US 20250262061A1

(19) United States
(12) Patent Application Publication
Josse et al.

(10) Pub. No.: US 2025/0262061 A1
(43) Pub. Date: Aug. 21, 2025

(54) DUAL EXPANDABLE INTER-BODY DEVICE

(71) Applicant: **Warsaw Orthopedic, Inc.**, Warsaw, IN (US)

(72) Inventors: **Loic Josse**, Palm Beach Gardens, FL (US); **Bertrand Peultier**, Les Hopitaux Neufs (FR)

(73) Assignee: **Warsaw Orthopedic, Inc.**, Warsaw, IN (US)

(21) Appl. No.: **19/199,702**

(22) Filed: **May 6, 2025**

Related U.S. Application Data

(63) Continuation of application No. 17/887,957, filed on Aug. 15, 2022, now Pat. No. 12,318,308, which is a continuation-in-part of application No. 17/391,403, filed on Aug. 2, 2021, now Pat. No. 11,833,059, which is a continuation-in-part of application No. 17/246,932, filed on May 3, 2021, now Pat. No. 11,963,881, which is a continuation-in-part of application No. 17/123,889, filed on Dec. 16, 2020, now Pat. No. 11,564,724, said application No. 17/887,957 is a continuation-in-part of application No. 17/123, 889, filed on Dec. 16, 2020, now Pat. No. 11,564,724.

(30) **Foreign Application Priority Data**

Nov. 5, 2020 (WO) PCT/IB2020/000932
Nov. 5, 2020 (WO) PCT/IB2020/000942
Nov. 5, 2020 (WO) PCT/IB2020/000953

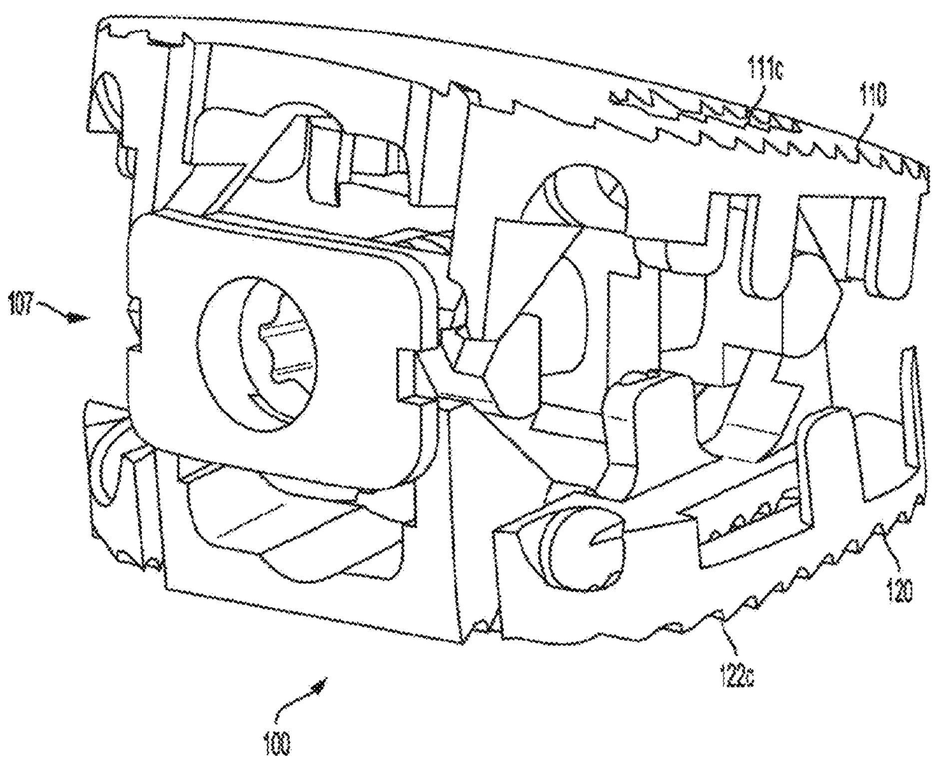
Publication Classification

(51) **Int. Cl.**
A61F 2/44 (2006.01)
A61F 2/30 (2006.01)
A61F 2/46 (2006.01)

(52) **U.S. Cl.**
CPC ***A61F 2/4455*** (2013.01); ***A61F 2/30749*** (2013.01); ***A61F 2/4611*** (2013.01); *A61F 2002/30433* (2013.01); *A61F 2002/30517* (2013.01); *A61F 2002/30538* (2013.01); *A61F 2002/30579* (2013.01); *A61F 2002/30782* (2013.01)

(57) **ABSTRACT**

The present disclosure provides for spinal implants configured for lateral insertion techniques deployable between a contracted position and an expanded position. The spinal implant may include a first endplate and a second endplate, each having a plurality of guide walls and inclined ramps. The spinal implant may further include a moving mechanism having first and second trolleys configured to act against the first and second plurality of ramps. The moving mechanism may further include a first set screw and a second set screw opposite the first set screw. The moving mechanism may be configured to operably adjust a spacing between the first and second endplates upon simultaneous rotation of the first and second set screws along a rotation axis, and may also operably adjust an angle of inclination between the first and second endplates upon rotating the first set screw or second set screw along the rotation axis.



