimed at least in the vicinity of the joint implant **25** when the proximal end **43** of the joint implant is releasably coupled to the distal end of the implant arm **110**. Similarly, the second guide hole (e.g., any one of guide holes **165***e*-**165***l* other than the first guide hole) is configured to orient the member when received in the second guide hole in a second approach aimed at least in the vicinity of the joint implant **25** when the proximal end **43** of the joint implant is releasably coupled to the distal end of the implant arm **110**. The first and second approaches are different. The member **100** is configured to guide the delivery of the anchor element **30** to at least in the vicinity of the joint implant **25** when the proximal end **43** of the joint implant is releasably coupled to the distal end of the implant arm **110**.

Depending on the embodiment, the joint implant **25** includes a body **45** extending between the distal and proximal ends **42**, **43** of the joint implant **25** and an anchor hole **40** extends through the body non-parallel to a longitudinal axis of the joint implant. The first approach is aimed so as to cause the member **100** when received in the first guide hole to guide the anchor element **30** into the anchor hole. A longitudinal axis of the implant arm **110** may be substantially at least one of coaxial or parallel with the longitudinal axis of the joint implant **25**.

The header **6539** may include a first arm **6544** that generally exists in a plane defined by at least portions of the implant

arm **110** and the anchor arm **115**. The first and second guide holes **165***f*, **165***l* are spaced apart from each other along the first arm and the respective first and second approaches are non-parallel to each other.

The header **6539** may include a first arm **6540** or **6542** that generally exists in a plane generally perpendicular to a plane defined by at least portions of the implant arm **110** and the anchor arm **115**. The first and second guide holes (e.g., any two of **165***e*-**165***i* or **165***j*-**165***k*, depending on which arm **6540**, **6542**) are spaced apart from each other along the first arm and the respective first and second approaches are non-parallel to each other.

The header **6539** may include a first arm **6544** and a second arm **6540** or **6542**. The first arm generally exists in a first plane defined by at least portions of the implant arm **110** and the anchor arm **115**. The second arm generally exists in a second plane generally perpendicular to the first plane. The first guide hole (e.g., any one of **165***f* or **165***l*) is located on the first arm and the second guide hole (e.g., any one of **165***e*-**165***i* or **165***j*-**165***k*, depending on which arm **6540**, **6542**) is located on the second arm. In such an embodiment, the first and second approaches are substantially parallel to each other (e.g., where the first and second guide holes are **165***f* and **165***e*) or the first and second approaches are non-parallel to each other (e.g., where the first and second guide holes are **165***l* and **165***h*).

In one embodiment, as can be understood from FIGS. **129**D-**129**K, the joint implant **25** includes a distal end **42**, a proximal end **43**, and a body **6579** extending between the distal and proximal ends. An anchor hole **40** extends through the body non-parallel to a longitudinal axis of the joint implant. A first planar member **6581** extends generally perpendicular to a first lateral edge of the body **6579** of the joint implant **25**, and a second planar member **6580** extends generally perpendicular to a second lateral edge of the body of the joint implant opposite the first lateral edge. The body **6579** is substantially a planar member. The first planar member **6581** is larger in at least one of length or width than the second planar member **6580**.

As can be understood from FIGS. **131**F-**131**I, in one embodiment, the body **45** may be generally hollow and include a hollow open-ended insert **5777** that substantially occupies in a generally mating manner the hollow body. The insert is removable from the body. The insert may include textured interior wall surfaces. The interior wall surfaces define a hollow interior of the insert. The insert may be separate from the distal end of the implant arm **110** or may be an extension of the implant arm.

As will be appreciated from FIGS. **134**B-**134**C, which show enlarged views of the distal end **6584** of the system of FIG. **134**A, wherein the distal end **6584** is decoupled and coupled to the implant, respectively, the handle **90** may displace longitudinally to advance the distal end **6584** towards the implant **25**. As best shown in FIGS. **1328**, **134**C and **134**D, the hook **6586** may have angular features to form a general "L-shape." As can be understood from FIG. **134**D and FIG. **134**F, which is an isometric view of the proximal end of the implant of FIGS. **134**B-**134**C, the proximal end **43** of the implant has a central opening **70** which has an elongated section **70**A extending radially outward from a centerline of the central opening **70**. The elongated section **70**A transitions to a side opening **70**B that is a transverse radial extension of the central opening that daylights at the surface of a wing portion **50** of the implant **25**.

The hook **6586** may engage the implant **25** by entering the opening **70** in the proximal end of the implant **25** such that the hook **6586** passes through the elongated section **70**A and enters the side opening **70**B to engage with an inner surface of the implant **25** in the engaging portion **6588**. After the hook **6586** is coupled to the engaging portion **6588**, the implant **25** may be extracted via repeatedly sliding the handle along the retainer **95** to cause the handle to repeatedly impact the cap **6599** of the retainer **95**.

As can be understood from FIG. **134**E, which is the same view as FIG. **134**A, except the system is exploded to better illustrate its components, the implant retainer **95** and the handle **90** have substantially similar features to the handle **90** and the implant retainer **95** described herein, for example, with respect to FIG. **3**, a main difference being that the shape of the handle **90** is contoured to fit into the palm of a user's hand and the handle is configured to slide along the retainer so as to allow impacting against the cap **6599** to create a proximally directed impacting force that can be used to extract the implant from a sacroiliac joint. The implant retainer **95** is introduced through the handle **90**, as described herein, such that a distal end **6582** of the implant retainer **95** may be coupled with a proximal end **6590** of the distal end **6584**.

In one embodiment, as can be understood from FIGS. **134**A-**134**E, the extractor **6583** is configured to remove a joint implant **25** including a distal end **42**, a proximal end **43** opposite the distal end, a body extending between the distal and proximal ends, and an opening **70** defined in the proximal end so as to define an inward edge **6591**. The extractor **6583** includes a distal end **6584**, a proximal end **6599**, a shaft **95** extending between the distal and proximal ends of the extractor, and a handle **90** displaceable along the length of the shaft back and forth proximal-distal. The shaft **95** includes a distal abutment **6593** and a proximal abutment **6599** respectively near distal and proximal ends of the shaft. The handle **90** is supported on the shaft **95** between the distal and proximal abutments. The distal end **6584** of the extractor **6583** includes a feature **6586** configured to engage the inward edge **6591** when the feature is received in the opening **70**. The feature may be a hook or L-shaped.

As can be understood from FIGS. **134**A-**134**E, and with continuing reference to FIG. **126**B, in one embodiment, an anchor **40** can be configured as a cable with an end that is able to be received in side opening **70**B and further configured to allow a setscrew that may be advanced down central opening **70** (and with abutting elements received in **70**A) to abut the cable end so as to anchor the cable end within implant **25**. The other end of the cable can pass through the plane of the sacroiliac joint and communicate with components of a pelvic or spinal fixation system.

For a discussion of an embodiment of the implant **25** that is configured to have a shape that generally mimics and even substantially fills a sacroiliac joint space, reference is made to FIGS. **135**A-**135**C. As can be understood from a comparison of the side view of the implant **25** as illustrated in FIG. **135**C to the shape of the sacroiliac joint articular region **1044** depicted in FIG. **106**B, 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. **135**A-**135**C or assembled or deployed in situ from multiple pieces, as discussed in further detail below. As illustrated in FIGS. **135**A-**135**C, the implant **25** includes a proximal end **43** for being removably coupled to the extreme distal end of an implant arm of any of the above described delivery devices **20**. The implant proximal end **43** includes grooves **6514** and holes **75** that interface and couple with members **140** and **150** on the implant arm **110** similar to those described above with respect to FIG. **124**D and FIG. **19**, respectively.

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**.

The implant **25** can be configured similar to previously described implant embodiments wherein the body of the implant is a generally continuous solid surface with one or more bores **40** defined therein. However, as indicated in FIGS. **135**A-**135**C, the implant **25** may have a skeletonized configuration, wherein the is an outside frame boundary **7110** that extends unbroken and unitary through all of the above-mentioned regions of the implant, thereby forming it outer boundary while the interior of the implant is generally open space across which support members **7112** extend to join the outside frame boundary **7110** at different locations. As a result of its open configuration, one or more anchors **30** may be extended through the implant when implanted in the sacroiliac joint. When implanted via the approach depicted in FIGS. **103**A-**108**B, it can be understood that the shape of the implant **25** of FIGS. **135**A-**135**C may at least somewhat resemble the sacroiliac joint space and more fully occupy the joint space than some of the more linearly shaped rectangle and cylindrical implant embodiments described above.

As can be understood from FIGS. **135**A-**135**C, in one embodiment, a sacroiliac joint fusion implant **25** includes a proximal end **43**, a distal end **42** generally opposite the proximal end, and first and second lateral sides **7117**, **7118** extending between the proximal and distal ends and defining a long portion of the implant **7100** and a short portion **7107** 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 **7119** 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 releaseably couple to an implant delivery system. The region of the implant between the lateral sides is open except for at least one cross member **7112** extending between the lateral sides **7117**, **7118**. An offset distance between the lateral sides is substantially greater than a thickness of the implant. The first lateral side **7118** transitions between the long and short portions **7100**, **7101** via a first curved portion **7103** and the second lateral side **7117** transitions between the long and short portions via a second curved portion **7102** having a radius smaller than the first curved portion. The first and second lateral sides define 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 first and second lateral sides define a shape resembling a boot for a human foot.

For a discussion of an embodiment of the implant **25** that is configured to have a shape that generally mimics and even substantially fills a sacroiliac joint space after in situ deployment of certain components of the implant **25**, reference is made to FIGS. **136**A-**136**J. As shown in FIGS. **136**A-**136**B and **136**F-**136**I, in one embodiment, the implant **25** includes a distal or leading end **42**, a proximal or trailing end **43**, a longitudinally extending body **45**, a rectangular void **7540** extending through the body, and keels, fins or planar members **50**, **55** that radially extend outwardly away from the body **45**. In one embodiment, the radially extending planar members **50**, **55** may be grouped into pairs of planar members **50**, **55** that are generally coplanar with each other. For example, planar members **50** that are opposite the body **45** from each other generally exist in the same plane. More specifically, as best understood from FIGS. **136**F and **136**G, the planar faces **60** of a first planar member **50** are generally coplanar with the planar faces **60** of a second planar member **50** opposite the body **45** from the first planar member **50**. Likewise, the planar faces **65** of a third planar member **55** are generally coplanar with the planar faces **65** of a fourth planar member **55** opposite the body **45** from the third planar member **55**. The body **45** may be a distinct central portion of the implant or may simply be an intersection of the four planar members **50**, **55**.

As best understood from FIGS. **136**F and **136**G, one set of planar members **50** (i.e., the large planar members **50**) may extend radially a greater distance than the distance extended radially by the other set of planar members **55** (i.e., the small planar members **55**). Also, the width of a large planar member **50** from its outer edge to its intersection with the body **45** may be greater than the width of a small planar member **55** from its outer edge to its intersection with the body **45**. Also, the thickness of the large planar members **50** may be greater than the thickness of the small planar members **55**. Thus, one set of planar members **50** may be both wider and thicker than the other set of planar members **55**. In other words, one set of planar members **50** may be larger than the other set of planar members **55**.

As can be understood from FIGS. **136**A-**136**D, a toe member **7541** having a square or rectangular boxed shape is supported in the implant body **45** near the distal end **42**. The toe member **7541** is moveably supported on rails **7542** relative to the rest of the implant and can be caused to move perpendicularly to the longitudinal axis of the implant **25** from a recessed location in the implant to a position that causes the toe member **7541** to project past the extreme edge face of one of the large planar members **50** such that the implant changes from having a rectangular box-like configuration to a boot or L-shaped configuration.

As can be understood from FIGS. **136**E and **136**J, the toe member **7541** includes slots **7543** that matingly engage with the rails **7542** such that the slots can slide along the rails. A fluid conduit **7545** extends from the proximal end **43** to a cylinder housing **7546** in which a piston **7547** of the toe member is displaceably received. An O-ring **7548** seals the interface between the cylinder inner wall and the outer circumferential piston surface. A pressurized fluid applied to the piston **7547** via the fluid conduit **7545** causes the toe member **7541** to move out of the rest of the implant so as to project laterally from the rest of the implant as indicated in FIGS. **136**C-**136**D.

As illustrated in FIG. **136**J and more clearly in FIGS. **136**K and **136**L, which are respective enlarged views of the upper and lower cylinder regions of FIG. **136**J, a lip **10050** defined in the upper end of the cylinder housing **7546** and a lip **10051** defined in the lower end of the piston **7547** interact to provide an extreme limit to outer movement of the toe member **7541**. Thus, the lips act as stops to prevent the toe member from extending off of the rest of the implant due to over extension of the piston in the cylinder.

While the deployment mechanism depicted in FIGS. **136**E and **136**J accomplishes the deployment of the toe member **7541** hydraulic or pneumatic lifting mechanism, in other embodiments the deployment mechanism may be via a screw or gear arrangement (e.g., spur, helical, rack, bevel, miter, worm, ratchet or pawl gears). Additionally, locking mecha-

nisms may be employed to prevent backward movement of the toe member after deployment.

As can be understood from FIGS. **136**A-**136**J, in one embodiment, the sacroiliac joint fusion implant **25** includes a proximal end **43**, a distal end **42** generally opposite the proximal end, first and second lateral sides **50**, **50** extending between the proximal and distal ends, and a member **7541** near the distal end configured to displace from a first position to a second position. As indicated in FIGS. **136**A-**136**B, the first position may be such that the member **7541** is generally recessed within the implant **25** such that a lateral side surface of the member is generally flush with the first lateral side **50**. As shown in FIGS. **136**C-**136**D, the second position may be such that the member **7541** extends from the first lateral side **50**, the lateral side surface of the member being offset from and generally parallel to the first lateral side. The member **7541** may be displaceably supported on the implant via a rail arrangement **7542**, **7543**. As indicated in FIGS. **136**E and **136**J, the implant **25** may be in the form of an actuation mechanism that drives the member from the first position to the second position and is actuatable via an access at the proximal end. For example, the actuation mechanism may include a hydraulic, pneumatic, geared or screwed mechanical arrangement.

For a discussion of an embodiment of the implant **25** that is configured to have a shape that generally mimics and even substantially fills a portion of a sacroiliac joint space, reference is made to FIGS. **137**A-**137**F. As can be understood from a comparison of the top plan view of the implant **25** as illustrated in FIG. **137**C to the shape of the sacroiliac joint extra-articular region **3007** depicted in FIG. **106**B, the implant has an overall exterior shape that generally mimics the sacroiliac joint extra-articular region **3007**. The implant has a generally isosceles triangle shape in the top plan view. The implant **25** includes a generally truncated, flat proximal end **43** from which two tapering lateral sides **8331** extend and converge at the distal end **42**, which forms a rounded or arcuate distal point. A void **7540** of a shape generally the same as the outer shape of the implant itself is defined in the body of the implant generally centered in the implant. The top and bottom surfaces **8332** of the implant have a serrated surface with edges oriented proximally so as to prevent proximal self-migration of the implant once implanted in the joint. The serrated edges extend parallel to the truncated, flat proximal end **43**. One or more anchors can be extended through the void **7540** or a bone growth material can be located in the void **7540**.