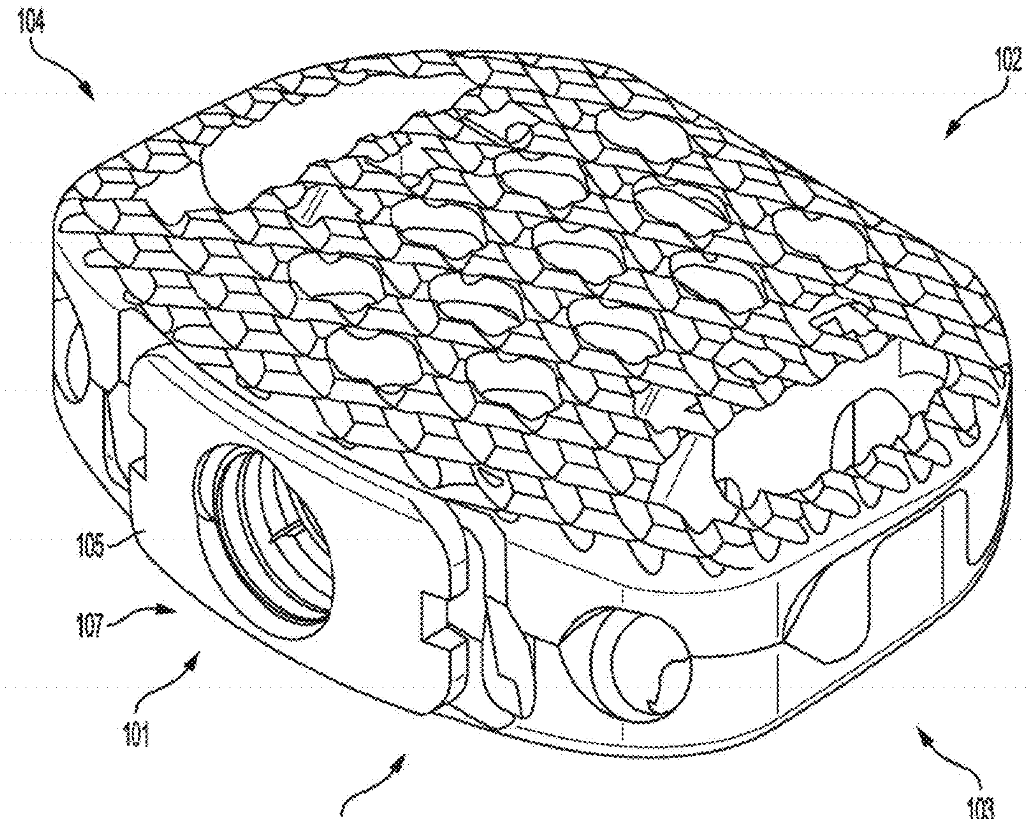


FIG. 1A

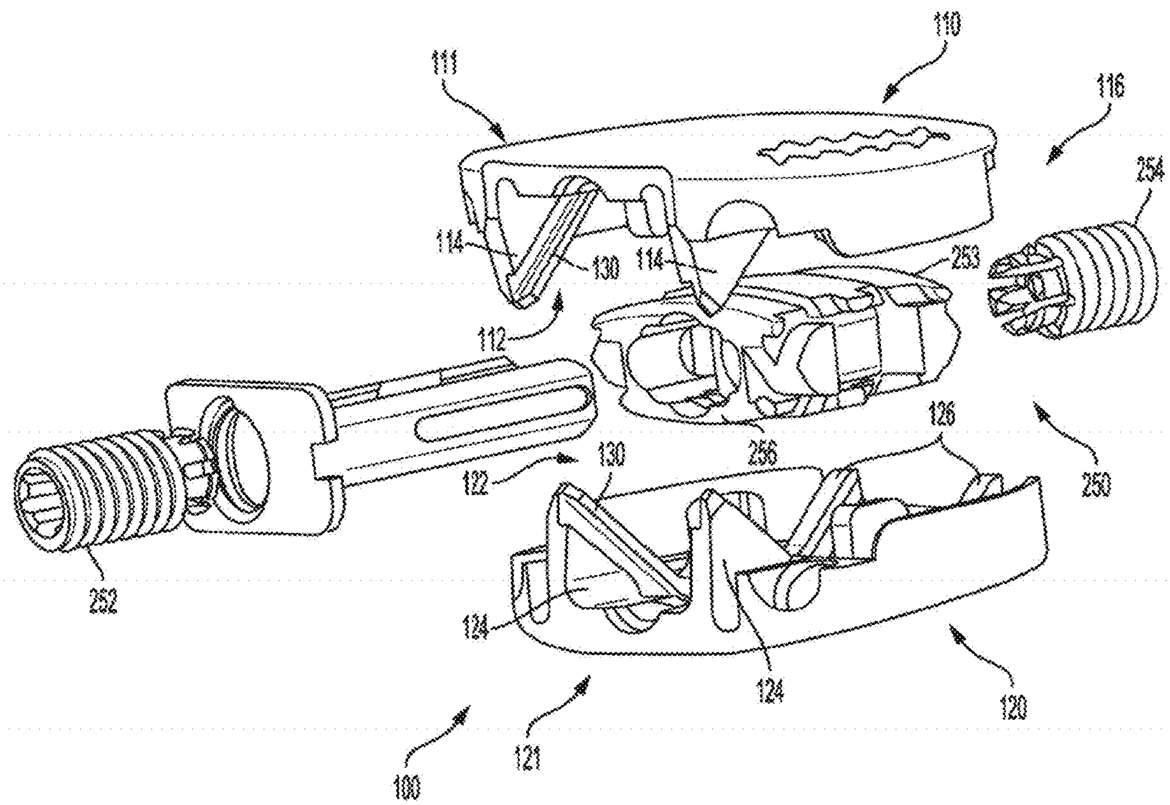

110
111
116
254
114
130
114
253
112
126
256
250
130
122
252
124
124
120
100
121

FIG. 1B

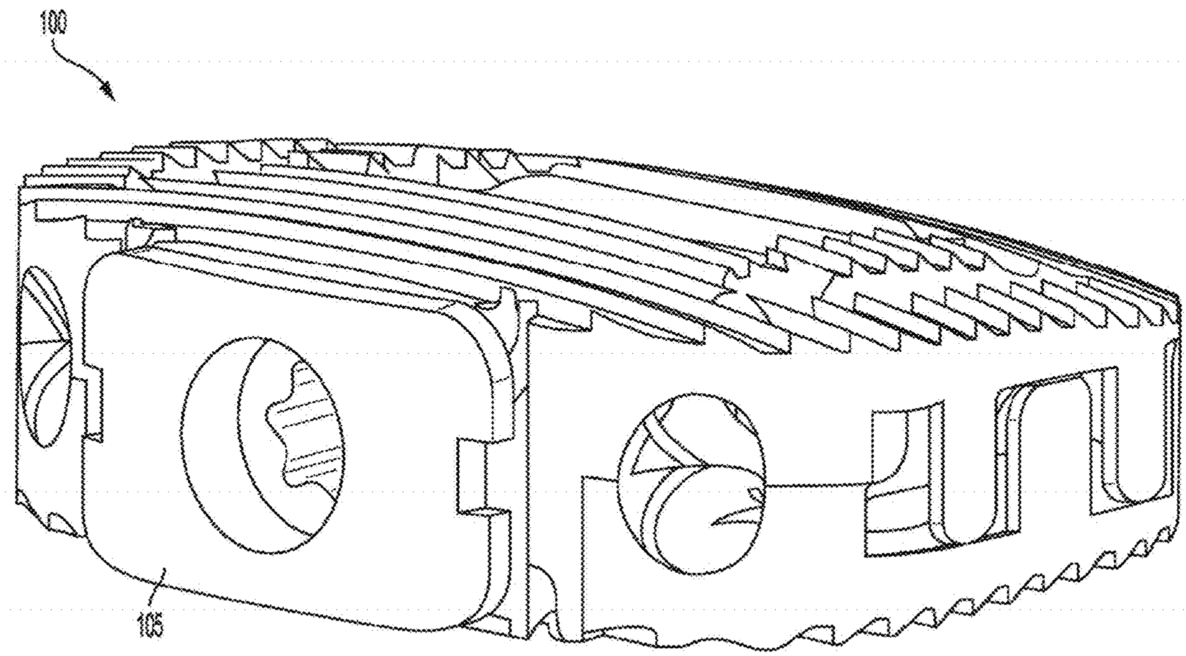


FIG. 1C

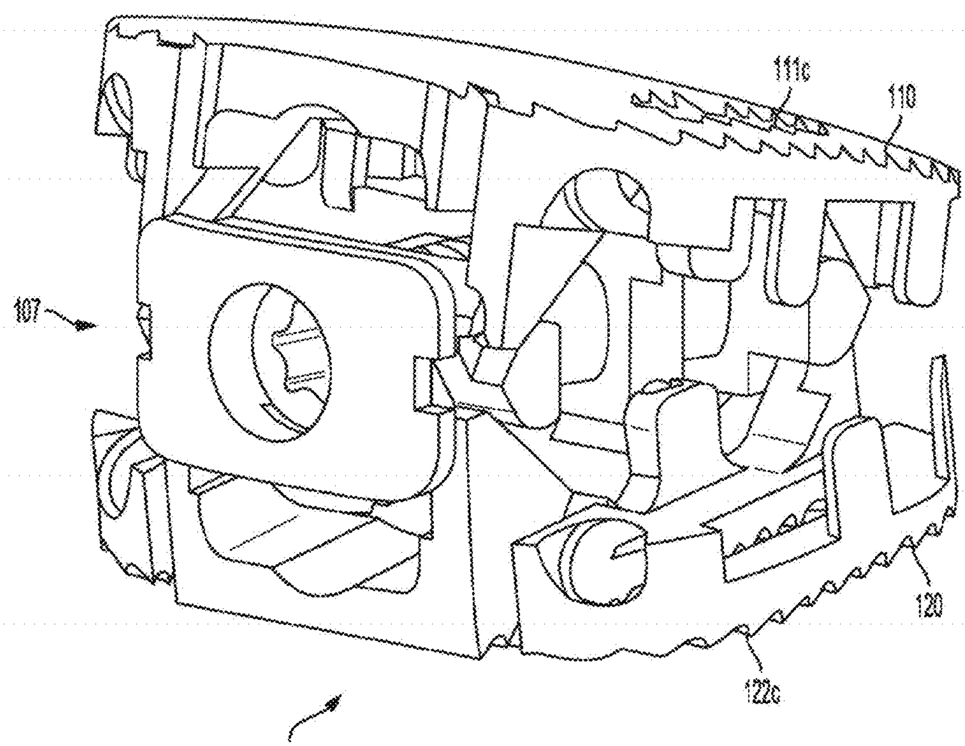


FIG. 1D

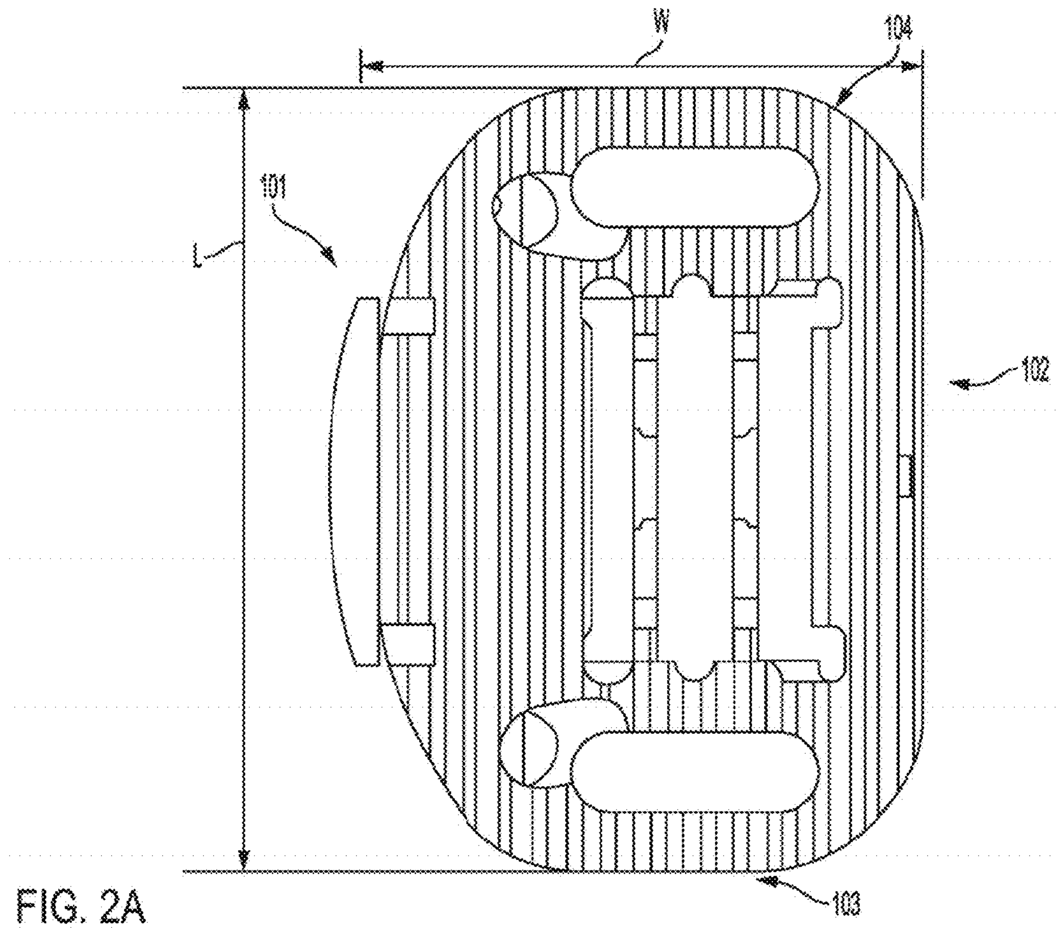


FIG. 2A

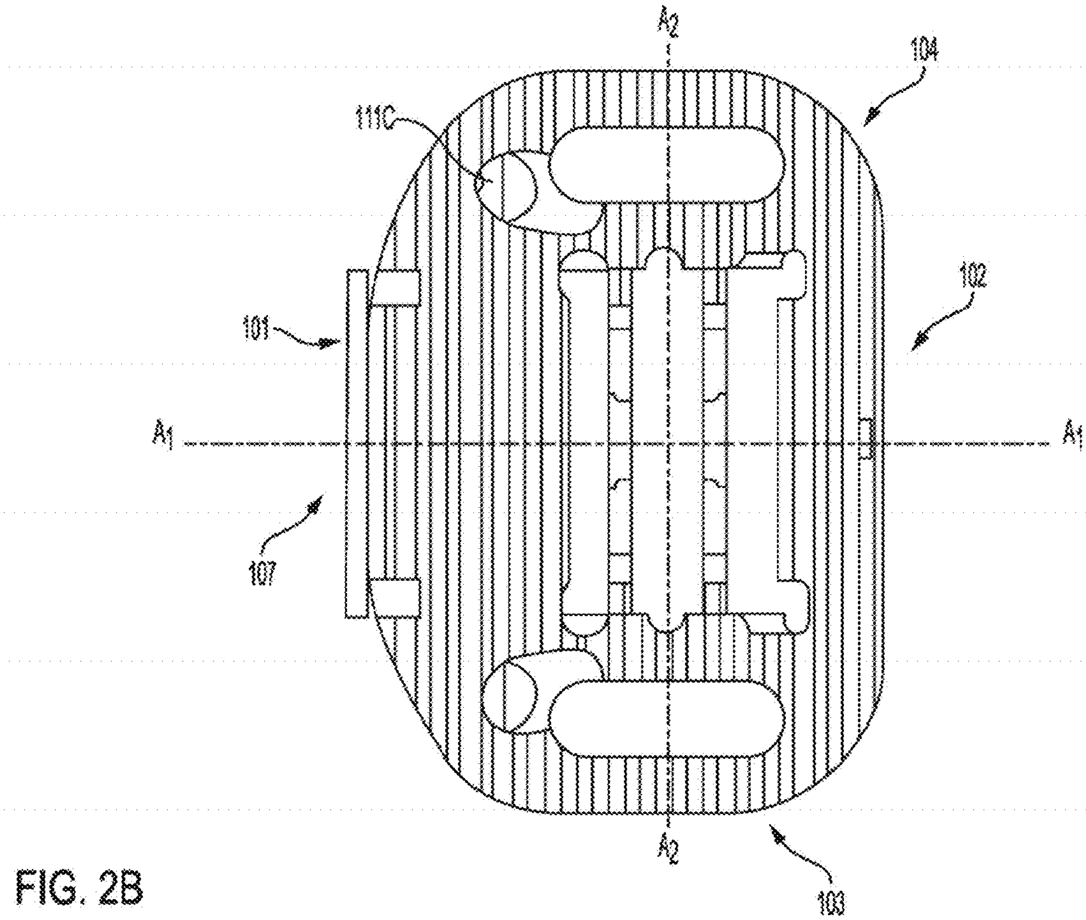


FIG. 2B

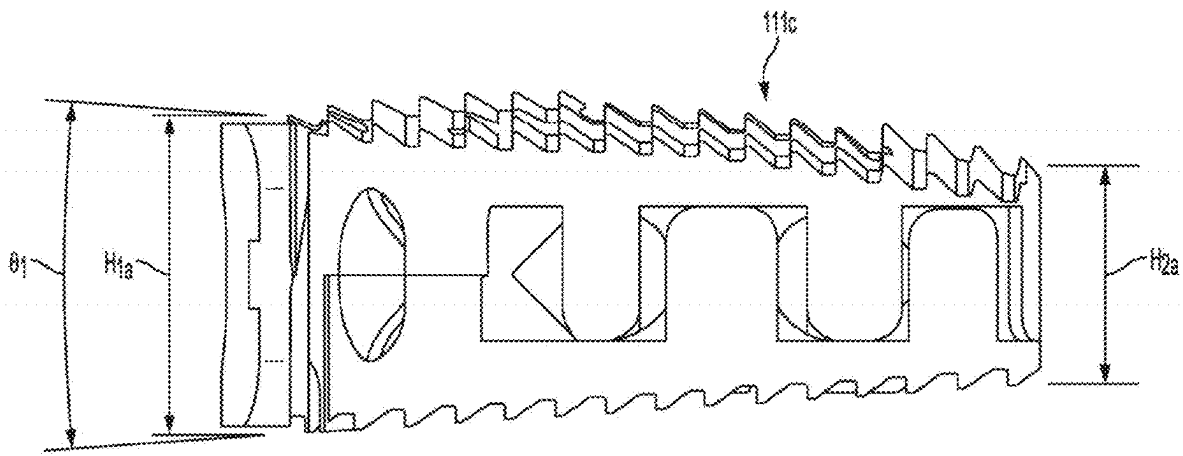


FIG. 2C

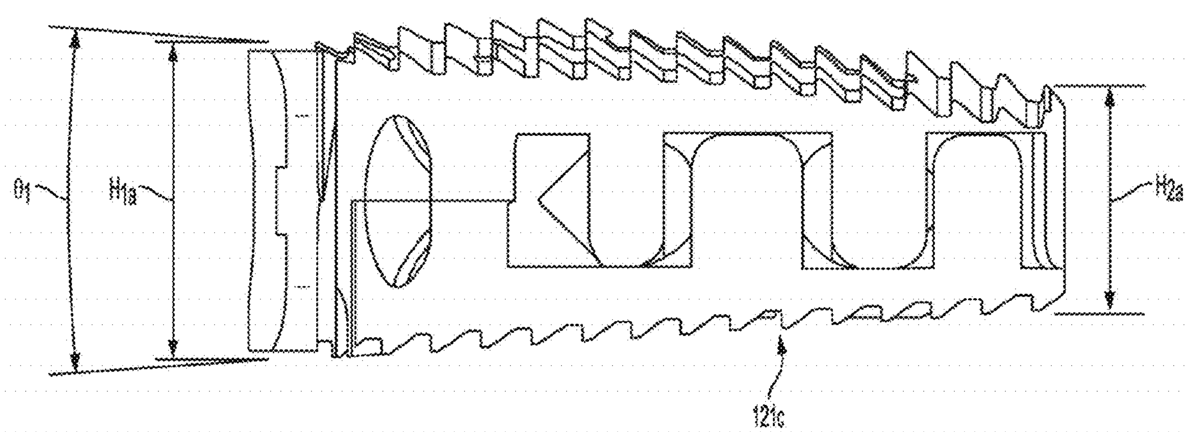


FIG. 2D