FIGS. **138**A-**138**F illustrate another embodiment the implant **25** that is configured to have a shape that generally mimics and even substantially fills a portion of a sacroiliac joint space. A comparison of the embodiment of FIGS. **138**A-**138**F to the embodiment of FIGS. **137**A-**137**F reveals that the embodiments are substantially similar except the embodiment of FIGS. **138**A-**138**F has a flat, truncated distal end **42** as opposed to an arcuate end, and the void **7540** is generally a circular bore as opposed to a shape that is generally triangular like the exterior boundaries of the implant. As can be understood from FIGS. **138**C and **138**D, the bore **7540** does not extend completely perpendicular between the opposed top and bottom faces **7540**, but instead has a slight cant or tilt.

As an example, due to idiopathic anatomic (e.g., skeletal or neurovascular) variations of certain patients it may be advantageous to have a custom implant, anchor, alignment tool or targeting arm manufactured for a particular individual. Pre-surgical imaging studies (e.g., CT or MRI) may be performed and post-processing, including 3D rendering, may assist in planning desired anchor trajectories, anchor dimensions or implant dimensions. The result of these studies and their interpretation may provide details specific to the manufacture of particular tools or implants and their implantation.

As can be understood from the foregoing, various embodiments of the delivery tools or system configurations as described herein can be similarly configured to operate with various embodiments of the sacroiliac joint implants disclosed in U.S. Provisional 61/520,956.

In summary and as can be understood from the preceding discussion, the sacroiliac joint fusion systems **10** disclosed herein include a joint implant **25**, an anchor element **30** and a delivery tool **20**. The joint implant **25** includes a longitudinal axis CA (e.g., see FIG. **10**) and a bore **40** extending non-parallel to the longitudinal axis CA. The anchor element **30** is configured to be received in the bore **40**.

The delivery tool **20** includes an implant arm **110** and an anchor arm **115**. The implant arm **110** is configured to releasably couple to the joint implant **25**. The anchor arm **115** is coupled to the implant arm and configured to deliver the anchor element **30** to the bore **40**.

The final manufactured configuration of the tool **20** and final manufactured configuration of the joint implant **25** are such that, when the system **10** is assembled such that the implant arm **110** is releasably coupled to the joint implant **25** (e.g., as shown in FIGS. **2**A, **21**A, **21**C, **32**, **37** and **109**), a delivery arrangement automatically exists such that the anchor arm **115** is correctly oriented to deliver the anchor element **30** to the bore **40**. Thus, when the system **10** is shipped from the manufacturer to the medical facility where the sacroiliac joint fusion will take place, the components **20**, **25**, **30**, **40**, **110**, **115** are each configured such that simply plugging them together such that the tool **20** is fully assembled and the implant **25** is supported off of the distal end of the tool **20** is all that is required to employ the tool **20** to both deliver the implant **25** into the sacroiliac joint **1000** and deliver the anchor element **30** into the bore **40** so as to anchor the implant **25** in the sacroiliac joint. In other words, once the components of the system **10** are coupled together, the cumulative result of the as-manufactured three dimensional configurations of each component of the system **10** is that the system **10** has a delivery arrangement such that the anchor arm **115** is correctly oriented to deliver the anchor element **30** to the bore **40** without having to adjust the as-manufactured three dimensional configurations of any of the components of the system **10**. This automatically arrived-at delivery arrangement is even the case wherein the anchor arm **115** being employed is part of a plurality of anchor arms (as discussed with respect to FIG. **21**B) or where the anchor arm **115** is pivotally coupled to the implant arm **110** and further equipped with an arcuate slider **105** at a free distal end of the anchor arm, the arcuate radius of the anchor arm **115** at the arcuate slider **105** being such that the radius extends through the bore **40** (as discussed with respect to FIG. **34**).

While the implant embodiment of FIGS. **5**-**17** and many of the other implant embodiments described herein depict the bore **40** as being defined in the implant body **45** such that the longitudinal axis of the bore **40** and the longitudinal axis of the implant body **45** are coincident, in other embodiments, the bore **40** may be defined elsewhere in the implant **25**. For example the bore **40** may be defined in the implant body **45** such that the longitudinal axes of the bore and implant body are offset from each other. As another such example, the bore **40** may even be defined to extend across a wing **50**, **55** so as to daylight at opposed planar surfaces **60** of a large wing **50** or the opposed planar surfaces **65** of a small wing **55**.

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 side pieces **12/14**, is configured to fuse a sacroiliac joint once implanted at the joint. The side pieces **12/14** are integrally supported on the implant **25** and configured to laterally project from sides of the implant. By acting on the side pieces **12/14** 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 **10088**), the side pieces **12/14** 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 side pieces **12/14** 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 yet other aspects and embodiments of the present invention, reference is made to FIGS. **139-144**. FIGS. **139-140** and FIG. **143** are isometric views of the implant assembly **15**A. FIG. **141** is an edge side elevation view of the implant assembly **15**A. FIG. **142** is a lateral side plan view of the implant assembly **15**A. FIG. **144** is a proximal end view of the implant assembly **15**A. FIG. **145** is a distal end view of the implant assembly **15**A. FIGS. **146-147** are exploded views of the implant assembly **15**A to better illustrate its components.

As can be understood from FIGS. **139-155**, the system **10**A includes a delivery tool **20**A and an implant assembly **15**A for implanting at the sacroiliac joint via the delivery tool **20**A, the implant assembly **15**A being for fusing the sacroiliac joint. The implant assembly **15**A includes a distal or leading end portion **42**A, a proximal or trailing end portion **43**A with a longitudinal body **25**A extending between the distal and proximal ends. The implant body **25**A further includes first and second side pieces or members **12**A/**14**A, each including an opening **50**A disposed therein. The parts **6515** of distal end **35**A of the delivery tool **20**A may interface with longitudinally extending rectangular notches **6514** formed in the body **25**A as discussed in the aforementioned related patent applications and in greater detail below. In one embodiment as shown in FIGS. **144** and **145**, a sacroiliac joint fusion implant **25**A includes a proximal end **43**A, a distal end **42**A generally opposite the proximal end, and side edge surfaces **7150** extending between the proximal and distal ends. 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**.

As can be understood from FIGS. **146-147**, and with continuing reference to FIGS. **139-155**, the implant body **25**A, includes oppositely disposed first and second side members **12**A/**14**A structured and arranged to expand into and engage the sacroiliac joint following insertion therein and an actuating body **72**A. The side pieces **12**A/**14**A are integrally supported on the implant **25**A and configured to laterally project from sides of the implant. Side pieces **12**A/**14**A each include a bone facing surface **7260**, an implant facing surface **7261**, ridges **7061**, a guide mechanism for guiding the expandable movement of the side pieces and including guide piece **6606** disposed in the body portion and having, a slope **6607**, and pins **6601** (or as indicated in particular in FIG. **151**, **6601**A-D). Implant **25**A may further include slots **6600**. The guide piece **6606** may be sized to allow side piece **12**A/**14**A to be housed in implant housing **6608**. Slots **6600** may be configured to house pins **6601** to limit the amount of laterally projecting movement of side pieces **12**A/**14**A. The ridges **7061** are structured and arranged to securely engage the sides of the sacroiliac joint when urged into operative engagement therewith by the actuating body **72**.

To begin a detailed discussion of an implant assembly **15**A in a deployed or expanded state, reference is made to FIGS. **148-154**. FIGS. **148-150** are isometric views of the implant assembly **15**A in a deployed or expanded state. FIGS. **151-154** are cross section views of the implant assembly **15**A in a deployed or expanded state. As can be understood from the figures, body **72**A when inserted into implant **25**A via bore **70**A can cause the side pieces **12**V/**14**A to laterally project from sides of the implant. Body **72**A may be fully or partially threaded and may have a leading end which is tapered. Body **72**A may be driven by longitudinally acting forces or by rotational forces by a tool **10088** through bore **70**A and further driven to hit the slopes or slope surfaces **6607**, thereby causing the side pieces **12**V/**14**A to laterally project from sides of the implant.

To begin a detailed discussion of a delivery tool **20**A of the system **10**A, reference is made to FIG. **155**. In one embodiment, a delivery tool **20**A for use with the implant embodiments of the FIGS. **139-154** may be configured as illustrated in FIG. **155**. Such a tool **20**A may have an implant arm **110**A 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 **1102**.

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 **6515**. As shown in FIG. **155**, when the rod **110**X is free of the sleeve **110**Z, the opposed arms **1032** are biased apart, resulting in a space-apart distance indicated by arrow D that is sufficiently wide to allow the implant **25**A to be received between the prong arms **6515** at the rod distal end **120**A.

As indicated in FIG. **155**, the sleeve **110**Z includes a distal end **10040**, a proximal end **10042**, 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. **155**, when the sleeve **110**Z is advanced coaxially 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. The sleeve **110**Z advancing coaxially distally causes prong arms **6515** 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**A 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**A is coupled to the implant **15**A, a hex-head **10083** wrench or screwdriver **10088** with a handle **10082** may be extended down a central lumen of the shaft **10030** to engage the hex-head end of the body **72**A to drive body **72**A a distance towards implant proximal end **42**A thereby causing the side pieces **12**A/**14**A to laterally project from sides of the implant. 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.

Referring now to FIGS. **158-164**, another embodiment of an implant insertion tool **1000**A is shown. Tool **1000**A is in

the form of a tong apparatus and includes a handle **10004**A pivotally connected at a first end **1006**A thereof to a multi-segmented elongated arm **1008**A/**1013**A, the segments being pivotally joined at pin **1015**A. The elongated arm **1008**A/**1013**A includes a proximal end **1020**A and distal end **1021**A. A second multi-segmented elongated arm **1010**A/**1011**A is pivotally connected at a midpoint **1012** thereof at approximately the midpoint of arm **1008**A/**1013**A and is operatively engaged at a proximal end **1014**A thereof to a ratchet **1016**A positioned on handle **1004**A. The segments **1010**A and **1011**A are pivotally connected at pin **1019**A. Arm **1010**A further includes a distal end **1017**A oppositely disposed from distal end **1021** of arm **1008**A, as is more clearly illustrated in FIGS. **161** and **162**. The arms **1018**A and **1010**A are structured and arranged to form a tong-type tool adapted for insertion of an implant into a sacroiliac joint as hereinabove described with respect to an alternate embodiment of this invention.

FIGS. **164-170** illustrate yet another embodiment of a sacroiliac implant device **3000**A and insertion tool **1000**B. With the exception of distal ends **1017**B and **1021**B, insertion tool **1000**B is structured in the same manner as tool **1000**A described above. According, similar numerals followed by the letter "B" are shown in the drawings to differentiate between the two embodiments.

As best shown in FIGS. **169** and **170**, insert **3000**A comprises a body portion **3002**A having an elastic generally U-shaped middle portion **3004**A and a pair of opposite disposed legs **3006**A/**3008**A having a proximal end **3007**A/**3009**A respectively operatively connected to the U-shaped middle portion and extending therefrom creating a spring-like force extending transversely therefrom. Each leg includes a generally U-shaped opening or channel **3012**A/**3014**A formed in a distal end **3016**A/**3018**A thereof respectively, each channel adapted to receive a respective end **1017**B/**1021**B of tool **1000**B for insertion into a joint. Each end **3016**A/**3018**A includes a plurality of outwardly extending wedge or V-shaped projections **3020**A structured and arranged to be urged by the spring force of the implant into engagement with the joint interfaces into which it is implanted.

Referring to FIGS. **171-173**, yet another embodiment of a sacroiliac joint implant is shown at **4000**A. Similar in configuration and operation to the embodiment of FIGS. **169** and **170**, the implant device of the instant embodiment has legs **4006**A/**4008**A extending substantially parallel from an elastic U-shaped middle portion **4004**A. Outwardly extending wedge or V-shaped projections are structured and arranged to be forcibly driven into a joint interface upon insertion by a tool such as tool **1000**A hereinabove described.

Yet another embodiment of an implant device **5000**A is depicted in FIG. **174**. Implant **5000**A includes an expandable body portion **5002**A having a first end configured in the shape of a chisel **5004**A and a second end **5006**A having an aperture **5008**A formed therein and adapted to receive a wedge element **5012**A. After insertion into a sacroiliac or other applicable joint, wedge **5012**A is forced into aperture **5008**A, thereby expanding the body portion of the implant into contact with the joint interfaces. Four orthogonally positioned projections **5012**A are structured and arranged to be forced into engagement with the joint interfaces, thereby securely retaining the implant in its desired location.

Insertion tool **1000**A further includes a pair of oppositely disposed spring elements positioned intermediate a proximate end **1020**A of the first arm **1008**A and a proximate end **1022**A of the second arm **1010**A to urge the proximate ends away from one another, thereby urging the distal ends **1017**A and **1021**A into engagement with an implant **1025**A. The tool further includes a guide member **1026**A adapted to receive expanding member **72**A and tool **10088** for engagement with the expandable implant device for insertion and fixation in a sacroiliac joint. An x-shaped pivotal cross-brace **1028**A pivotally connects at a pair of oppositely disposed ends **1030**A thereof to each of the arms **1008**A and **1010**A and slideably connected at a pair of second ends **1032**A to the arms to reinforce and stabilize the distal end of tool **1000**A during the insertion process.

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 fusing a sacroiliac joint including: bone material including a sacrum and an ilium, the sacrum including a lateral anterior curved boundary, the ilium including a posterior superior iliac spine having a posterior inferior overhang and a posterior inferior iliac spine; a joint space defined between the sacrum and the ilium and defining a joint plane; an extra-articular space including an extra-articular recess access region; and an articular region including a posterior inferior access region, a posterior boundary segment, an anterior-inferior corner, a caudal region, and a cranial region, the method comprising:

positioning an implant assembly adjacent the sacroiliac joint, the implant assembly comprising a distal end portion, a proximal end portion, and a body portion extending between the distal and proximal end portions, the body portion including a first side member including a first opening and a second side member including a second opening and oppositely disposed with the first side member such that the first and second openings are generally aligned to define a passageway extending across the body portion, each of the first and second openings bounded by a fixed perimeter, each side member being structured and arranged to expandably engage the sacroiliac joint following insertion therein;

delivering the implant assembly into the sacroiliac joint via a posterior approach with a generally anterior trajectory of delivery, the implant assembly being positioned in the joint space such that the first and second oppositely disposed side members generally oppose the sacrum and the ilium respectively; and

expanding the first and second oppositely disposed side members into operative engagement with the sacrum and the ilium.

2. The method of claim **1** wherein each of the side members includes a bone engaging surface having a plurality of ridges formed thereon structured and arranged to operatively engage the sacrum or the ilium in response to the expansion of the implant assembly.

3. The method of claim **1** wherein each of the side members includes a guide mechanism operatively connected thereto and adapted to guide the movement of the side member into

operative engagement with the sacroiliac joint in response to the expansion of the side members.

4. The method of claim **1** wherein the each of the side members includes a sloped surface, the sloped surface being structured and arranged to operatively engage an actuating body configured to cause the oppositely disposed side members to expand.

5. The method of claim **1** wherein the body portion of the implant assembly includes an actuating body movably disposed in the proximal end of the implant assembly, the expanding step further comprising moving the actuating body into engagement with each of the oppositely disposed side members to expand them into engagement with the sacrum or the ilium.