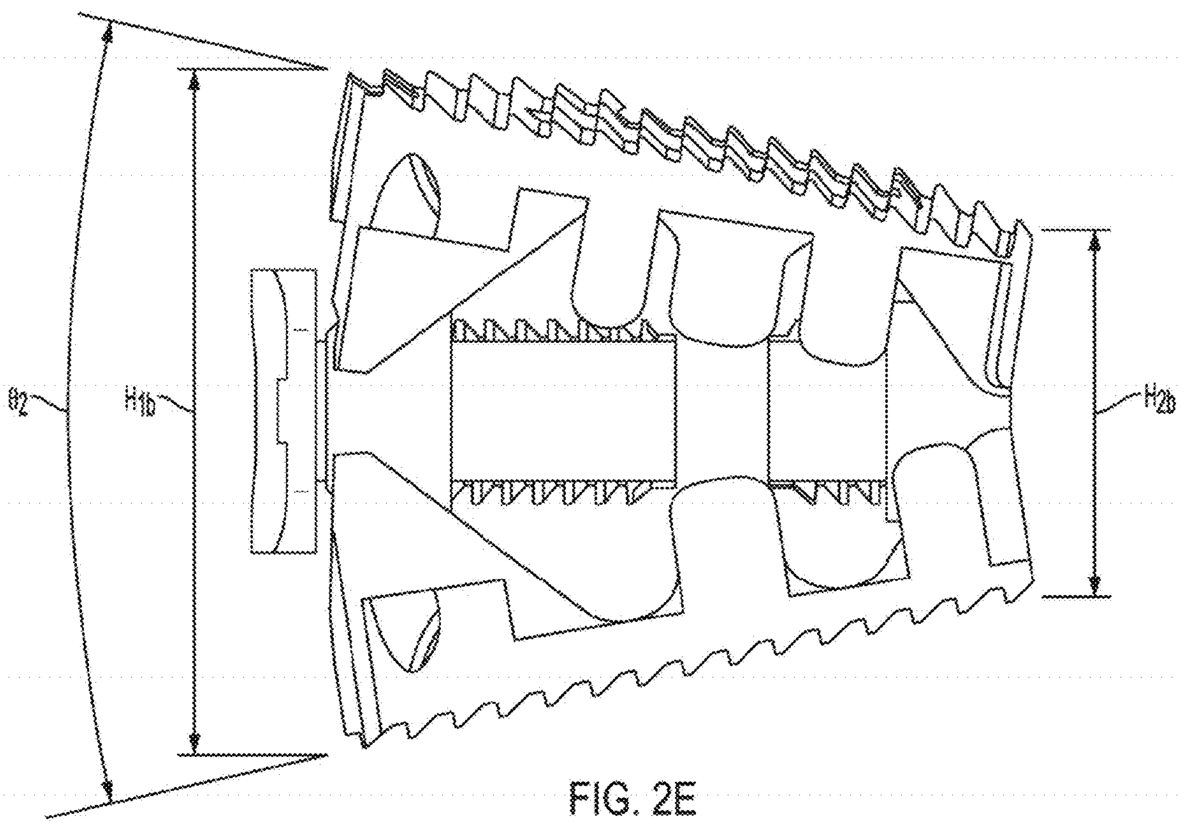


FIG. 2E

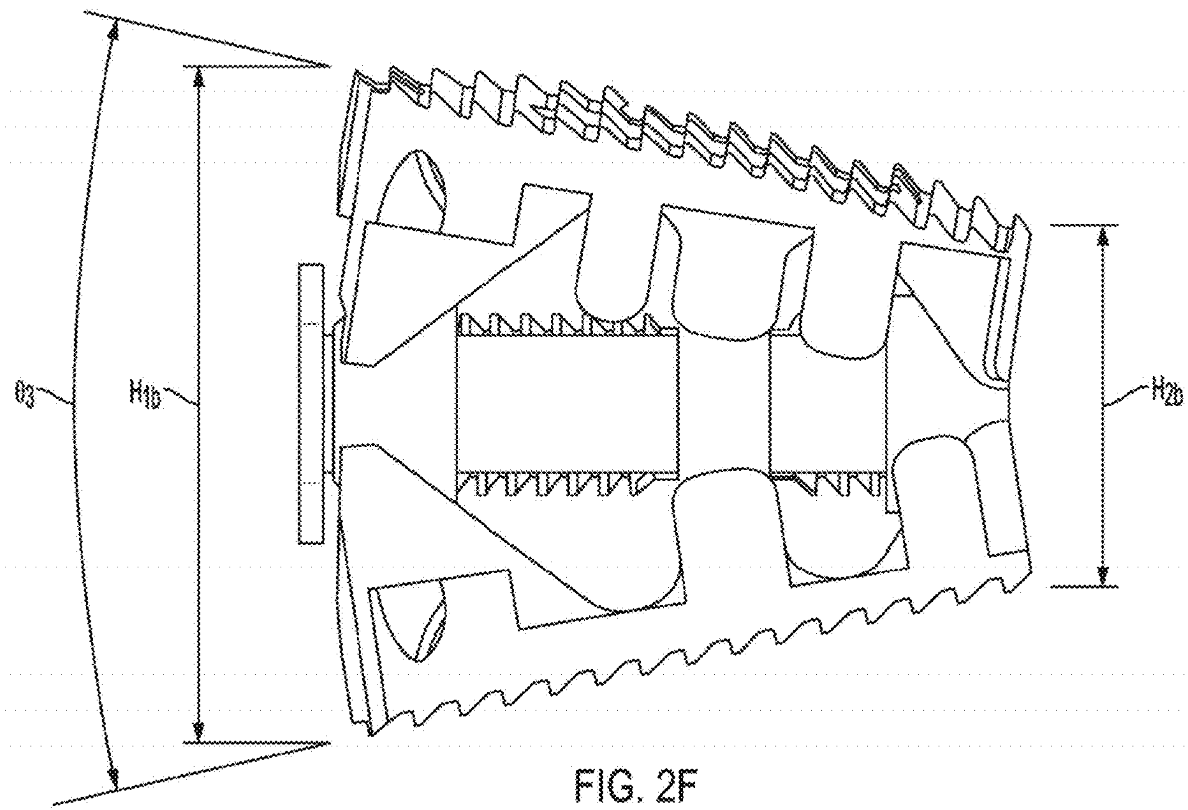


FIG. 2F

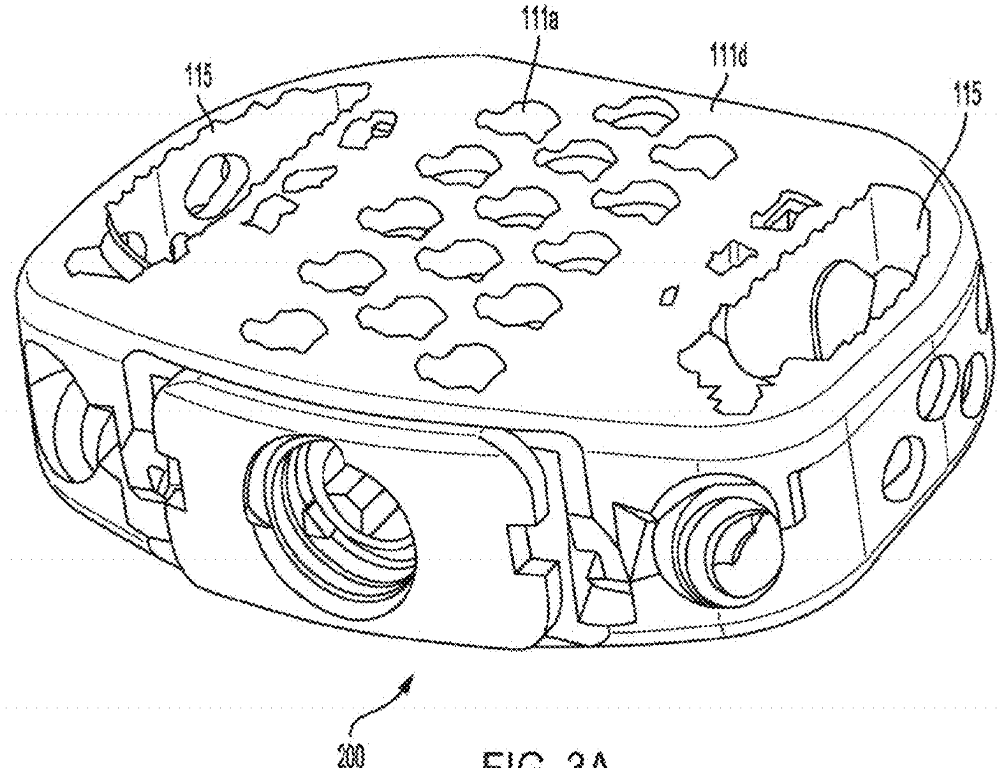


FIG. 3A

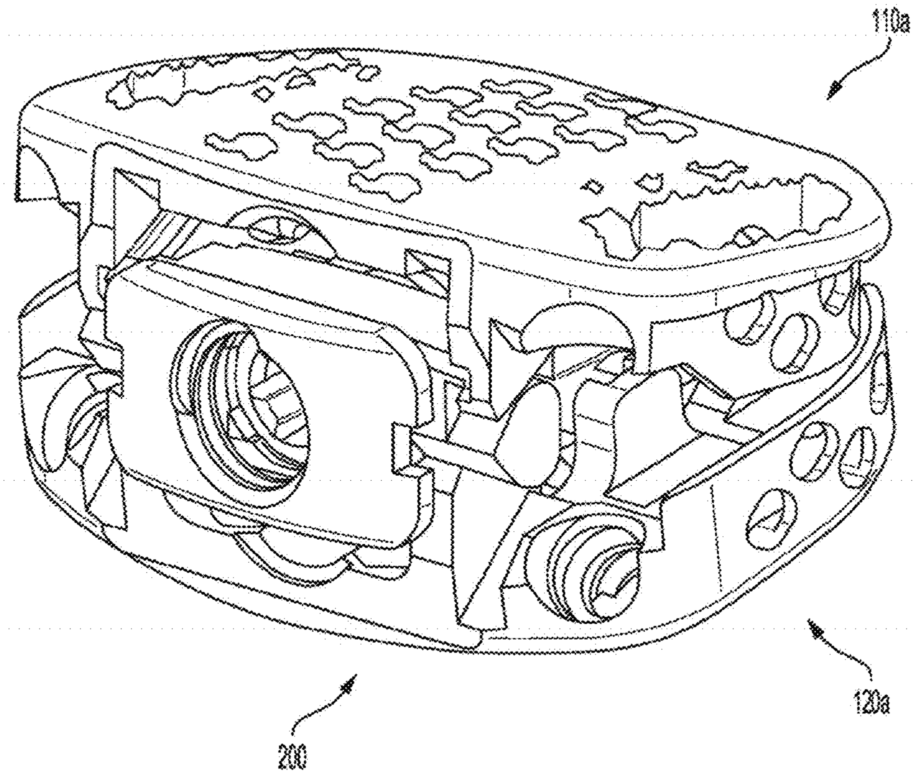


FIG. 3B

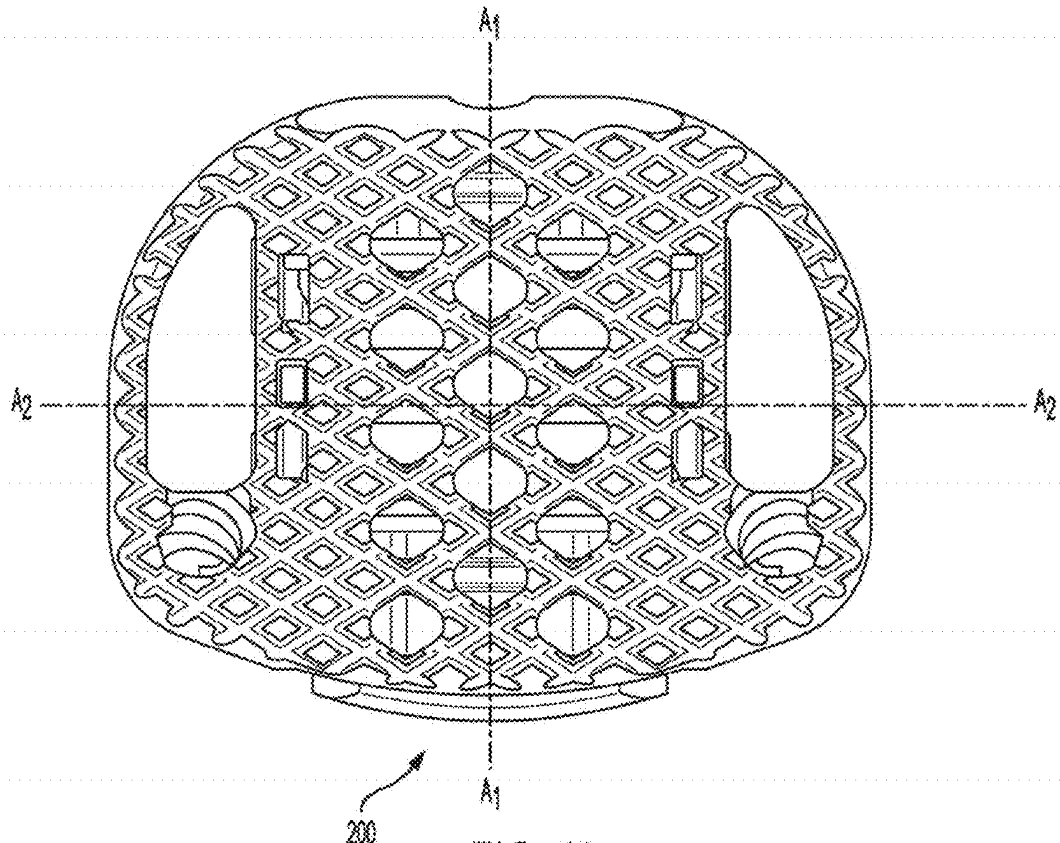


FIG. 4A

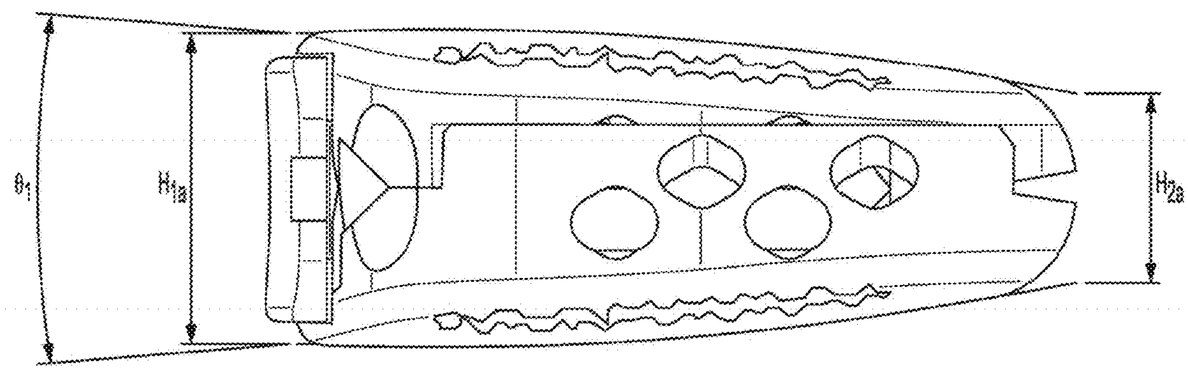


FIG. 4B

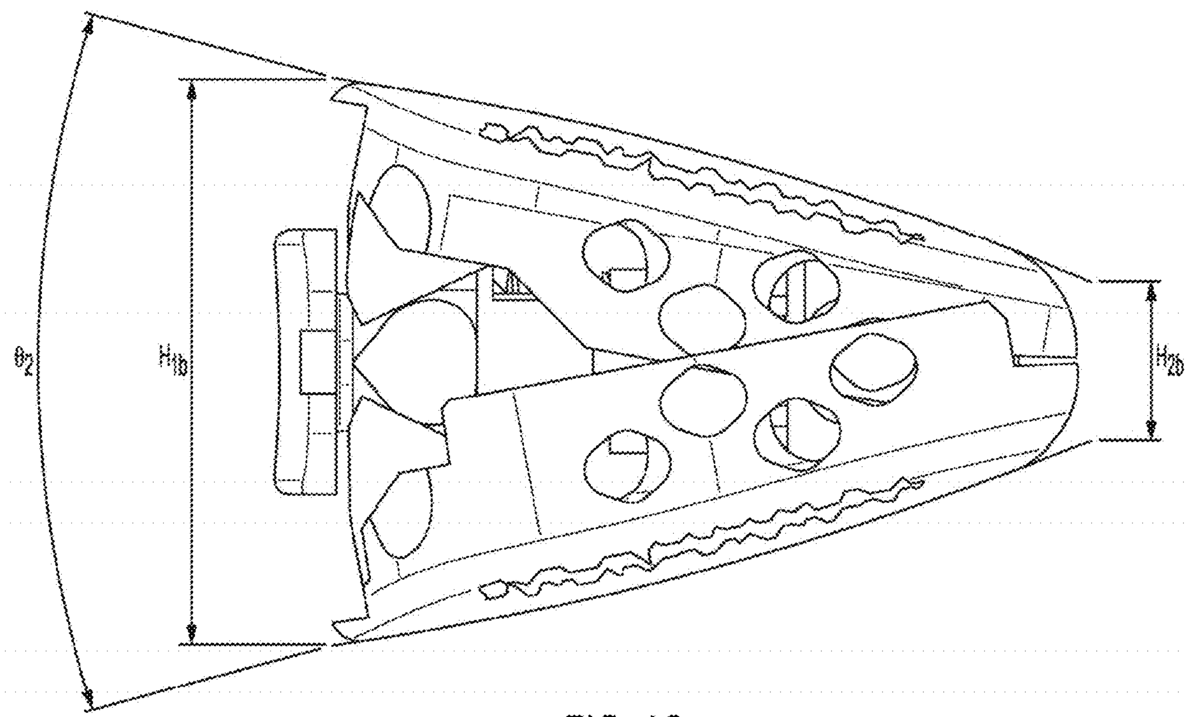


FIG. 4C

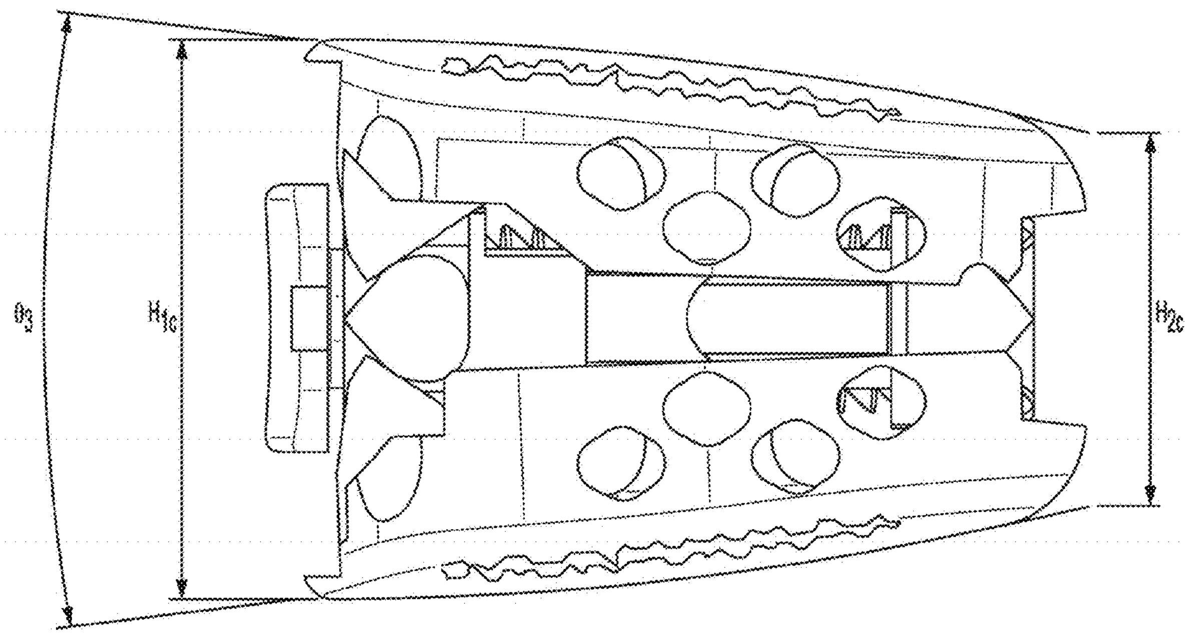


FIG. 4D

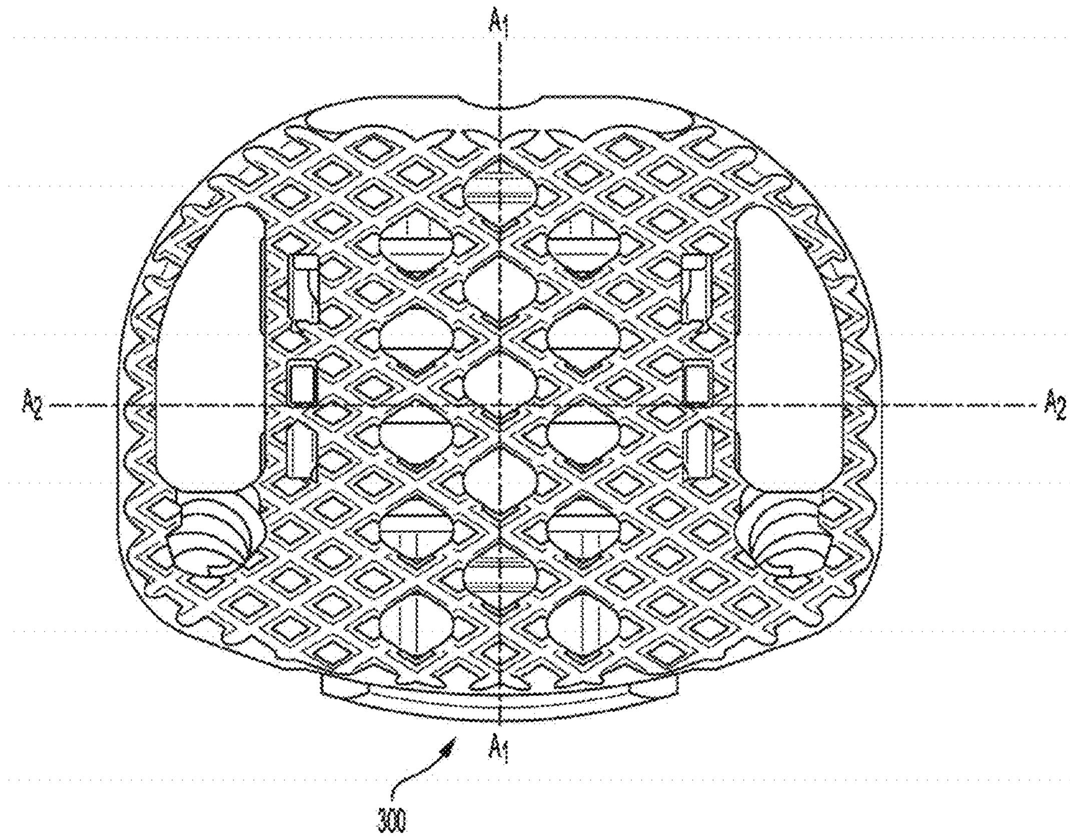


FIG. 5A

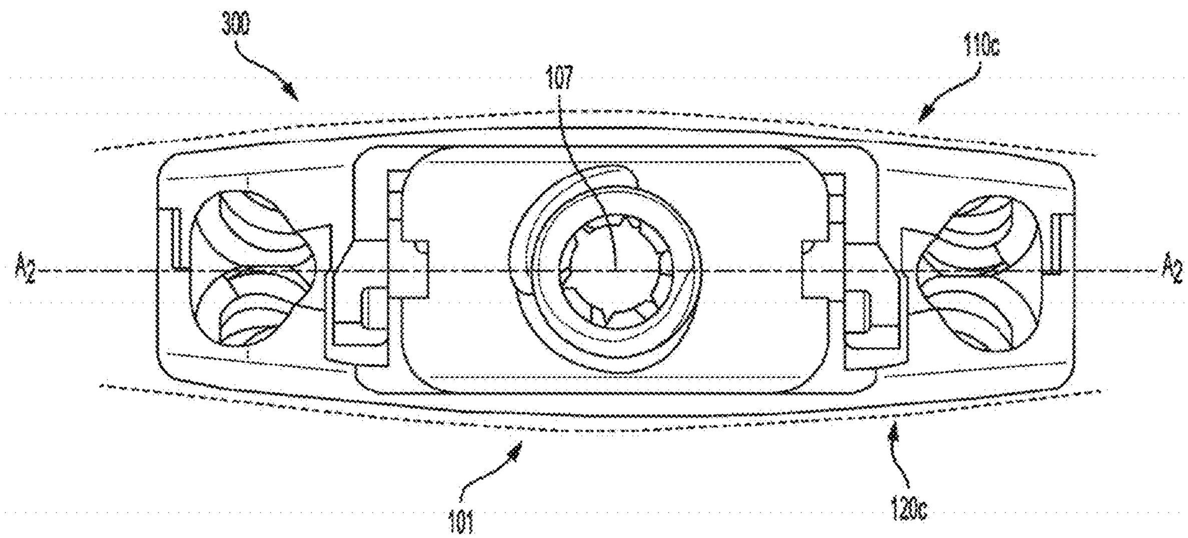