6. The method of claim **5** wherein the actuating body includes a tapered surface.

7. The method of claim **4** wherein the body portion of the implant assembly includes the actuating body having a tapered surface movably disposed in the proximal end of the implant assembly, the expanding step further comprising moving the tapered surface of the actuating body into engagement with at least one of the sloped surfaces of the oppositely disposed side members to expand them into engagement with the sacrum and the ilium.

8. The method of claim **7** wherein the actuating body is at least partially threaded.

9. The method of claim **1** wherein the implant assembly is delivered into the joint space through the posterior inferior access region of the articular region of the sacroiliac joint.

10. The method of claim **1** wherein the posterior inferior access region has a superior end and an inferior end, the superior end being about 0 mm to about 40 mm inferior of the posterior inferior overhang of the posterior superior iliac spine.

11. The method of claim **10** wherein the inferior end is about at the intersection of the posterior inferior iliac spine and the lateral anterior curved boundary of the sacrum.

12. The method of claim **1** wherein the posterior inferior access region has a superior end and an inferior end, the inferior end being about at the intersection of the posterior inferior iliac spine and the lateral anterior curved boundary of the sacrum.

13. The method of claim **1** wherein the implant assembly is delivered into the joint space via a cranial access.

14. The method of claim **13** wherein the implant assembly is delivered into a cranial region of the sacroiliac joint.

15. The method of claim **1** wherein the implant assembly is delivered into the joint space via a caudal access.

16. The method of claim **15** wherein the implant assembly is delivered into a caudal region of the sacroiliac joint.

17. The method of claim **16** wherein the caudal region is bounded on an inferior side by an inferior boundary segment and on a superior side by a laterally extending portion of a posterior boundary segment.

18. The method of claim **1** wherein, in delivering the implant assembly into the joint space, a longitudinal edge of the body portion of the implant assembly is generally immediately adjacent an inferior sacroiliac joint space border while the distal end portion of the body portion is oriented towards: 1) an anterior sacroiliac joint space border; 2) a superior sacroiliac joint space border; or 3) somewhere between 1 and 2.

19. The method of claim **1** wherein the first and second openings maintain substantial alignment prior to and subsequent to delivery of the implant assembly into the sacroiliac joint.

20. The method of claim **1** wherein each of the side members includes a planar bone engaging surface.

21. The method of claim **20** wherein, when the implant assembly is positioned in the joint space, the planar bone engaging surfaces of the side members are generally parallel with the joint plane of the sacroiliac joint.

22. The method of claim **20** wherein the planar bone engaging surfaces remain planar when expanded into operative engagement with the sacrum and the ilium.

23. The method of claim **1** wherein each of the side members includes a bone engaging surface having at least one ridge formed thereon structured and arranged to operatively engage the sacrum or the ilium, the at least one ridges being in a fixed relation to the bone engaging surfaces.

24. The method of claim **1** wherein the expansion of the first and second side members is generally perpendicular to the joint plane.

25. The method of claim **1** wherein the expansion of the first and second side members is generally limited to being perpendicular to the joint plane.

26. The method of claim **1** wherein the expansion of the first and second side members is restrained to certain planes of expansion.

27. The method of claim **26** wherein the certain planes are planes generally perpendicular to the joint plane.

28. A method of fusing a sacroiliac joint including: bone material including a sacrum and an ilium, the sacrum including a lateral anterior curved boundary, the ilium including a posterior superior iliac spine having a posterior inferior overhang and a posterior inferior iliac spine; a joint space defined between the sacrum and the ilium and defining a joint plane; an extra-articular space including an extra-articular recess access region; and an articular region including a posterior inferior access region, a posterior boundary segment, an anterior-inferior corner, a caudal region, and a cranial region, the method comprising:

delivering an implant assembly non-transversely into the joint plane of the sacroiliac joint, the implant assembly comprising a distal end portion, a proximal end portion, and a body portion extending along a longitudinal axis between the distal and proximal end portions, the body portion including first and second oppositely disposed side members, a portion of each of the first and second side members configured to laterally expand relative to the longitudinal axis to engage the sacrum and ilium respectively following insertion therein, the body portion further including a feature configured to constrain the lateral expansion to within a predetermined amount of expansion, the implant assembly being positioned in the joint space such that the first and second oppositely disposed side members generally oppose the sacrum and the ilium respectively; and

expanding each of the first and second side members within the predetermined amount of expansion and into operative engagement with the sacrum and the ilium respectively.

29. The method of claim **28** wherein the first and second side members are expanded by an actuating body extending distally from the proximal end portion.

30. The method of claim **29** wherein the first and second side members include sloped surfaces on a proximal end, the actuating body configured to cause the proximal ends of the first and second side members to laterally expand when the actuating body extends distally.

31. The method of claim **29** wherein the actuating body is at least partially threaded.

32. The method of claim 28 wherein the implant assembly is delivered into the joint space through the posterior inferior access region of the articular region of the sacroiliac joint.

33. The method of claim 28 wherein the posterior inferior access region has a superior end and an inferior end, the superior end being about 0 mm to about 40 mm inferior of the posterior inferior overhang of the posterior superior iliac spine.

34. The method of claim 33 wherein the inferior end is about at the intersection of the posterior inferior, iliac spine and the lateral anterior curved boundary of the sacrum.

35. The method of claim 28 wherein the posterior inferior access region has a superior end and an inferior end, the inferior end being about at the intersection of the posterior inferior iliac spine and the lateral anterior curved boundary of the sacrum.

36. The method of claim 28 wherein the implant assembly is delivered into the joint space via a cranial access.

37. The method of claim 36 wherein the implant assembly is delivered into a cranial region of the sacroiliac joint.

38. The method of claim 28 wherein the implant assembly is delivered into the joint space via a caudal access.

39. The method of claim 38 wherein the implant assembly is delivered into a caudal region of the sacroiliac joint.

40. The method of claim 39 wherein the caudal region is bounded on an inferior side by an inferior boundary segment and on a superior side by a laterally extending portion of a posterior boundary segment.

41. The method of claim 28 wherein, in delivering the implant assembly into the joint space, a longitudinal edge of the body portion of the implant assembly is generally immediately adjacent an inferior sacroiliac joint space border while the distal end portion of the body portion is oriented towards: 1) an anterior sacroiliac joint space border; 2) a superior sacroiliac joint space border; or 3) somewhere between 1 and 2.

42. The method of claim 28 wherein each of the side members includes a planar bone engaging surface.

43. The method of claim 42 wherein, when the implant assembly is positioned in the joint space, the planar bone engaging surfaces of the side members are generally parallel with the joint plane of the sacroiliac joint.

44. The method of claim 28 wherein each of the side members includes a bone engaging surface having at least one ridge formed thereon structured and arranged to operatively engage the sacrum or the ilium, the at least one ridges being in a fixed relation to the bone engaging surfaces.

45. The method of claim 28 wherein the lateral expansion of the first and second side members is, generally perpendicular to the joint plane.

46. The method of claim 28 wherein the feature includes a pin engaged with a slot.

47. The method of claim 46 wherein the first and second side members include the pin and a portion of the body portion includes the slot.