FIG. 5B

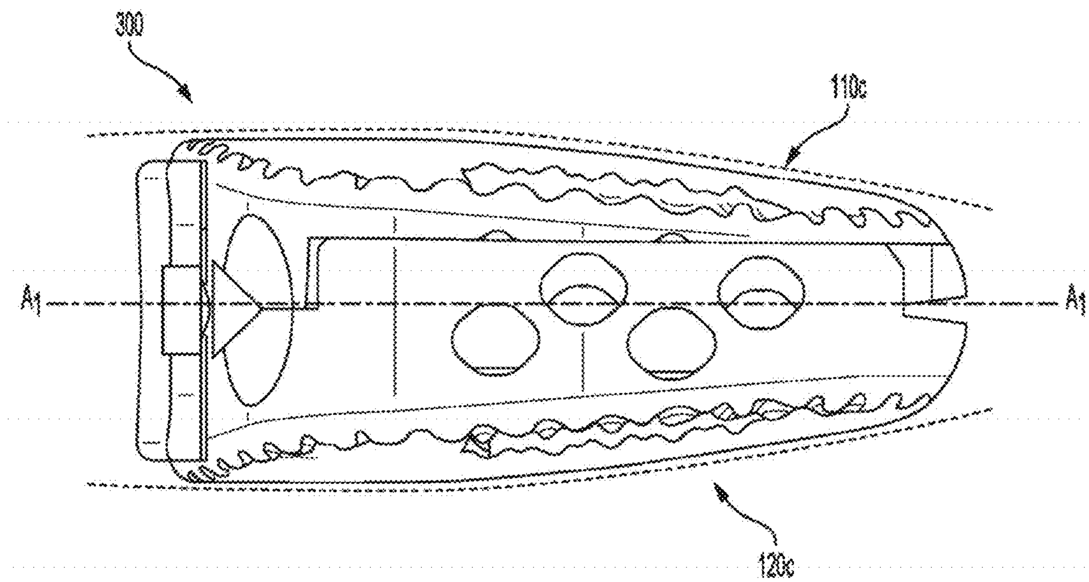


FIG. 5C

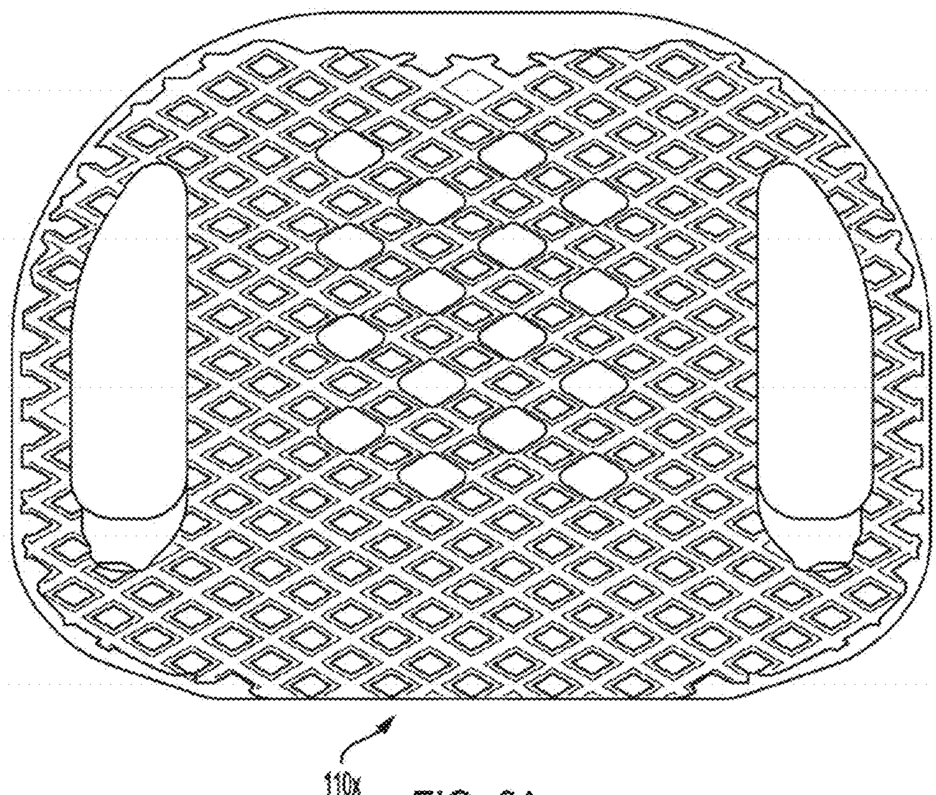


FIG. 6A

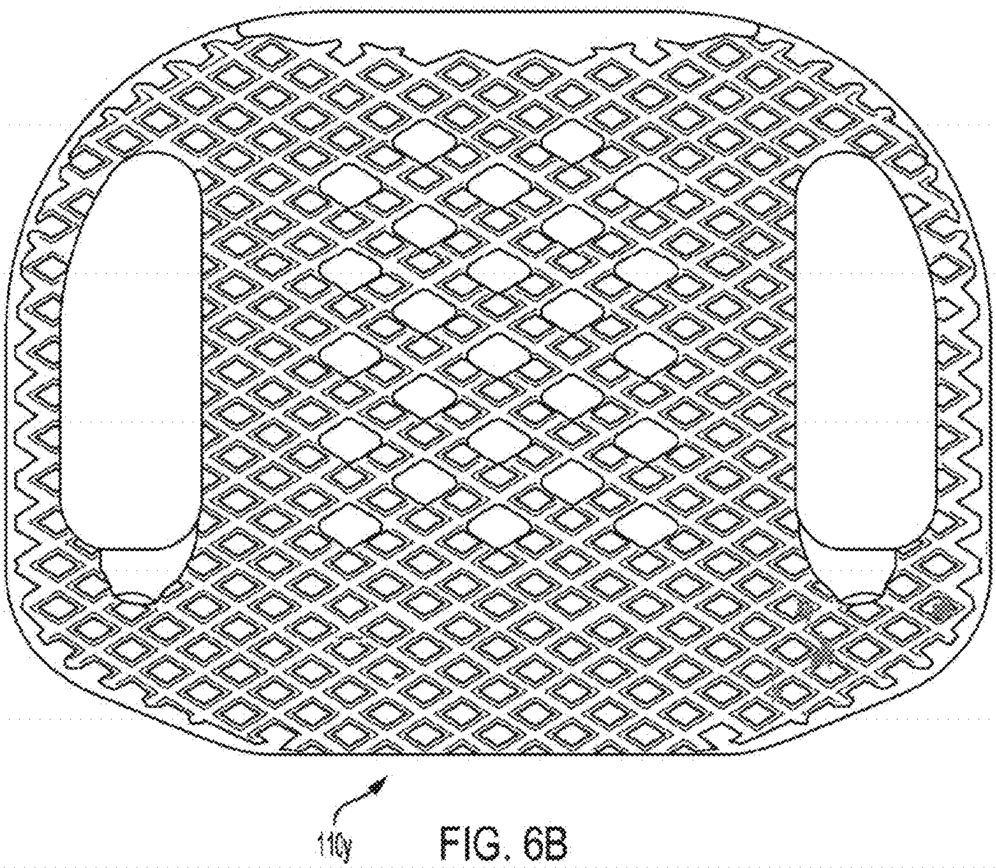


FIG. 6B

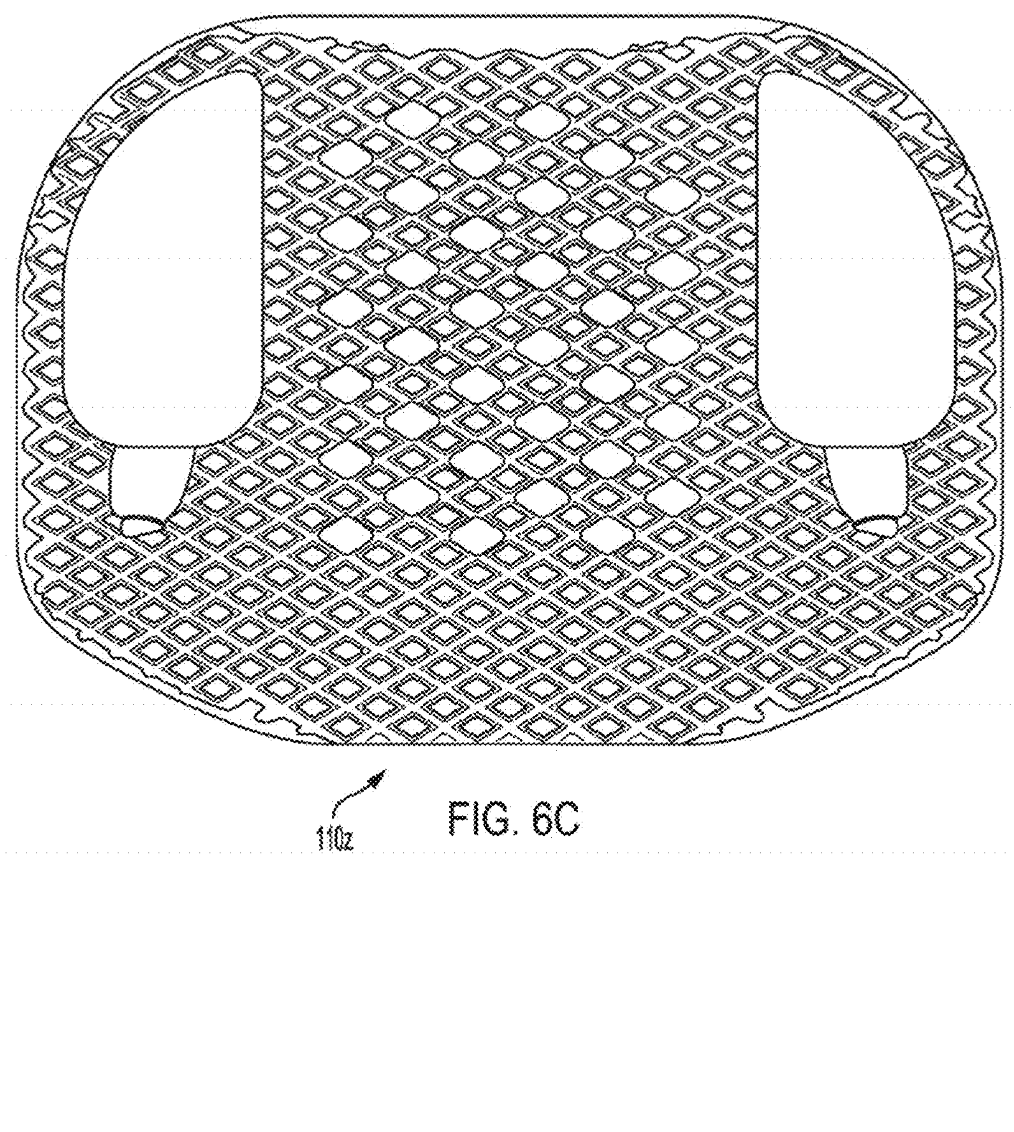


FIG. 6C

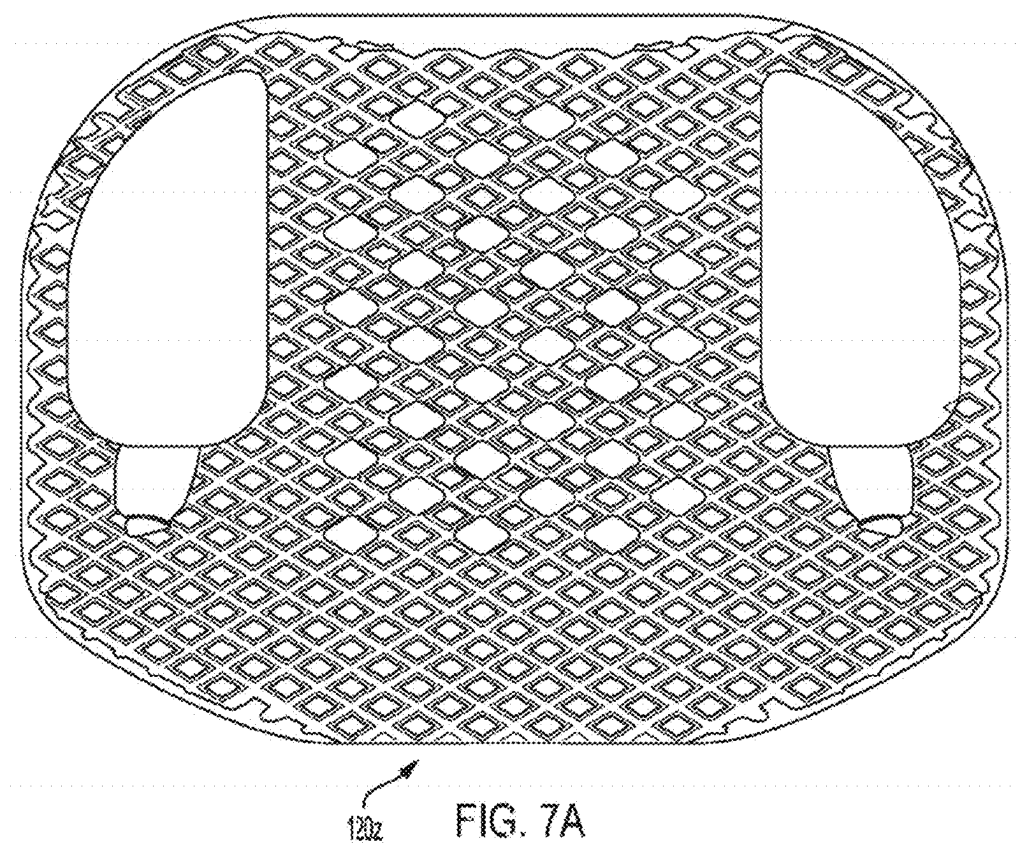


FIG. 7A

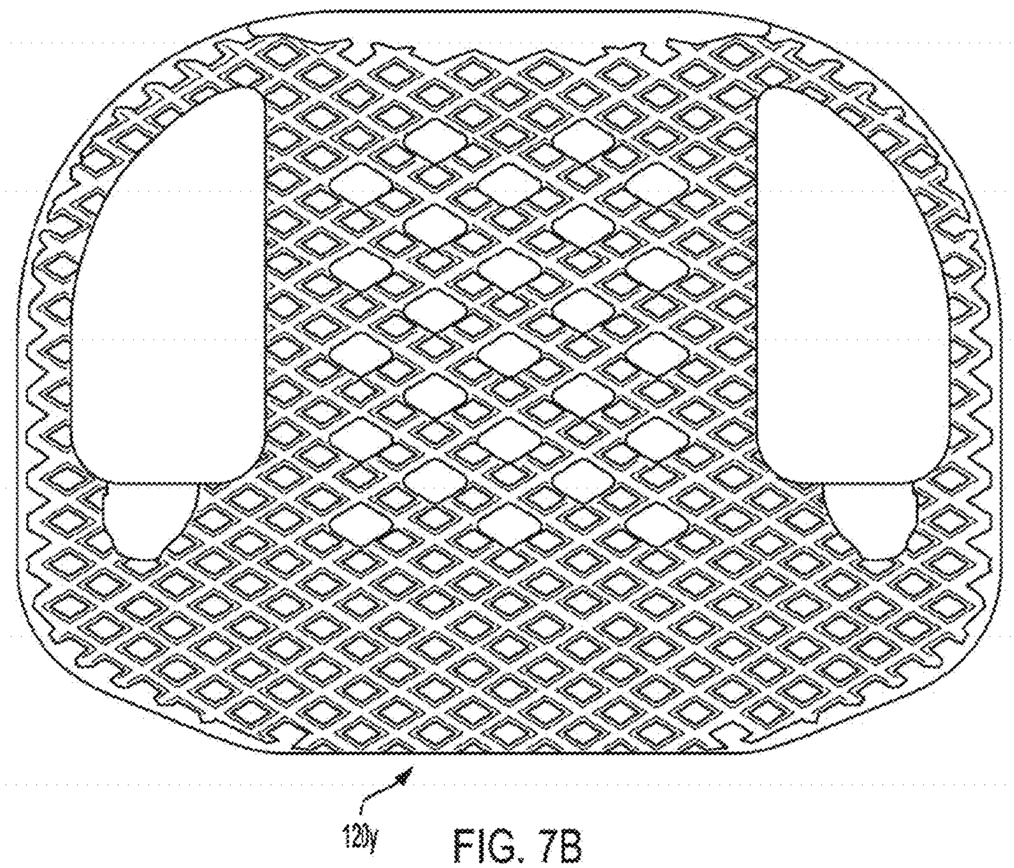


FIG. 7B

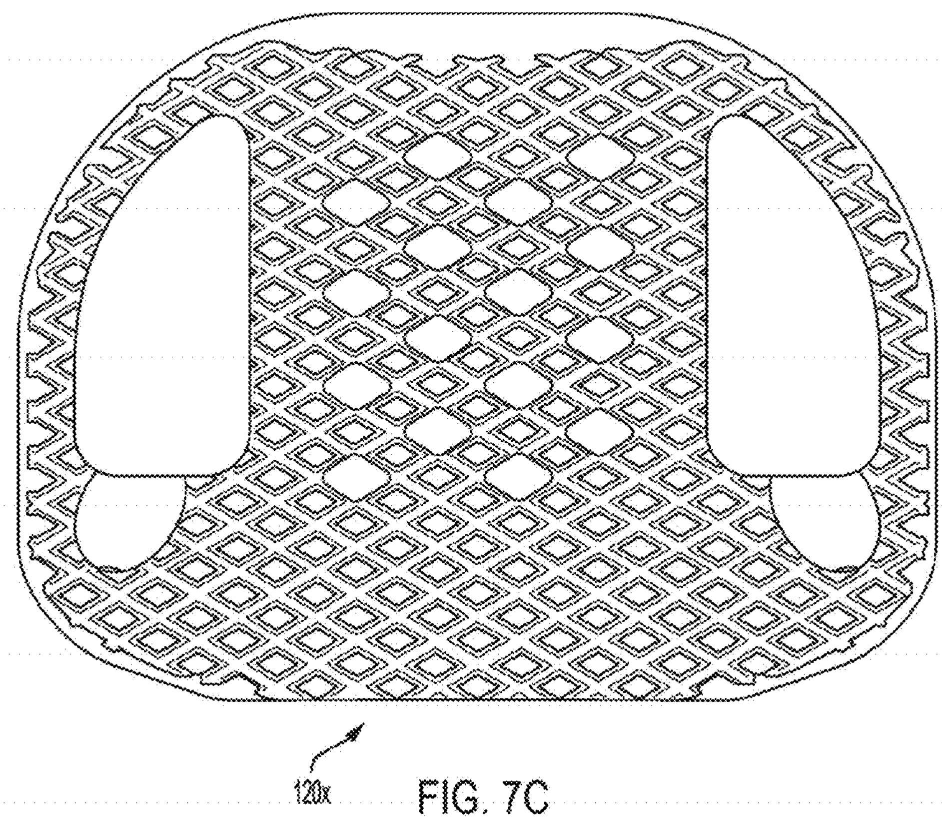


FIG. 7C

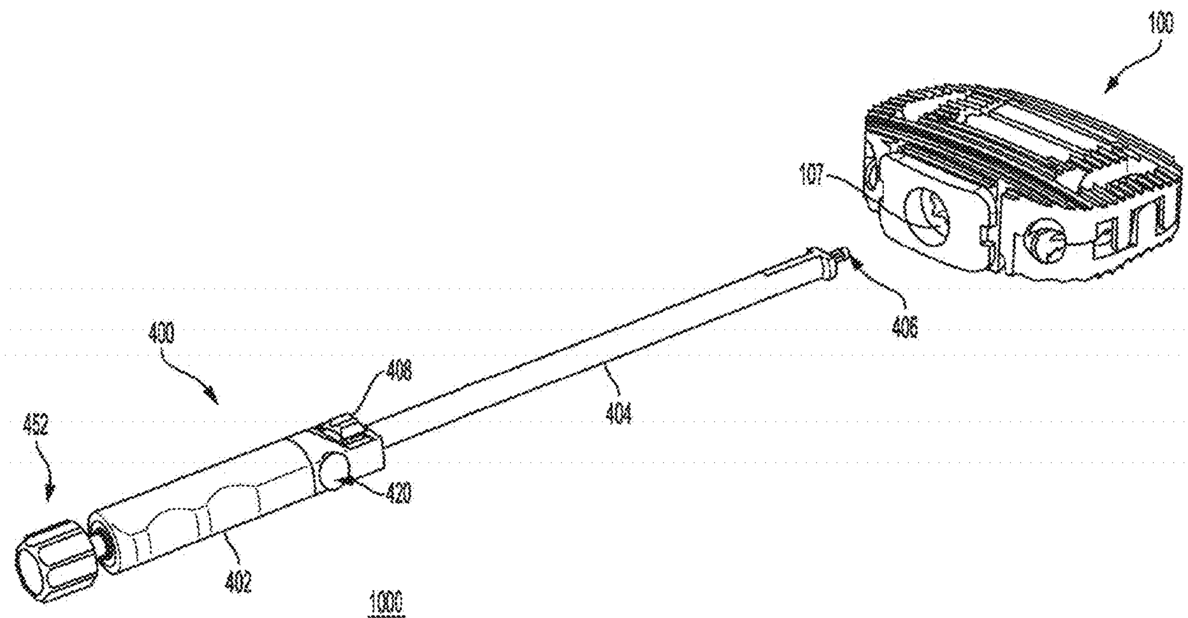


FIG. 8

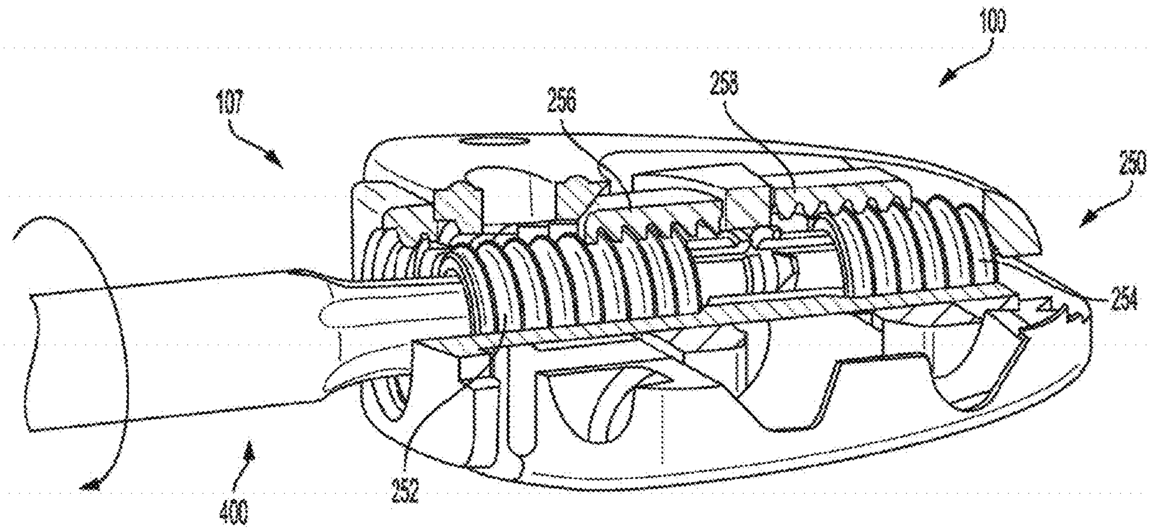


FIG. 9A

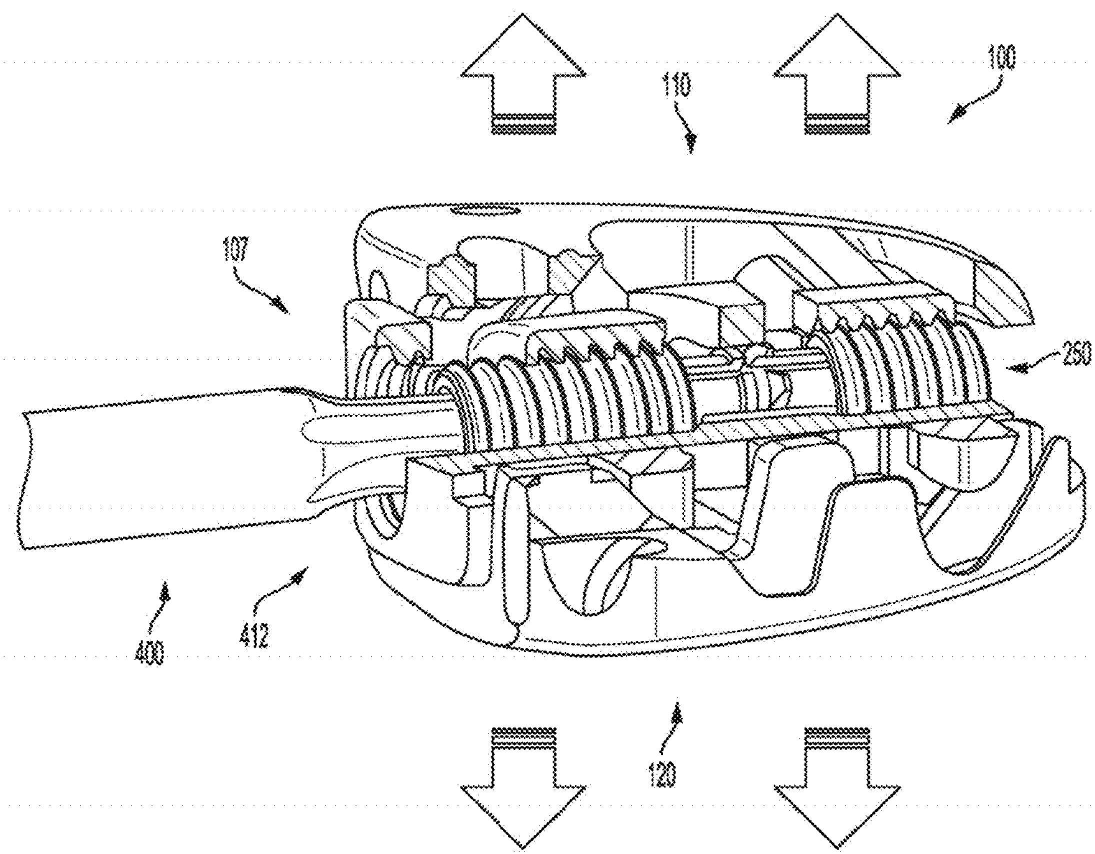