48. A method of fusing a sacroiliac joint including: bone material including a sacrum and an ilium, the sacrum including a lateral anterior curved boundary, the ilium including a posterior superior iliac spine having a posterior inferior overhang and a posterior inferior iliac spine; a joint space defined between the sacrum and the ilium and defining a joint plane; an extra-articular space including an extra-articular recess access region; and an articular region including a posterior inferior access region, a posterior boundary segment, an anterior-inferior corner, a caudal region, and a cranial region, the method comprising:

delivering an implant assembly non-transversely into the joint plane of the sacroiliac joint, the implant assembly comprising a distal end portion, a proximal end portion, and a body portion extending a fixed length along a longitudinal axis between the distal and proximal end portions, the body portion including a first side member including a first bone engaging surface and a second side member including a second bone engaging surface, the first bone engaging surface opposite of and disposed a pre-expanded width from the second bone engaging surface, the first and second side members configured to laterally expand relative to the longitudinal axis to engage the sacrum and ilium respectively following insertion therein, the implant assembly being delivered in the joint space such that the first and second bone engaging surfaces generally oppose the sacrum and the ilium respectively; and

expanding the first and second side members with respect to the longitudinal axis such that the first and second bone engaging surfaces are disposed an expanded width apart to operatively engage the sacrum and the ilium respectively, the expanded width being wider than the pre-expanded width.

49. The method of claim 48, wherein the first and second side members are expanded by an actuating body extending distally from the proximal end portion.

50. The method of claim 49 wherein the first and second side members include sloped surfaces on a proximal end, the actuating body configured to cause the proximal ends of the first and second side members to laterally expand when the actuating body extends distally.

51. The method of claim 49 wherein the actuating body is at least partially threaded.

52. The method of claim 48 wherein the implant assembly is delivered into the joint space through the posterior inferior access region of the articular region of the sacroiliac joint.

53. The method of claim 28 wherein the posterior inferior access region has a superior end and an inferior end, the superior end being about 0 mm to about 40 mm inferior of the posterior inferior overhang of the posterior superior iliac spine.

54. The method of claim 53 wherein the inferior end is about at the intersection of the posterior inferior iliac spine and the lateral anterior curved boundary of the sacrum.

55. The method of claim 48 wherein the posterior inferior access region has a superior end and an inferior end, the inferior end being about at the intersection of the posterior inferior iliac spine and the lateral anterior curved boundary of the sacrum.

56. The method of claim 48 wherein the implant assembly is delivered into the joint space via a cranial access.

57. The method of claim 56 wherein the implant assembly is delivered into a cranial region of the sacroiliac joint.

58. The method of claim 48 wherein the implant assembly is delivered into the joint space via a caudal access.

59. The method of claim 58 wherein the implant assembly is delivered into a caudal region of the sacroiliac joint.

60. The method of claim 59 wherein the caudal region is bounded on an inferior side by an inferior boundary segment and on a superior side by a laterally extending portion of a posterior boundary segment.

61. The method of claim 48 wherein, in delivering the implant assembly into the joint space, a longitudinal edge of the body portion of the implant assembly is generally immediately adjacent an inferior sacroiliac joint space border while the distal end portion of the body portion is oriented towards:

1) an anterior sacroiliac joint space border; 2) a superior sacroiliac joint space border; or 3) somewhere between 1 and 2.

62. The method of claim **48** wherein the first and second bone engaging surfaces are planar.

63. The method of claim **62** wherein, when the implant assembly is positioned in the joint space, the planar first and second bone engaging surfaces are generally parallel with the joint plane of the sacroiliac joint.

64. The method of claim **48** wherein each of the first and second bone engaging surfaces has at least one ridge formed thereon structured and arranged to operatively engage the sacrum or the ilium, the at least one ridges being in a fixed relation to the bone engaging surfaces.

65. The method of claim **48** wherein the lateral expansion of the first and second side members is generally perpendicular to the joint plane.

66. The method of claim **48** wherein the body portion further includes a feature configured to constrain the lateral expansion to within a predetermined amount of expansion.

67. The method of claim **66** wherein the feature includes a pin engaged with a slot, the first and second side members include the pin and a portion of the body portion includes the slot.

68. A method of fusing a sacroiliac joint including: bone material including a sacrum and an ilium, the sacrum including a lateral anterior curved boundary, the ilium including a posterior superior iliac spine having a posterior inferior overhang and a posterior inferior iliac spine; a joint space defined between the sacrum and the ilium and defining a joint plane; an extra-articular space including an extra-articular recess access region; and an articular region including a posterior inferior access region, a posterior boundary segment, an anterior-inferior corner, a caudal region, and a cranial region, the method comprising:

delivering an implant assembly non-transversely into the joint plane of the sacroiliac joint, the implant assembly comprising a distal end portion, a proximal end portion, and a body portion extending a length along a longitudinal axis between the distal and proximal end portions, the body portion including a first side member and a second side member opposite the first side member, the first side member including a first ridge extending a first fixed length of the first side member, the second side member including a second ridge extending a second fixed length of the second member, the first and second ridges generally aligning in a plane extending transversely across the body portion, the first and second side members configured to laterally expand relative to the longitudinal axis to engage the sacrum and ilium respectively following insertion therein, the implant assembly being positioned in the joint space such that the first and second oppositely disposed side members generally oppose the sacrum and the ilium respectively; and

expanding the first and second side members with respect to the longitudinal axis and into operative engagement with the sacrum and the ilium respectively, wherein the first and second ridges remain generally aligned in the plane following expansion of the first and second side members.

69. The method of claim **68** wherein the first and second side members are expanded by an actuating body extending distally from the proximal end portion.

70. The method of claim **69** wherein the first and second side members include sloped surfaces on a proximal end, the actuating body configured to cause the proximal ends of the first and second side members to laterally expand when the actuating body extends distally.

71. The method of claim **69** wherein the actuating body is at least partially threaded.

72. The method of claim **68** wherein the implant assembly is delivered into the joint space through the posterior inferior access region of the articular region of the sacroiliac joint.

73. The method of claim **68** wherein the posterior inferior access region has a superior end and an inferior end, the superior end being about 0 mm to about 40 mm inferior of the posterior inferior overhang of the posterior superior iliac spine.

74. The method of claim **73** wherein the inferior end is about at the intersection of the posterior inferior iliac spine and the lateral anterior curved boundary of the sacrum.

75. The method of claim **68** wherein the posterior inferior access region has a superior end and an inferior end, the inferior end being about at the intersection of the posterior inferior iliac spine and the lateral anterior curved boundary of the sacrum.

76. The method of claim **68** wherein the implant assembly is delivered into the joint space via a cranial access.

77. The method of claim **76** wherein the implant assembly is delivered into a cranial region of the sacroiliac joint.

78. The method of claim **68** wherein the implant assembly is delivered into the joint space via a caudal access.

79. The method of claim **48** wherein the implant assembly is delivered into a caudal region of the sacroiliac joint.

80. The method of claim **49** wherein the caudal region is bounded on an inferior side by an inferior boundary segment and on a superior side by a laterally extending portion of a posterior boundary segment.

81. The method of claim **68** wherein, in delivering the implant assembly into the joint space, a longitudinal edge of the body portion of the implant assembly is generally immediately adjacent an inferior sacroiliac joint space border while the distal end portion of the body portion is oriented towards: 1) an anterior sacroiliac joint space border; 2) a superior sacroiliac joint space border; or 3) somewhere between 1 and 2.

82. The method of claim **68** wherein each of the side members includes a planar bone engaging surface.

83. The method of claim **82** wherein, when the implant assembly is positioned in the joint space, the planar bone engaging surfaces of the side members are generally parallel with the joint plane of the sacroiliac joint.

84. The method of claim **82** wherein the first and second ridges are in a fixed relation to the bone engaging surfaces.

85. The method of claim **68** wherein the lateral expansion of the first and second side members is generally perpendicular to the joint plane.

86. The method of claim **68** wherein the body portion further includes a feature configured to constrain the lateral expansion to within a predetermined amount of expansion.

87. The method of claim **86** wherein the feature extends non-parallel to the longitudinal axis.

88. The method of claim **86** wherein the feature includes a pin engaged with a slot, the first and second side members include the pin and a portion of the body portion includes the slot.