FIG. 9B

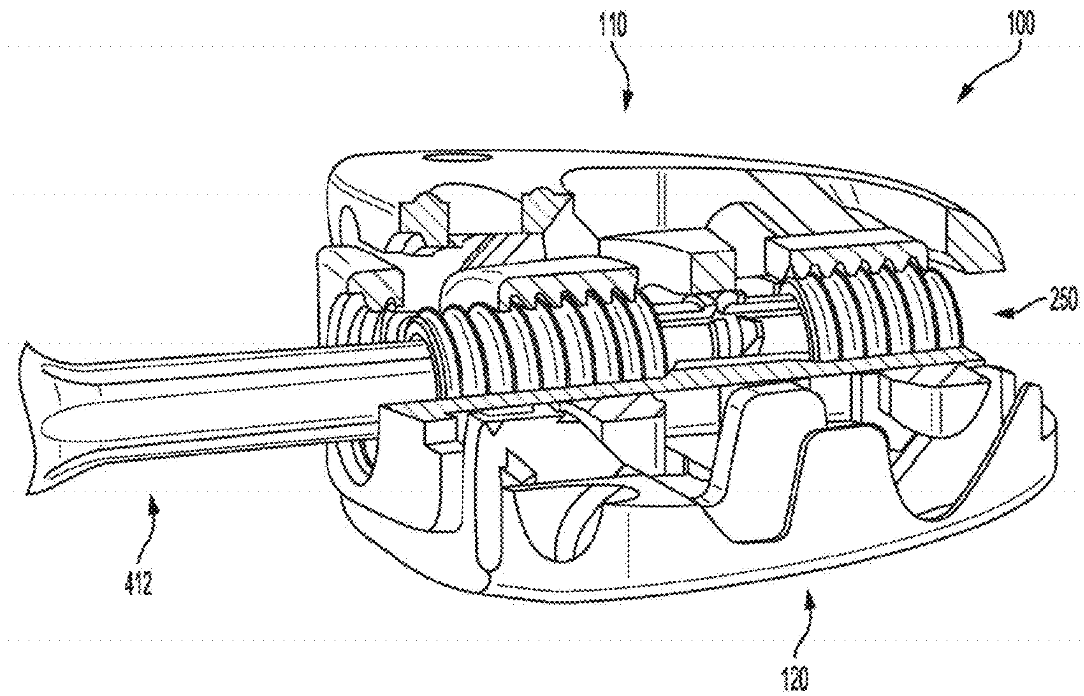


FIG. 10A

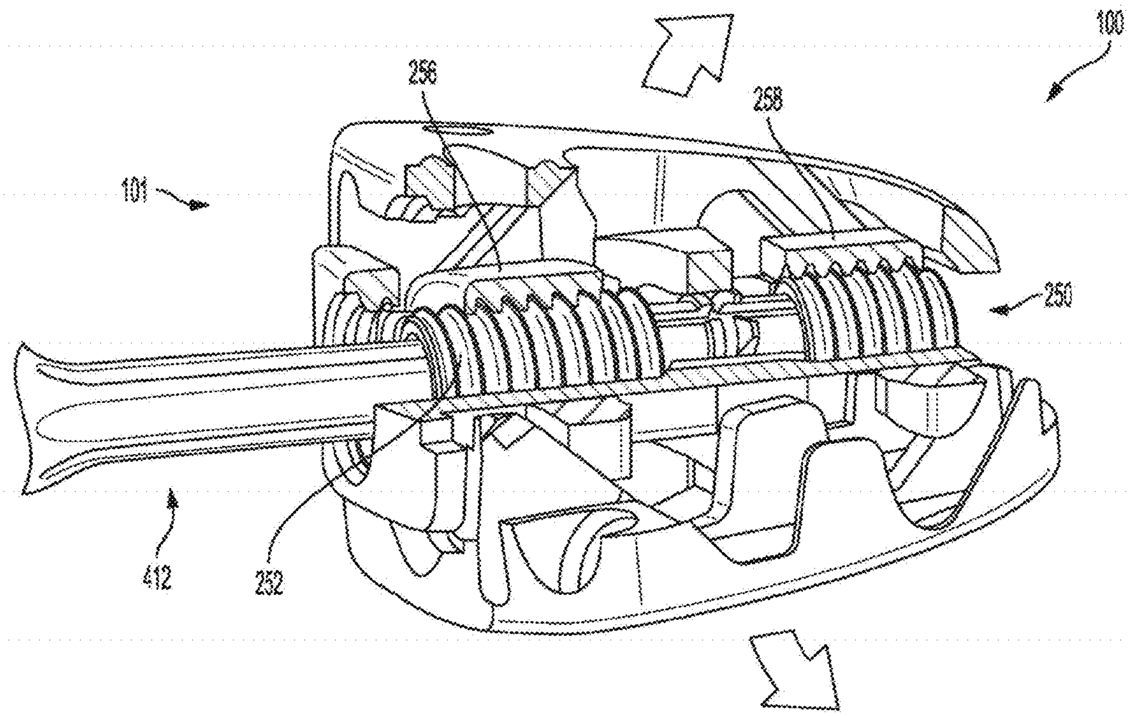


FIG. 10B

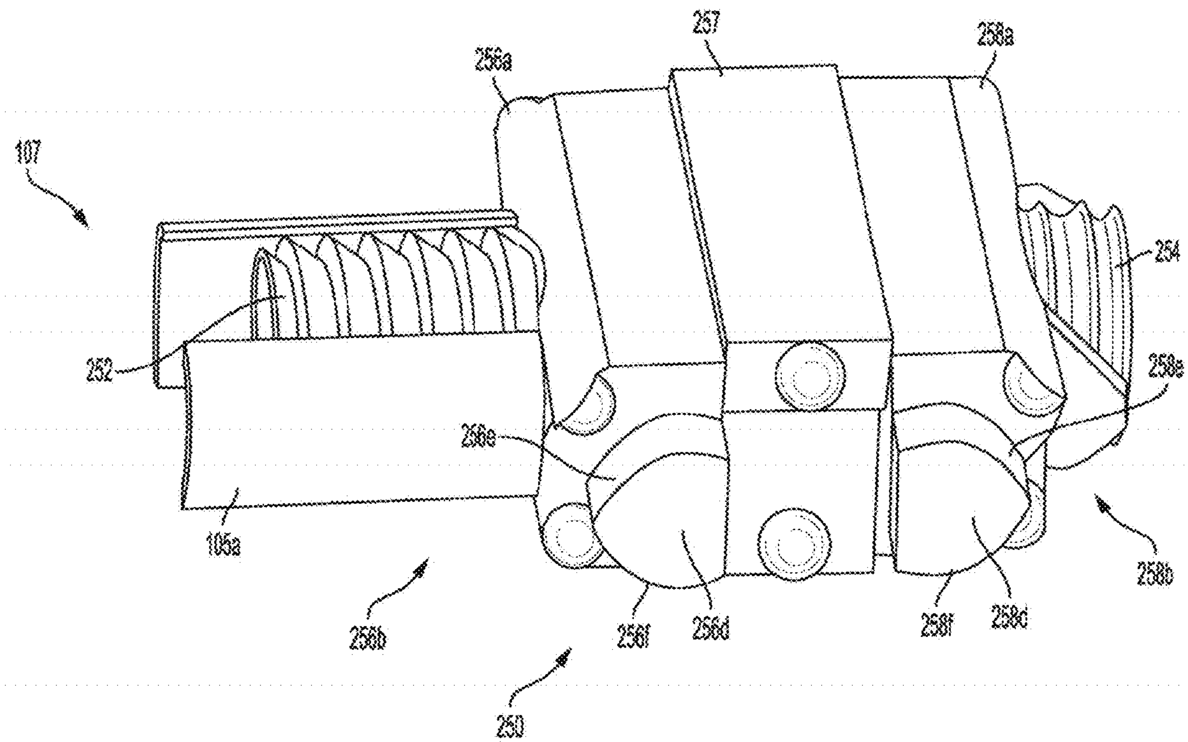

257
256a
258a
107
254
252
258e
256e
105a
258b
256b
256f
256d
258f
258d
250

FIG. 11A

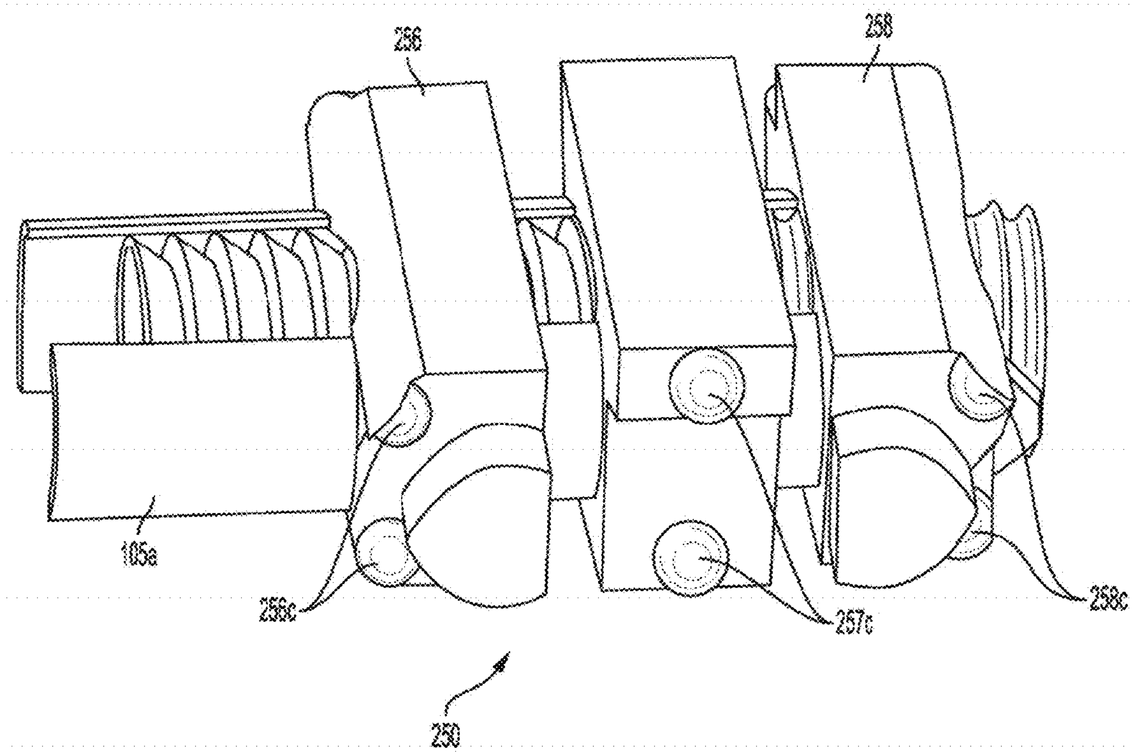


FIG. 11B

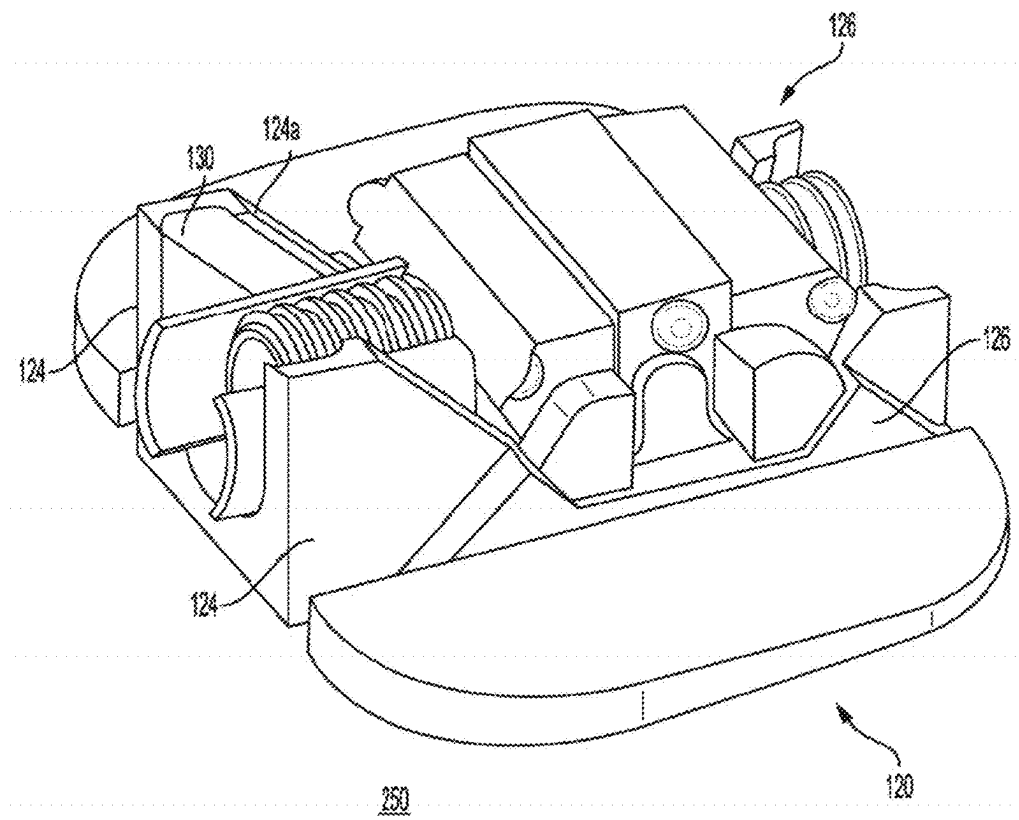


FIG. 12A

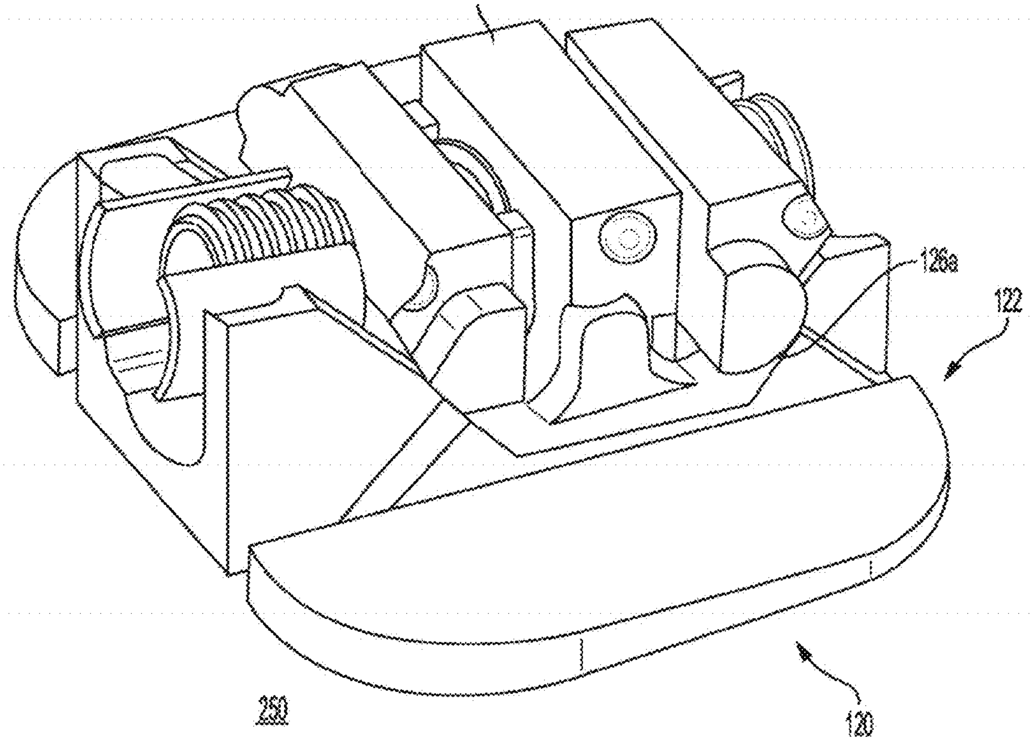


FIG. 12B

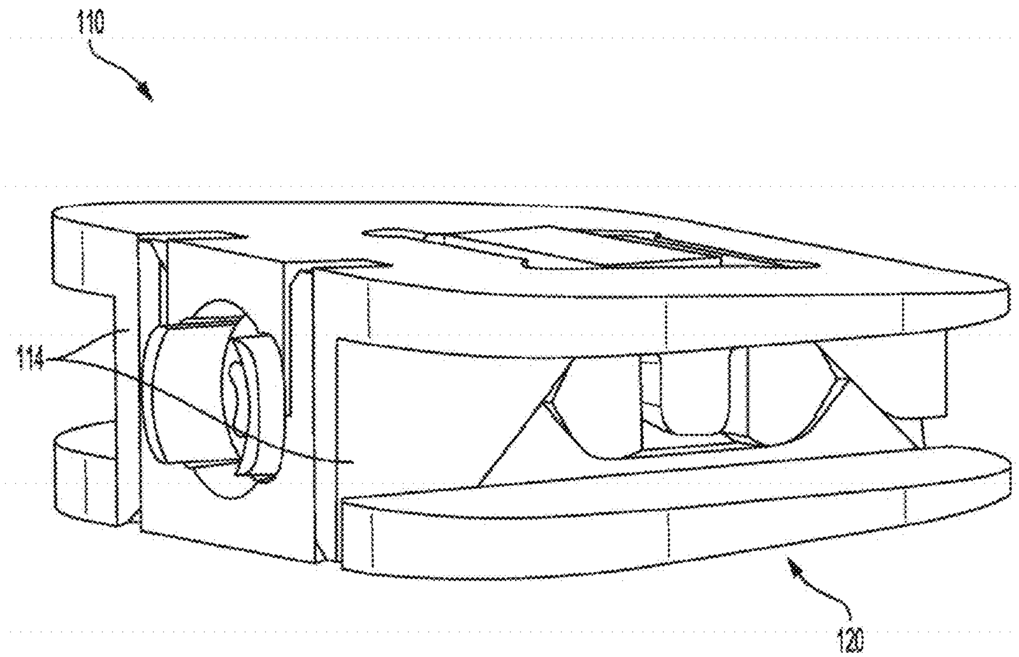


FIG. 13A

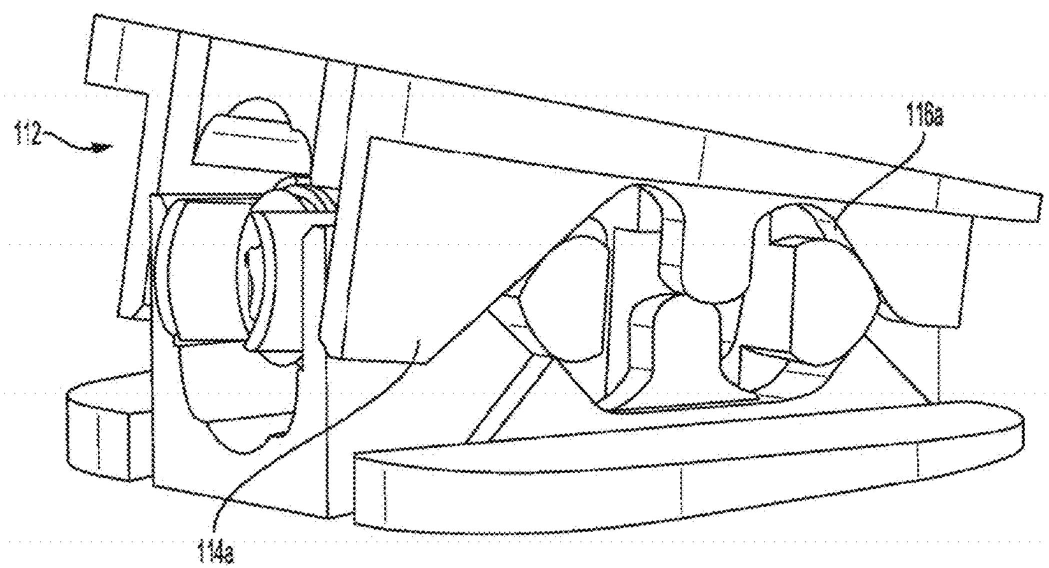