89. A method of fusing a sacroiliac joint including: bone material including a sacrum and an ilium, the sacrum including a lateral anterior curved boundary, the ilium including a posterior superior iliac spine having a posterior inferior overhang and a posterior inferior iliac spine; a joint space defined between the sacrum and the ilium and defining a joint plane; an extra-articular space including an extra-articular recess

access region; and an articular region including a posterior inferior access region, a posterior boundary segment, an anterior-inferior corner, a caudal region, and a cranial region, the method comprising:

delivering an implant assembly non-transversely into the joint plane of the sacroiliac joint, the implant assembly comprising a distal end portion, a proximal end portion, and a body portion extending a length along a longitudinal axis between the distal and proximal end portions, the body portion comprising a first side member and a second side member opposite the first side member, the first side member comprising a first ridge extending a first length between distal and proximal portions of the first side member, the second side member comprising a second ridge extending a second length between distal and proximal portions of the second member, the first and second ridges generally aligning in a plane extending transversely across the body portion, the plane being spaced a distance apart from the longitudinal axis such that the plane does not intersect the longitudinal axis, the first and second side members configured to laterally expand relative to the longitudinal axis to engage the sacrum and ilium respectively following insertion therein, the implant assembly being positioned in the joint space such that the first and second oppositely disposed side members generally oppose the sacrum and the ilium respectively; and

expanding the first and second side members with respect to the longitudinal axis and into operative engagement with the sacrum and the ilium respectively, wherein the first and second ridges remain generally aligned in the plane following expansion of the first and second side members.

90. The method of claim **88**, wherein the longitudinal axis extends through a central portion of the body portion.

91. The method of claim **88**, wherein the body portion defines a body plane extending between the first and second side members, the body plane being generally perpendicular with the plane extending transversely across the body portion.

92. A method of fusing a sacroiliac joint including: bone material including a sacrum and an ilium, the sacrum including a lateral anterior curved boundary, the ilium including a posterior superior iliac spine having a posterior inferior overhang and a posterior inferior iliac spine; a joint space defined between the sacrum and the ilium and defining a joint plane; an extra-articular space including an extra-articular recess access region; and an articular region including a posterior inferior access region, a posterior boundary segment, an anterior-inferior corner, a caudal region, and a cranial region, the method comprising:

delivering an implant assembly non-transversely into the joint plane of the sacroiliac joint, the implant assembly comprising:

a distal end portion, a proximal end portion, and a body portion extending a length along a longitudinal axis between the distal and proximal end portions, the body portion comprising:

a first member at least a portion of which is housed substantially within an interior region of the body portion when in a pre-deployed condition, the first member comprising a tapered lateral termination, the first member aligned generally perpendicular to both the joint plane and to an iliac facing surface of the body portion, and

a second member at least a portion of which is housed substantially within an interior region the body portion when in a pre-deployed condition, the second member comprising a tapered lateral termination, the second member aligned generally perpendicular to both the joint plane and to a sacral facing surface of the body portion,

each of the first and second members aligned in a generally parallel manner relative to a plane extending transversely across the body portion, the plane spaced a distance apart from the longitudinal axis such that the plane does not intersect the longitudinal axis, the first and second members configured to laterally deploy relative to the longitudinal axis to engage the sacrum and the ilium respectively following insertion therein, the implant assembly being positioned in the joint space such that the iliac and sacral facing surfaces generally oppose the ilium and the sacrum respectively; and

deploying the first and second members with respect to the longitudinal axis and into operative engagement with the ilium and the sacrum respectively, wherein the first and second members remain generally aligned in a generally parallel manner relative to the plane following deployment of the first and second members and wherein at least one of the first and second members is coplanar with the plane.

93. The method of claim **92**, wherein the first member, when deploying relative to the second member, is spaced apart from the second member in a direction generally perpendicular to both the plane and longitudinal axis.

94. The method of claim **92**, wherein the body portion further comprises a passageway communicating between the iliac and sacral facing surfaces and wherein the first and second members are spaced apart in a manner such that the first member is located near a superior end of the passageway and the second member is located near an inferior end of the passageway.

95. The method of claim **92**, wherein the implant assembly, when in a pre-deployed condition, comprises a height between a top surface and a bottom surface which is substantially greater than a width between the iliac and sacral facing surfaces.

96. The method of claim **92**, wherein, when transitioning from the pre-deployed condition to a deployed condition, the first and second members are constrained and guided by a guide mechanism comprising a guide path which extends in a direction substantially transverse to the longitudinal axis, the first member configured to slide along an interior planar surface of the interior region of the body portion when transitioning from the pre-deployed condition to the deployed condition.

97. The method as in any of claim **1**, **28**, **48**, **68**, **89** or **92**, in which the implant assembly is delivered into the joint plane of the sacroiliac joint through the extra-articular recess access region of the sacroiliac joint.

98. The method of claim **97**, wherein in delivering the implant assembly into the joint plane, a general direction of travel of the distal end portion is towards the anterior-inferior corner of the articular region.

99. The method of claim **97**, wherein in delivering the implant assembly into the joint plane, the distal end portion of the implant assembly extends across the posterior boundary segment of the articular region.

100. The method as in any of claim **1**, **28**, **48**, **68**, or **89**, in which the implant assembly further comprises a first pair of sloped surfaces at the distal end region comprising a first surface and a second surface, the first surface being at a distal most end of the first side member, the second surface being at

a distal most end of the body portion, wherein, when the implant assembly is in a pre-expanded condition, the first and second surfaces are coplanar with each other.

101. The method of claim **100**, wherein upon the implant assembly transitioning into an expanded condition, the first and second surfaces of the first pair of sloped surfaces occupy two separate planes, the separate planes being parallel and spaced apart by a first distance.

102. The method of claim **101**, wherein the implant assembly further comprises a second pair of sloped surfaces comprising a third surface and a fourth surface, wherein a disposition of the third and fourth surfaces of the second pair of sloped surfaces is a substantial mirror image of a disposition of the first and second surfaces of the first pair of sloped surfaces when mirrored over a plane which extends along a longitudinal length of the implant assembly.

103. The method as in any of claim **1**, **28**, **48**, **68**, **89** or **92**, in which delivery of the implant assembly into the sacroiliac joint is via a delivery system comprising:

i) an implant assembly arm configured to releasably couple to the implant assembly; and

ii) a targeting arm in cooperation with the implant assembly arm and configured to guide a delivery of a member into a region of the sacroiliac joint relative to the implant assembly.

104. The method of claim **103**, wherein the member is at least one of: a) a tool; b) a biocompatible material; c) an anchor; d) an elongated body; e) a nail; f) a rod; g) a pin; h) a threaded screw; i) an expanding body; or j) a cable.

105. The method of claim **103**, wherein the targeting arm is configured to guide the delivery of the member though an opening of the implant assembly.

106. The method of claim **105**, wherein the delivery of the member through the opening is along a trajectory that is non-coaxial with an implant assembly delivery trajectory.

107. The method as in any of claim **1**, **28**, **48**, **68**, **89** or **92**, in which the step of expanding the implant assembly comprises actuating an actuating body to engage a portion of the implant assembly,

wherein delivering the implant assembly into the sacroiliac joint and actuating the actuating body is via a tool system comprising: a delivery tool assembly configured to releasably couple to the implant assembly and comprising a guide member configured to receive and align the actuating body with the portion of the implant assembly; and an actuation tool configured to actuate the actuating body into engagement with the portion of the implant assembly.