FIG. 13B

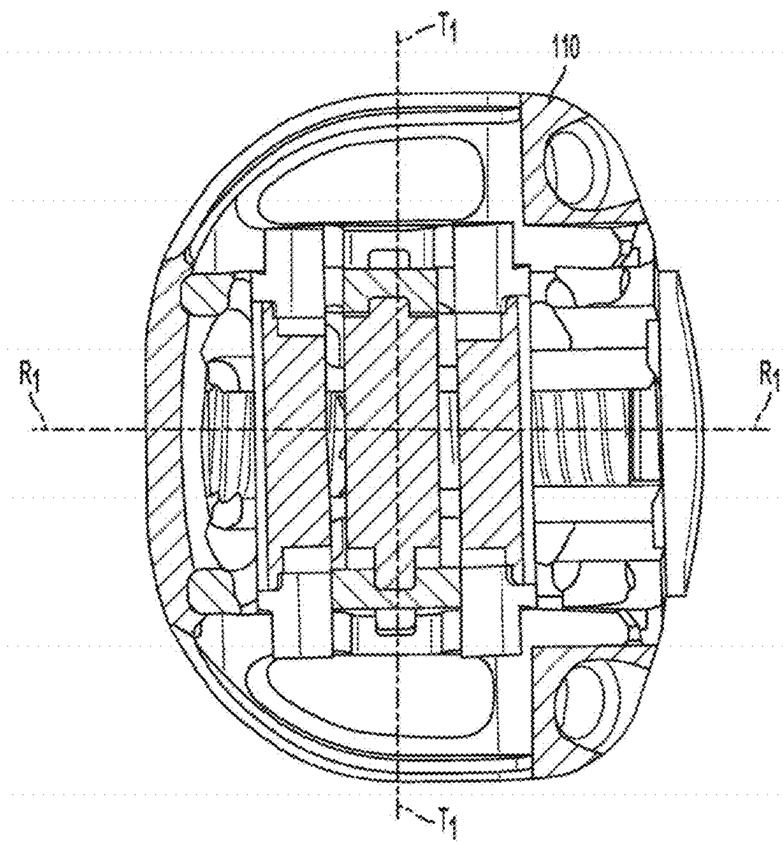


FIG. 14A

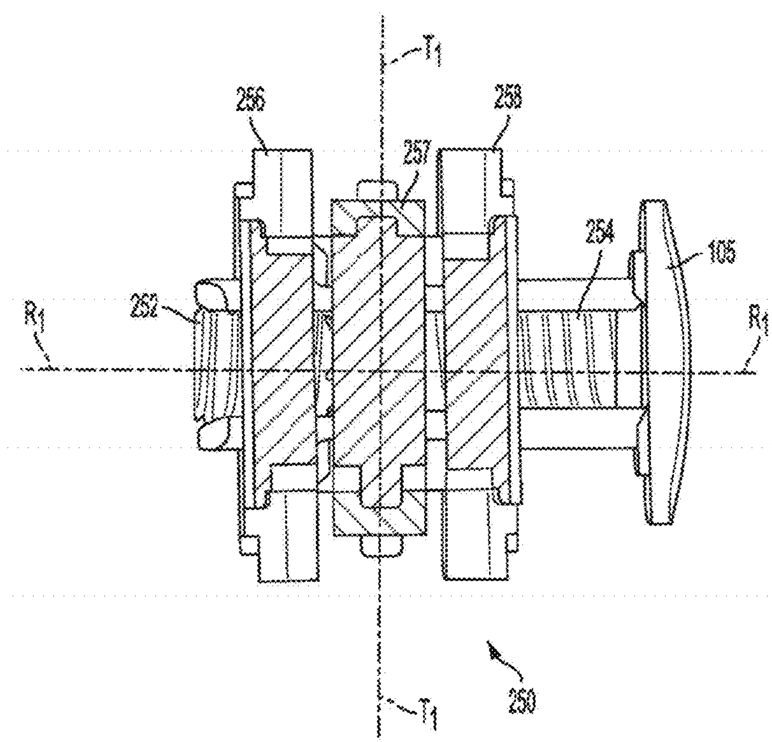


FIG. 14B

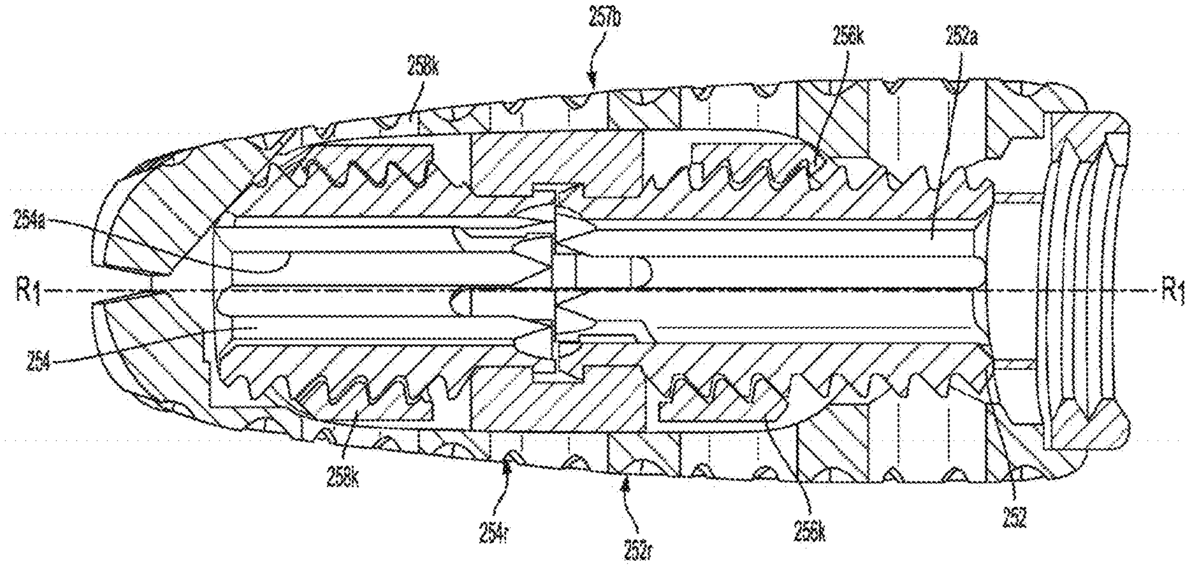


FIG. 15

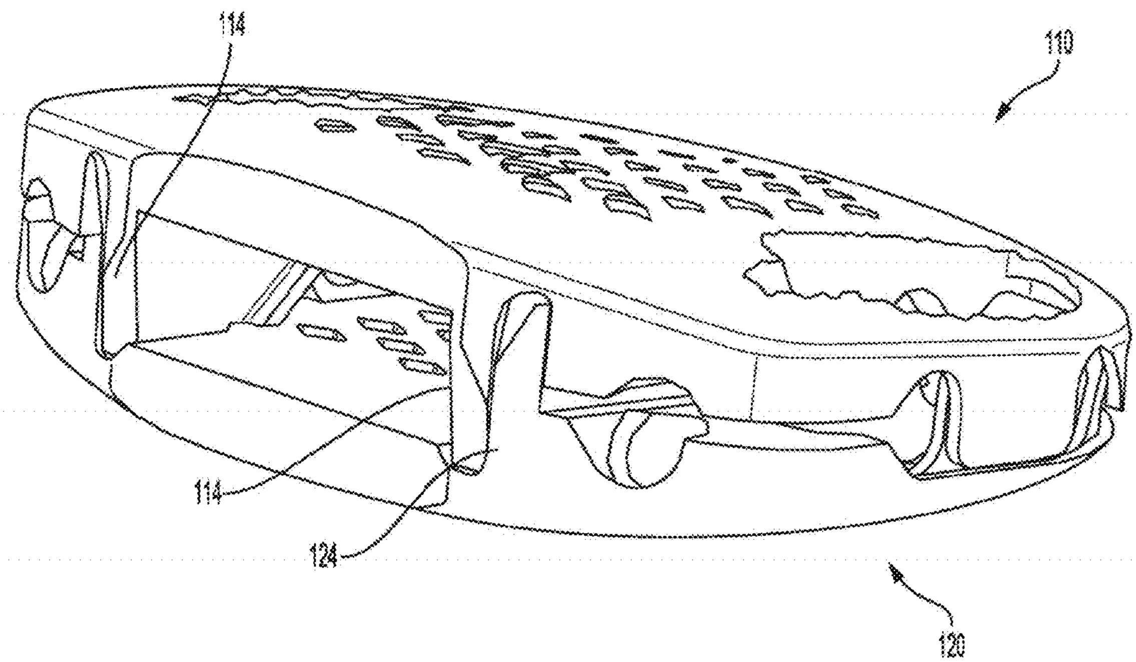


FIG. 16

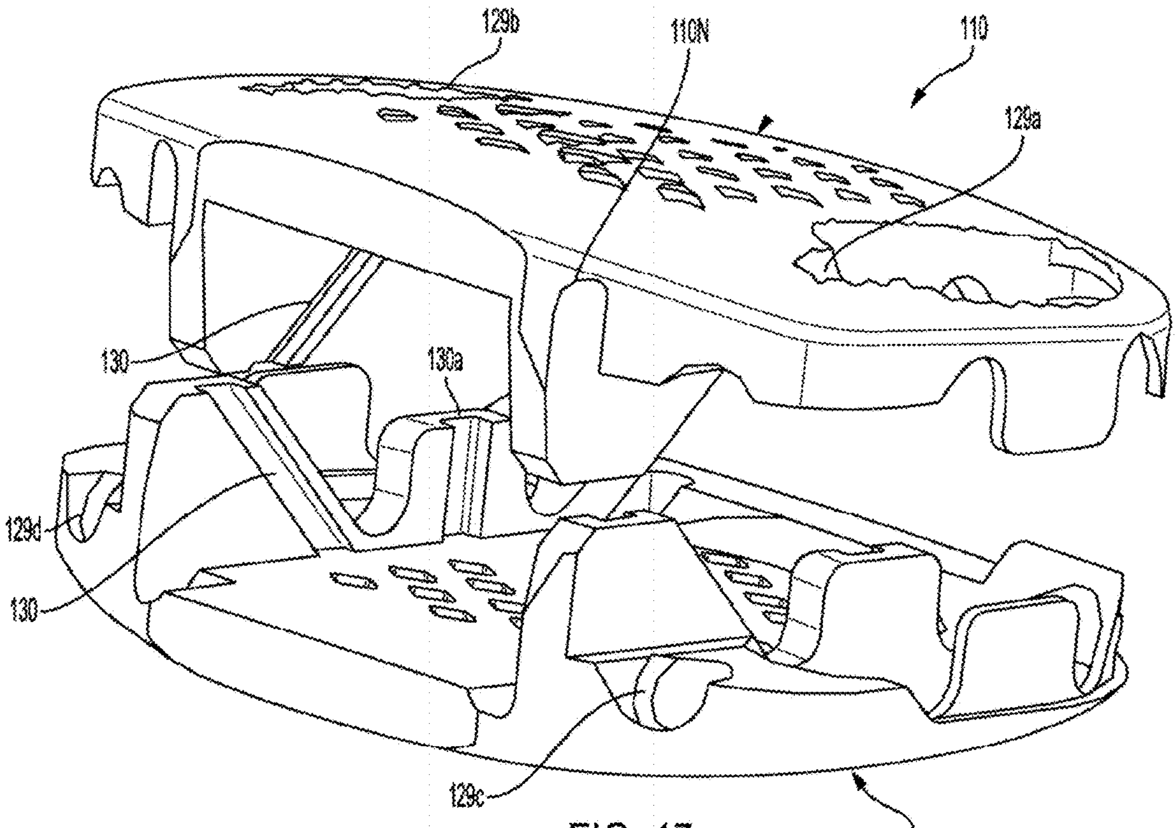


FIG. 17

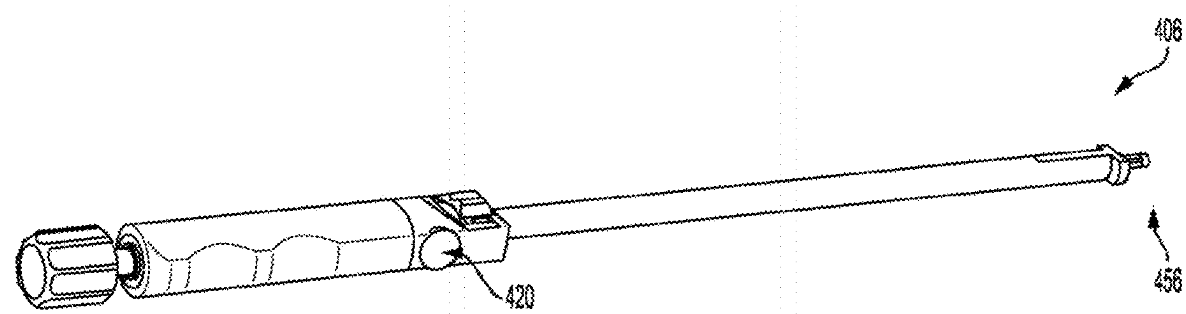


FIG. 18A

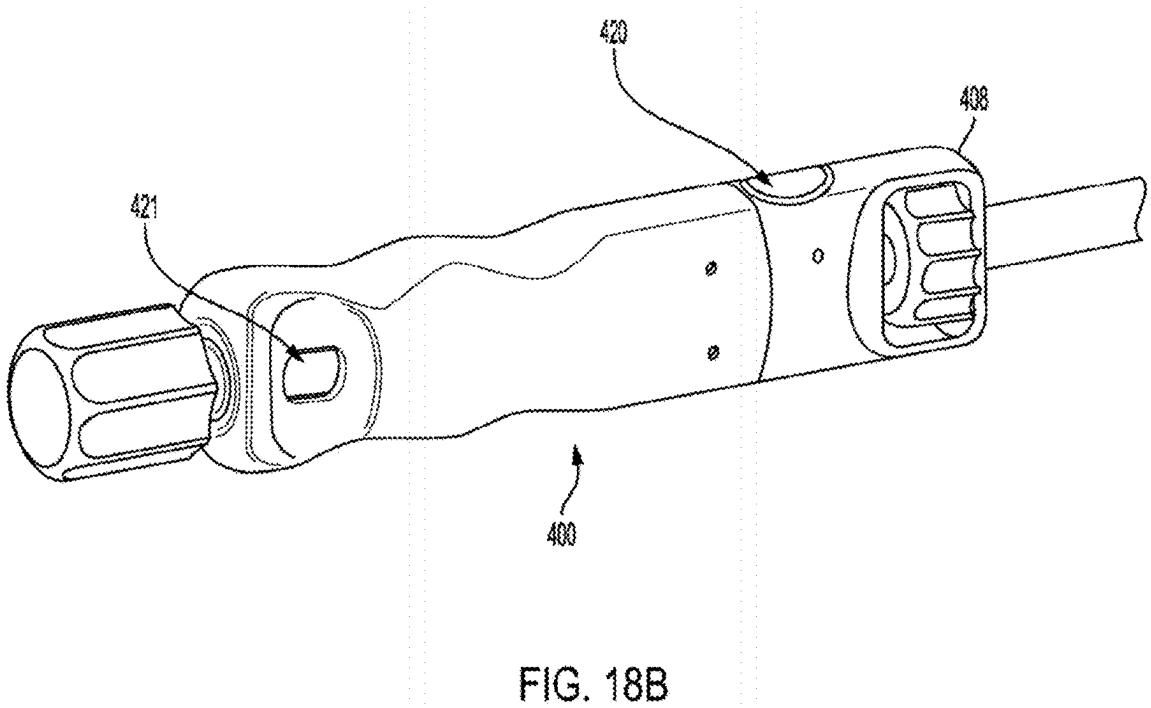


FIG. 18B

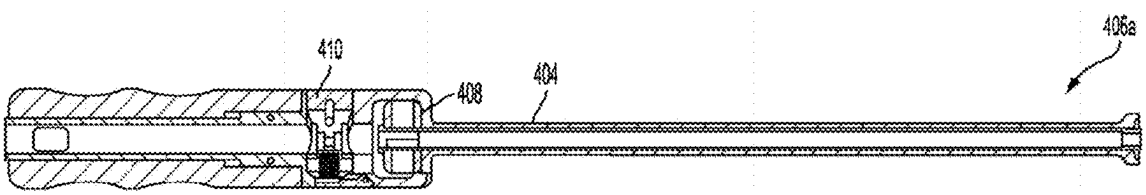


FIG. 19A

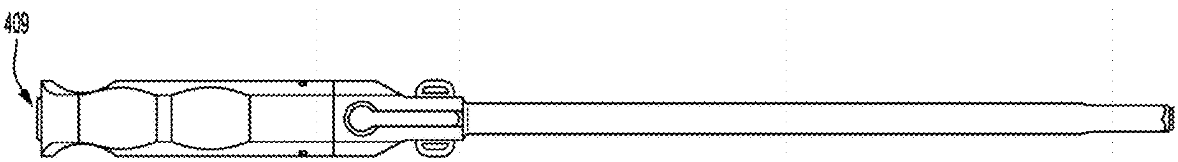


FIG. 19B

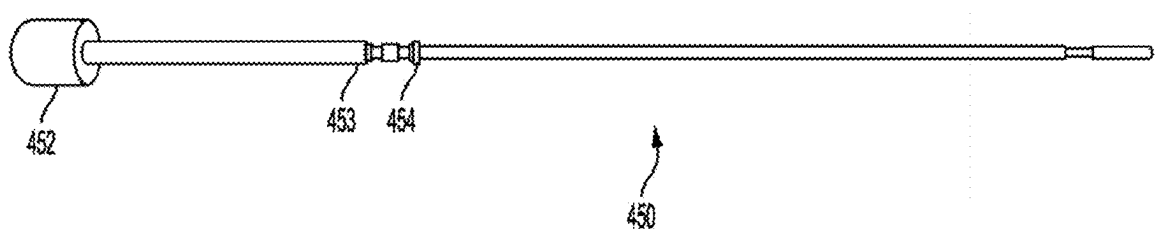


FIG. 19C

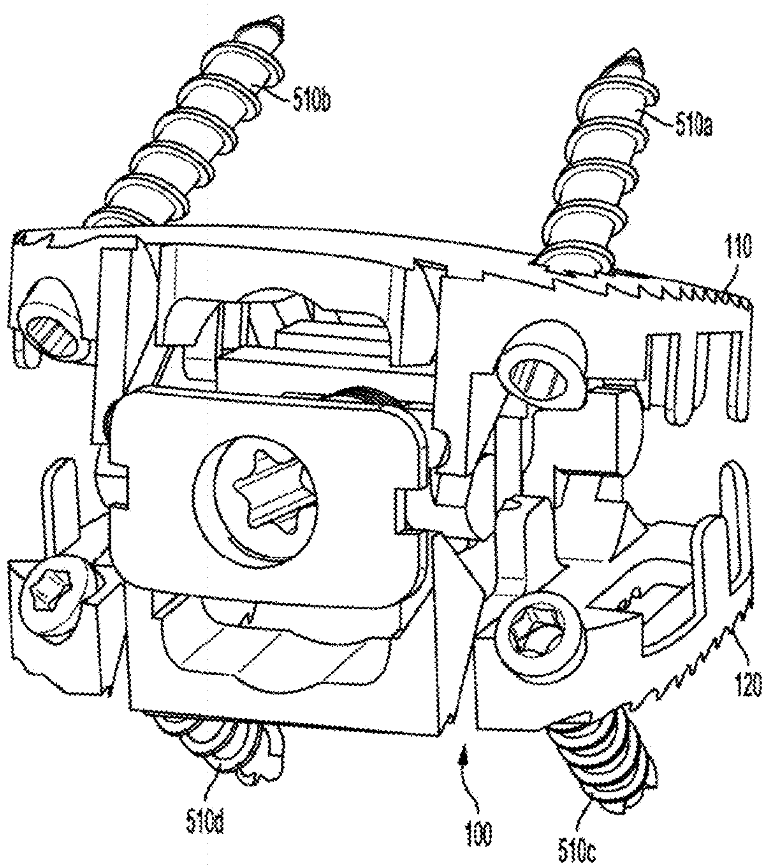


FIG. 20

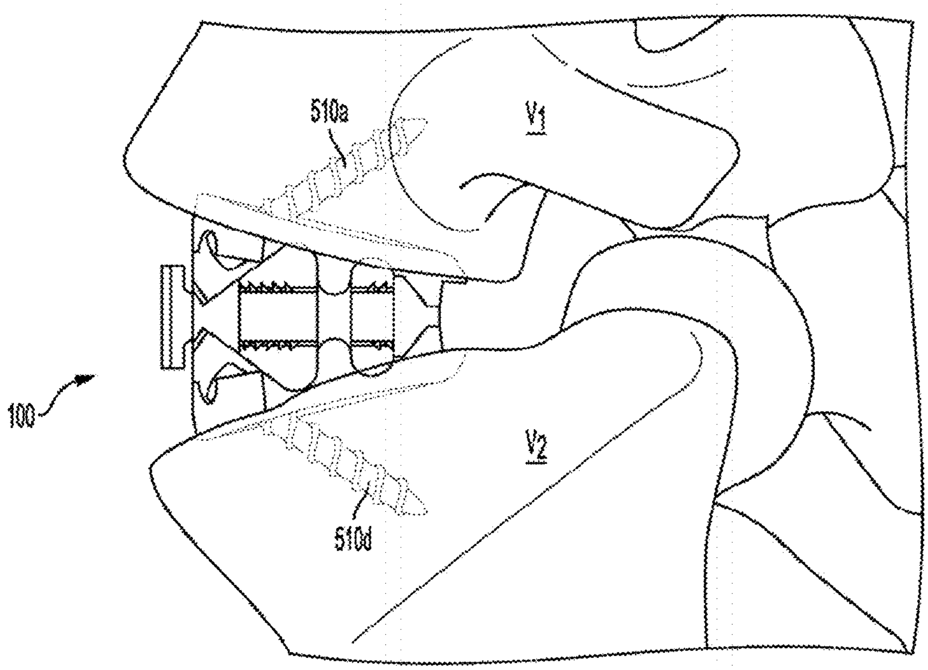


FIG. 21A

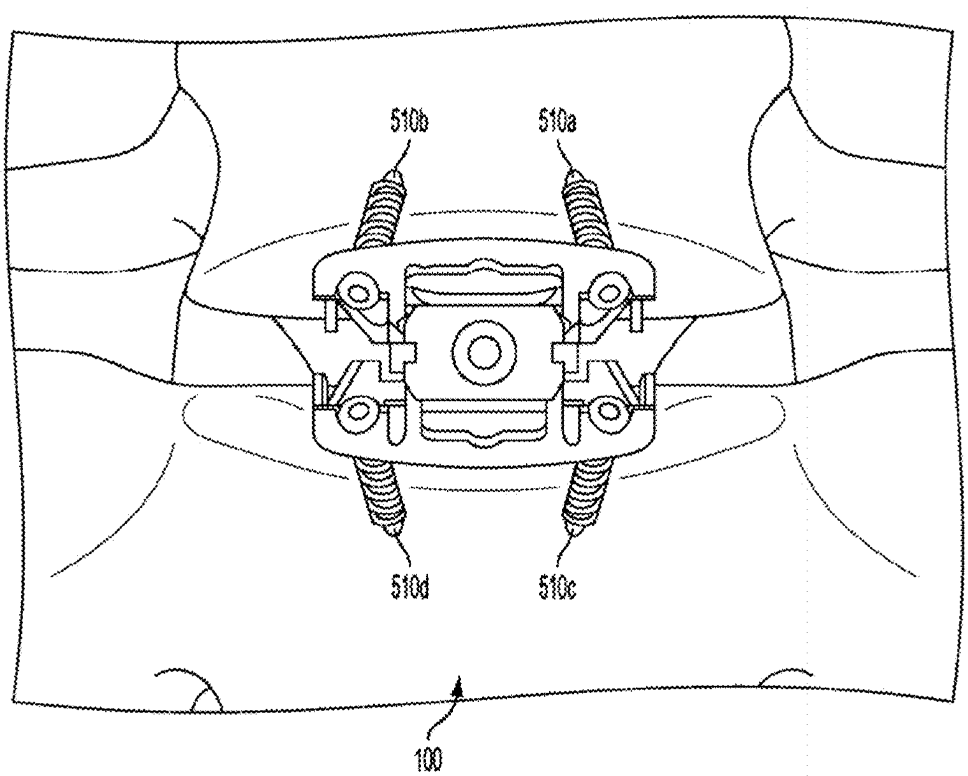


FIG. 21B

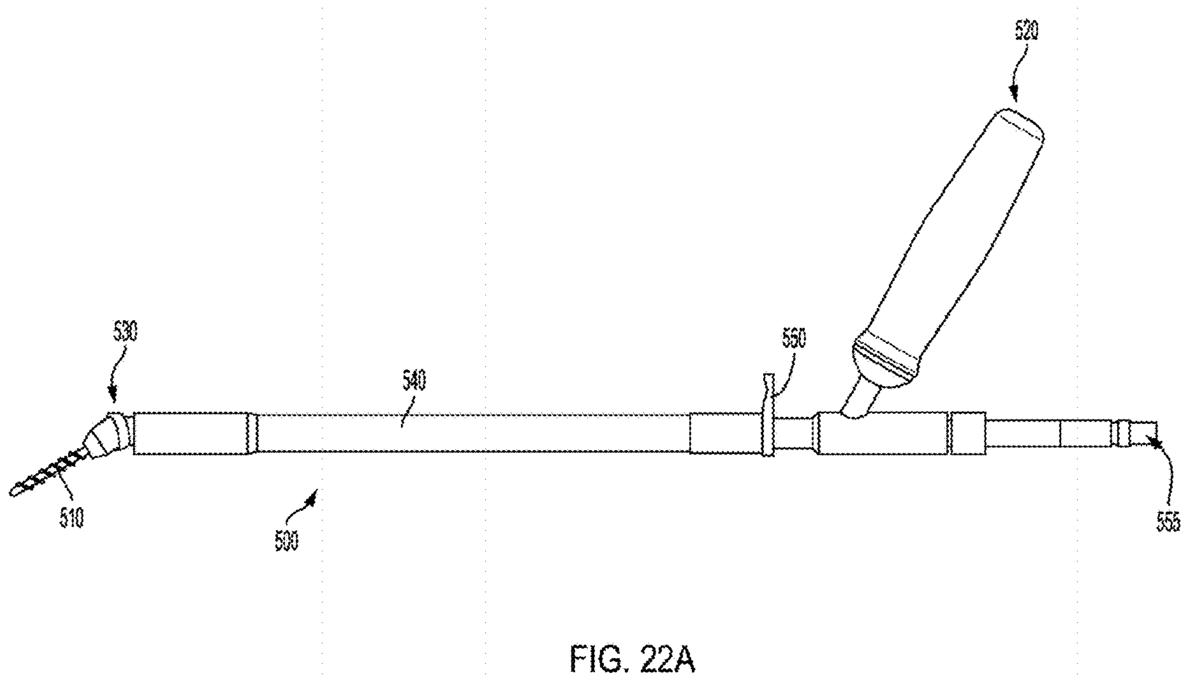


FIG. 22A

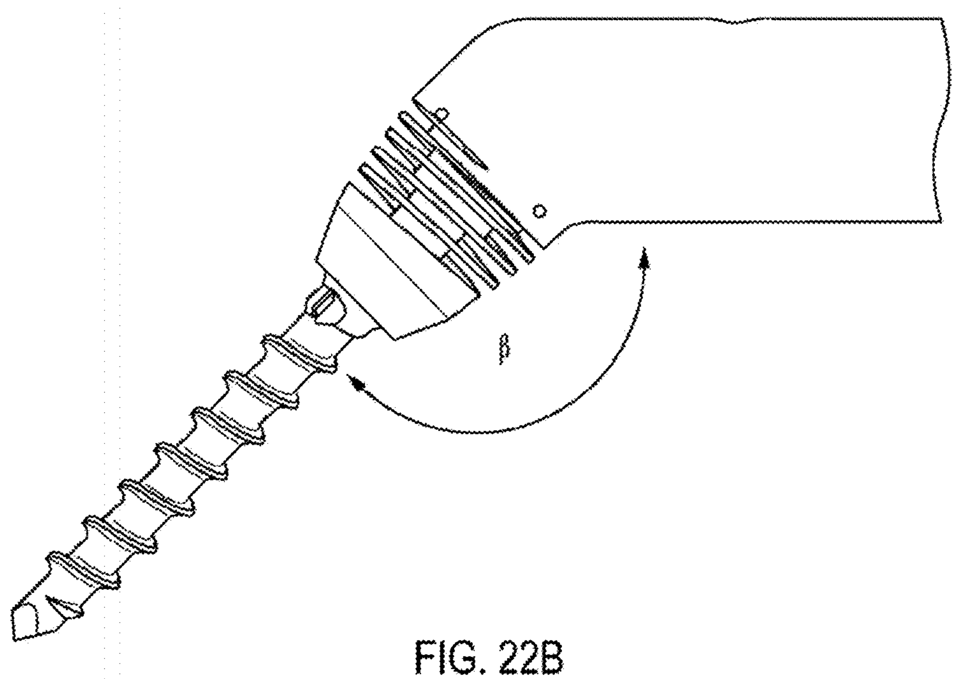


FIG. 22B

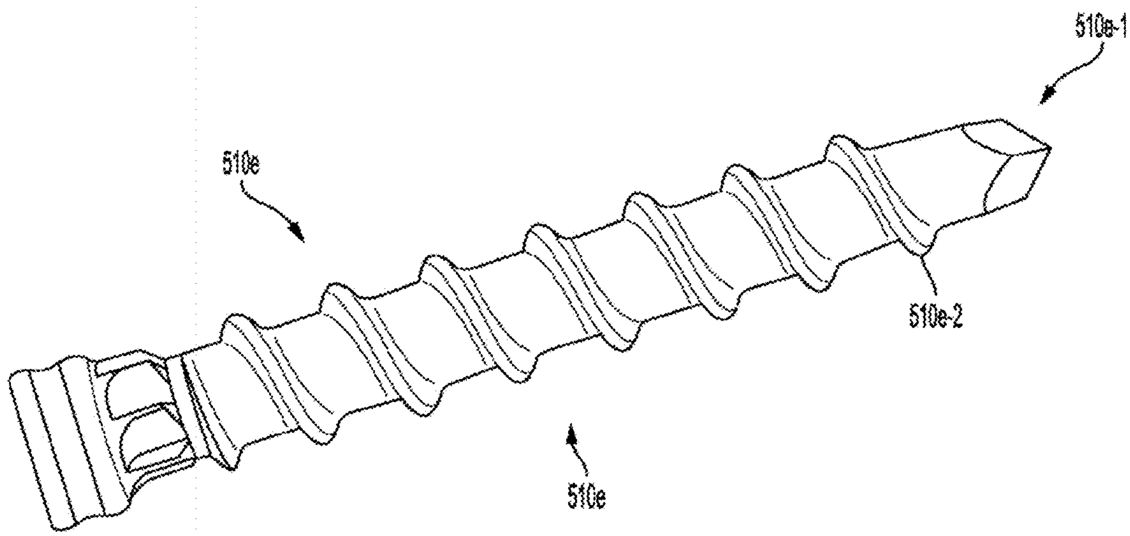


FIG. 23A

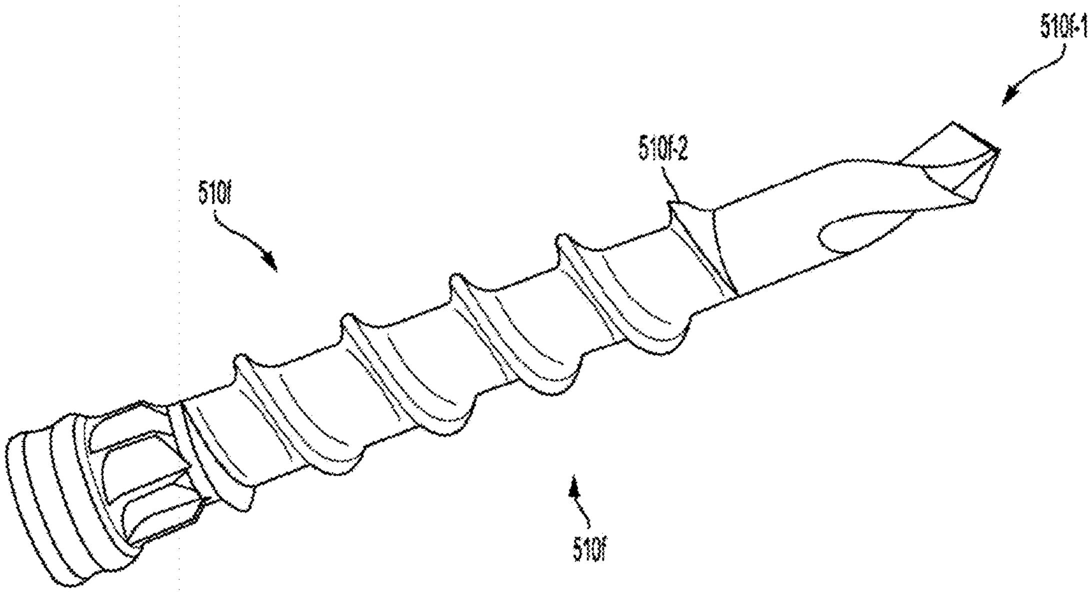


FIG. 23B

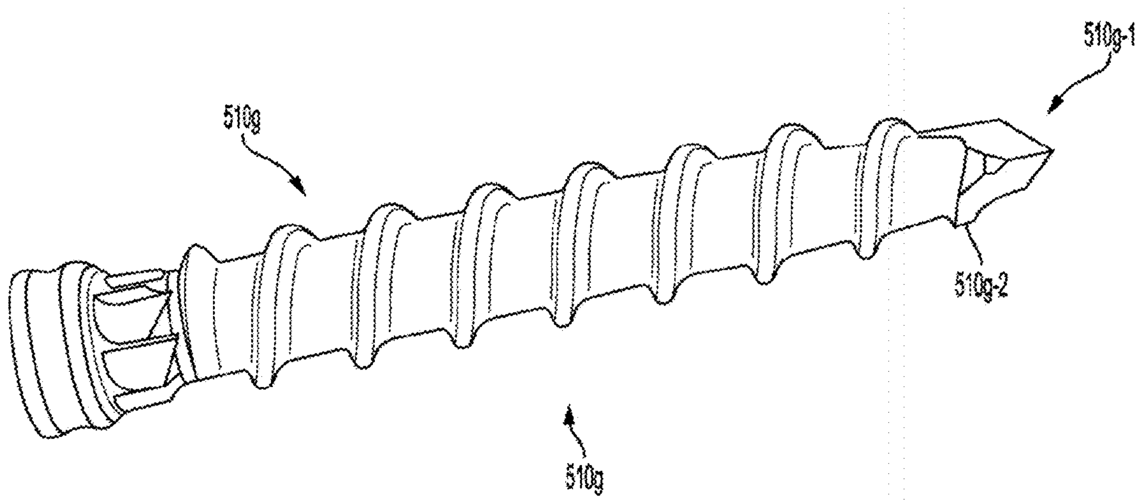


FIG. 23C

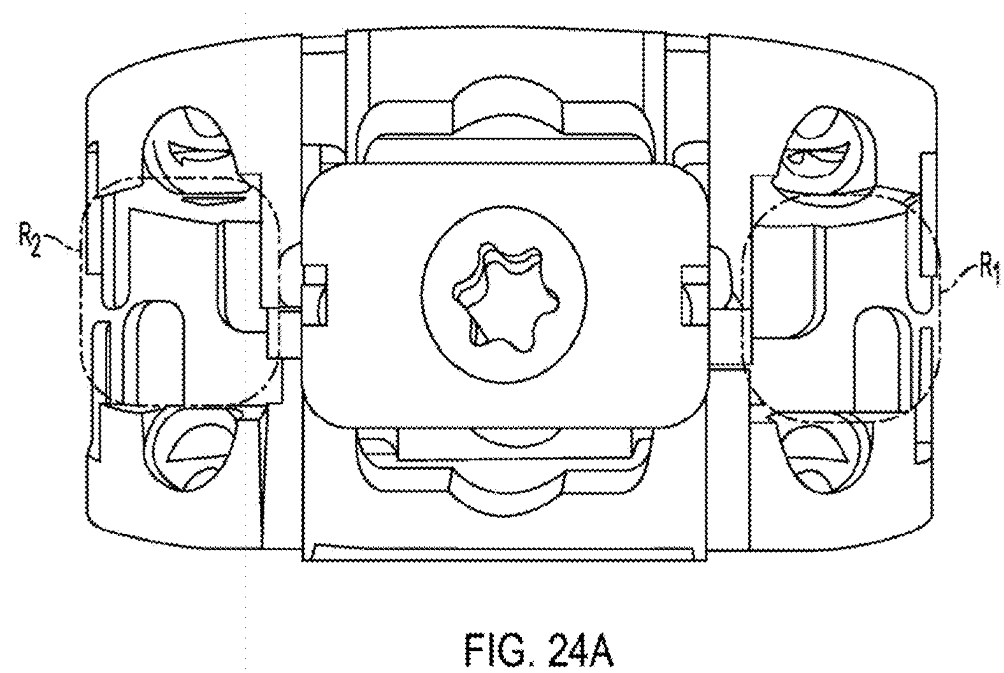