108. The method as in any of claim **1**, **28**, **48**, **68**, **89** or **92**, in which the step of expanding the implant assembly comprises actuating a portion of the implant assembly,

wherein delivering the implant assembly into the sacroiliac joint and actuating the implant assembly is via a tool system comprising: a delivery tool assembly configured to releasably couple to the implant assembly and comprising a guide member configured to receive and align an actuation tool with the portion of the implant assembly; and the actuation tool configured to actuate a portion of the implant assembly.

109. The method of claim **28**, wherein the first side member includes a first opening and the second side member includes a second opening and oppositely disposed with the first side member such that the first and second openings are generally aligned to define a passageway extending across the body portion, each of the first and second openings bounded by a fixed perimeter.

110. The method as in any of claim **1** or **109**, in which the fixed perimeter comprises a fixed perimeter length bounding the each of the first and second openings, the fixed perimeter length remaining substantially unchanged upon expanding the first and second side members.

111. The method as in any of claim **1** or **109**, in which the fixed perimeter comprises a shape that remains substantially unchanged upon expanding the first and second side members.

112. The method as in any of claim **1** or **109**, in which the fixed perimeters of the first and second openings are positioned relative to the distal and proximal end portions such that the fixed perimeters do not move in a distal-proximal direction upon expanding the first and second side members.

113. The method as in any of claim **1**, **28** or **48**, in which the first side member comprises a fixed outer perimeter remaining substantially unchanged upon expanding the first and second side members.

114. The method as in any of claim **42**, **62** or **82**, in which the planar bone engaging surfaces remain planar when expanded into operative engagement with the sacrum and the ilium.

115. The method of claim **114**, wherein the planar bone engaging surfaces are substantially parallel to each other prior to and subsequent to expanding the first and second side members.

116. The method of claim **22**, wherein the planar bone engaging surfaces are substantially parallel to each other prior to and subsequent to the expanding the first and second side members.

117. The method of claim **92**, wherein the body portion further comprises a passageway communicating between the iliac and sacral facing surfaces, wherein the first and second members are coplanar with each other.

118. The method as in any of claim **1**, **28** or **48**, in which at least one of the first or second side members comprises a bone engaging surface comprising a pointed protrusion configured to operatively engage the sacrum or the ilium in response to the expansion of the implant assembly.

119. The method as in any of claim **1**, **48**, **68** or **89**, in which the implant assembly comprises a U-shaped structure.

120. The method of claim **119**, wherein the distal end portion defines a closed portion of the U-shaped structure and the proximal end portion defines an opened portion of the U-shaped structure.

121. The method as in any of claim **1**, **48**, **68** or **89**, in which the implant assembly is a unitary construction.

122. The method of claim **121**, wherein the implant assembly comprises a U-shaped structure.

123. The method of claim **122**, wherein the distal end portion defines a closed portion of the U-shaped structure and the proximal end portion defines an opened portion of the U-shaped structure.

124. The method of claim **46**, wherein the first and second side members include the pin and a portion of the body portion includes the slot.

125. The method of claim **46**, wherein the pin includes a first pin positioned on the first side member and a second pin positioned on the second side member, the slot includes a first slot positioned on the body portion, the first and second pins configured to be positioned at least partially within the first slot and configured to displace within the first slot when the first and second side members expand.

126. The method of claim **125**, wherein the first slot is positioned at the distal end portion.

127. The method of claim **125**, wherein the pin further includes a third pin positioned on the first side member and a

fourth pin positioned on the second side member, the slot includes a second slot positioned on the body portion, the third and fourth pins configured to be positioned at least partially within the second slot and configured to displace within second slot when the first and second side members expand.

128. The method of claim **127**, wherein the first slot is positioned at the distal end portion and the second slot is positioned at the proximal end portion.

129. The method as in any of claim **1**, **48**, **68**, or **89**, in which the body portion further includes a feature configured to constrain the lateral expansion to within a predetermined amount of expansion.

130. The method of claim **129**, wherein the feature includes a pin engaged with a slot.

131. The method of claim **130**, wherein the pin includes a first pin positioned on the first side member and a second pin positioned on the second side member, the slot includes a first slot positioned on the body portion, the first and second pins configured to be positioned at least partially within the first slot and configured to displace within the first slot when the first and second side members expand.

132. The method of claim **131**, wherein the first slot is positioned at the distal end portion.

133. The method of claim **131**, wherein the pin further includes a third pin positioned on the first side member and a fourth pin positioned on the second side member, the slot includes a second slot positioned on the body portion, the third and fourth pins configured to be positioned at least partially within the second slot and configured to displace within second slot when the first and second side members expand.

134. The method of claim **133**, wherein the first slot is positioned at the distal end portion and the second slot is positioned at the proximal end portion.

135. The method as in any of claim **48**, **68**, or **89**, in which, when expanding the first and second side members, the first and second members are constrained and guided by a guide mechanism comprising a guide path which extends in a direction substantially transverse to the longitudinal axis, the first and second members configured to slide along an interior planar surface of the body portion when the first and second members expand.

136. The method of claim **135**, wherein the guide mechanism includes a first pin positioned on the first side member, a second pin positioned on the second side member, and a slot formed in the body portion, the first and second pins configured to be positioned at least partially within the slot and configured to displace within the slot as the first and second members expand.

137. The method of claim **136**, wherein each of the first and second side members includes a sloped surface near the proximal end region, the sloped surfaces being structured and arranged to operatively engage an actuating body configured to cause the first and second side members to expand.

138. The method of claim **137**, wherein the implant assembly is delivered into the joint plane of the sacroiliac joint through the extra-articular recess access region of the sacroiliac joint.

139. The method of claim **138**, wherein in delivering the implant assembly into the joint plane, a general direction of travel of the distal end portion is towards the anterior-inferior corner of the articular region.

140. The method of claim **138**, wherein in delivering the implant assembly into the joint plane, the distal end portion of the implant assembly extends across the posterior boundary segment of the articular region.

141. The method of claim **1**, wherein, when expanding the first and second side members, the first and second members are constrained and guided by a guide mechanism comprising a guide path which extends in a direction substantially transverse to a longitudinal axis extending between the distal and proximal end portions of the body portion, the first and second members configured to slide along an interior planar surface of the body portion when the first and second members expand.

142. The method of claim **141**, wherein the guide mechanism includes a first pin positioned on the first side member, a second pin positioned on the second side member, and a slot formed in the body portion, the first and second pins configured to be positioned at least partially within the slot and configured to displace within the slot as the first and second members expand.

143. The method of claim **142**, wherein each of the first and second side members includes a sloped surface near the proximal end region, the sloped surfaces being structured and arranged to operatively engage an actuating body configured to cause the first and second side members to expand.

144. The method of claim **141**, wherein the implant assembly is delivered into the joint plane of the sacroiliac joint through the extra-articular recess access region of the sacroiliac joint.

145. The method of claim **144**, wherein in delivering the implant assembly into the joint plane, a general direction of travel of the distal end portion is towards the anterior-inferior corner of the articular region.

146. The method of claim **144**, wherein in delivering the implant assembly into the joint plane, the distal end portion of the implant assembly extends across the posterior boundary segment of the articular region.

147. The method as in any of claim **1**, **28**, **48**, **68** or **89**, in which the implant assembly, when in a pre-expanded condition, comprises a height between a top surface and a bottom surface which is substantially greater than a width between an iliac facing surface and a sacral facing surface.

148. The method of claim **147**, wherein the implant assembly comprises a guide piece housing and a guide piece configured to be nested within the guide piece housing such that, when the first and second side members expand, movement of the guide piece relative to the guide piece housing is constrained.

149. The method of claim **148**, wherein movement of the guide piece relative to the guide piece housing includes planar sliding contact between the guide piece and the guide piece housing.

150. The method of claim **148**, wherein movement of the guide piece relative to the guide piece housing is limited to one degree of freedom.

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