FIG. 24A

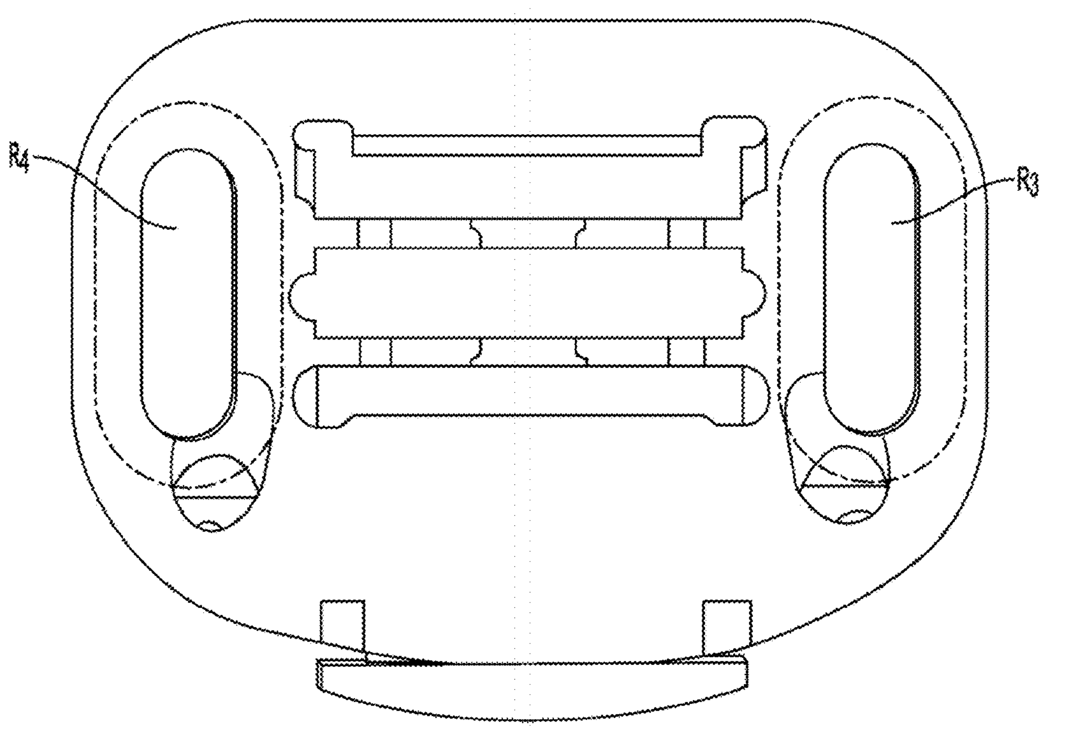


FIG. 24B

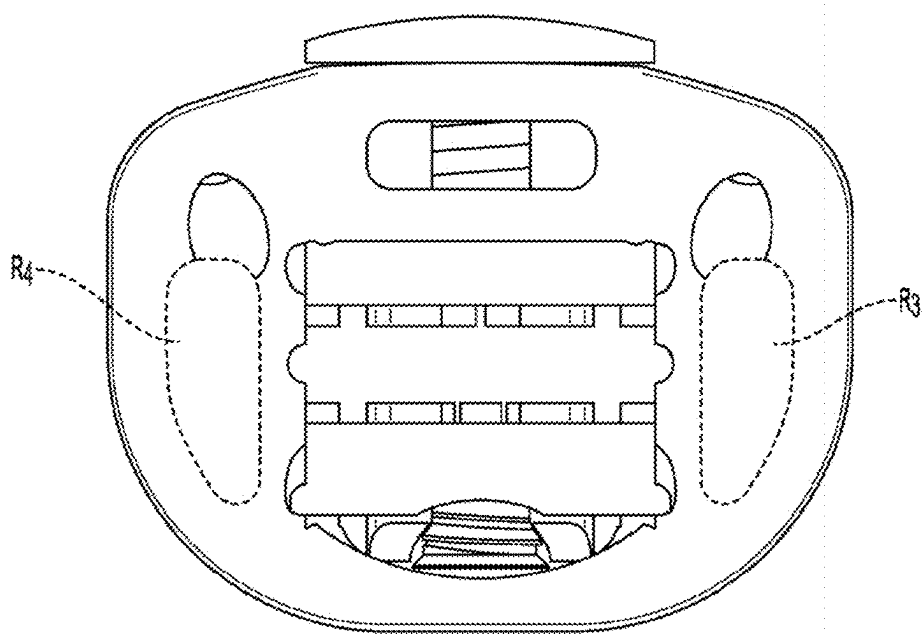


FIG. 24C

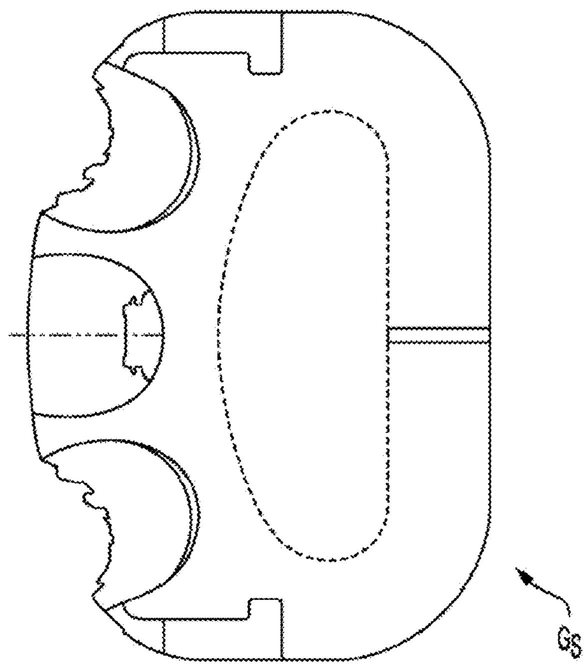


FIG. 24D

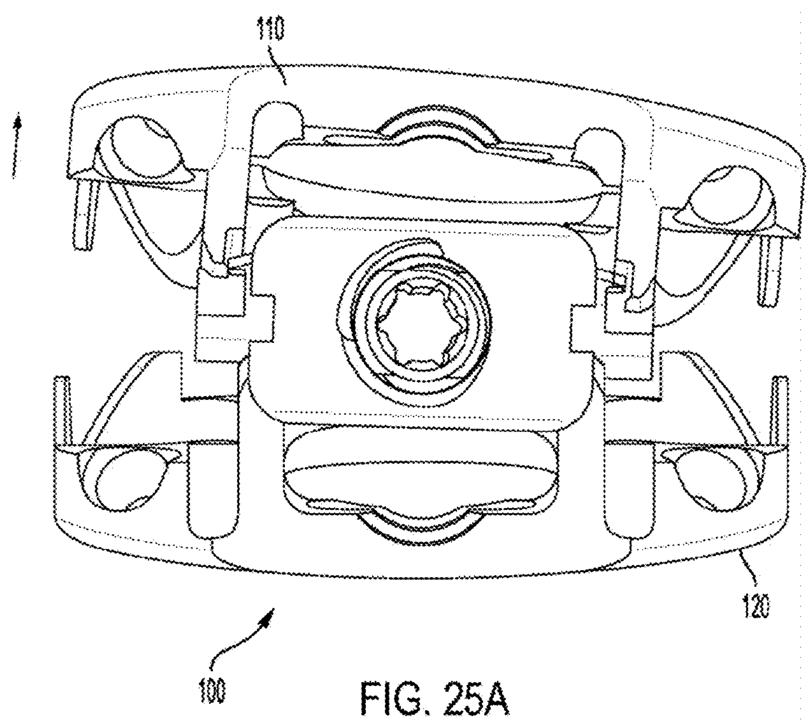


FIG. 25A

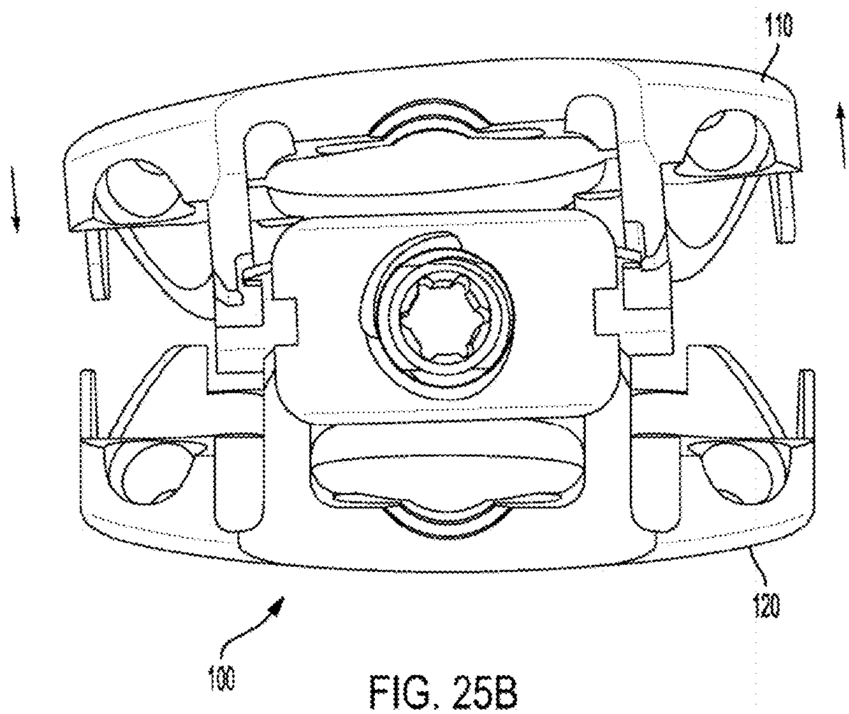


FIG. 25B

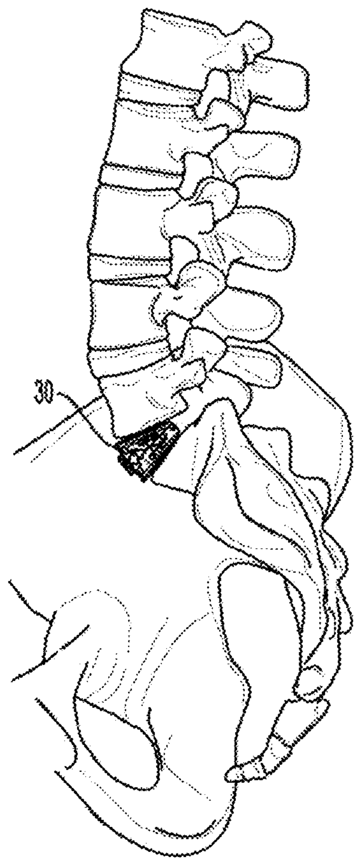


FIG. 26

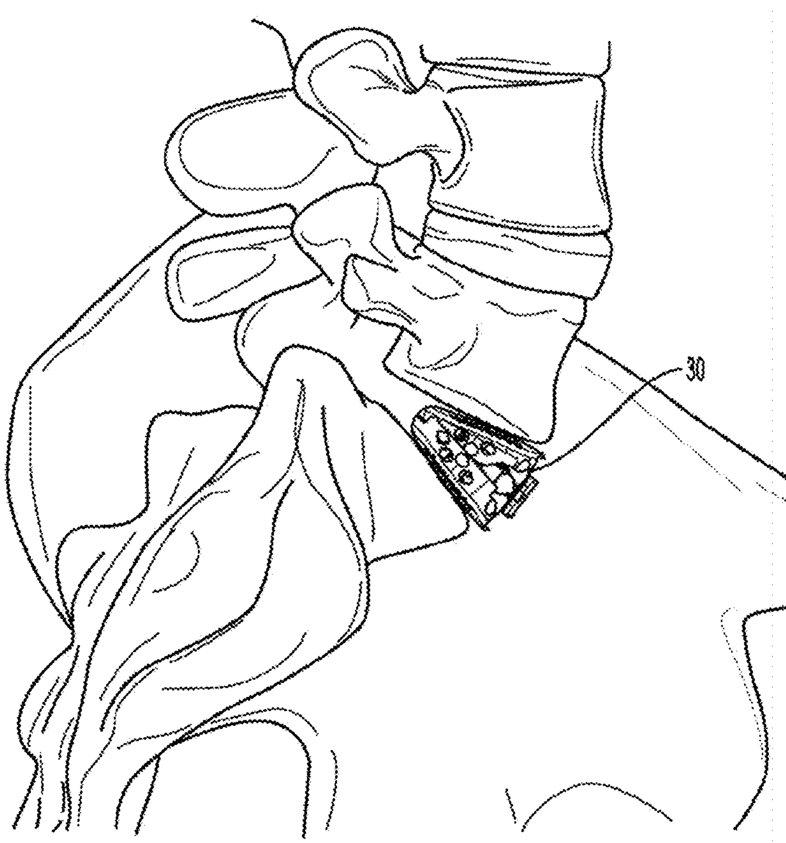


FIG. 27

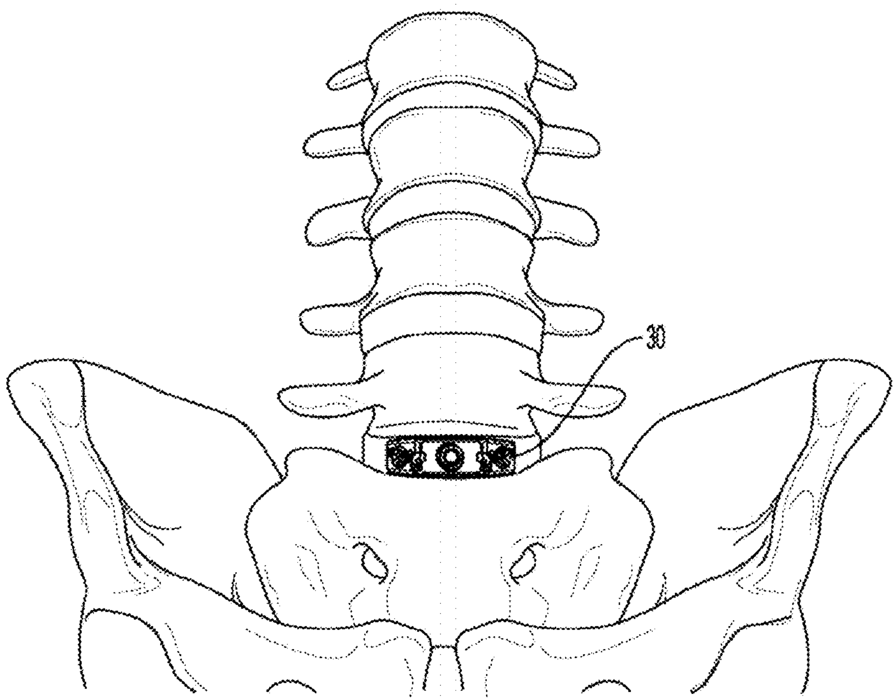


FIG. 28

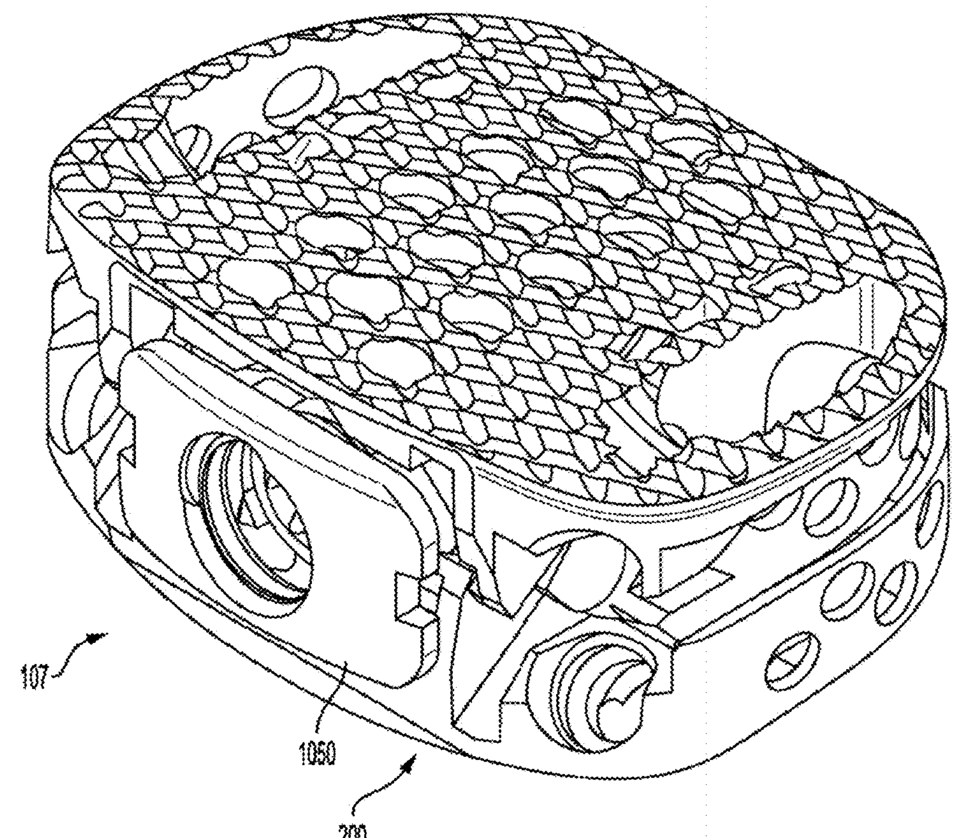


FIG. 29A

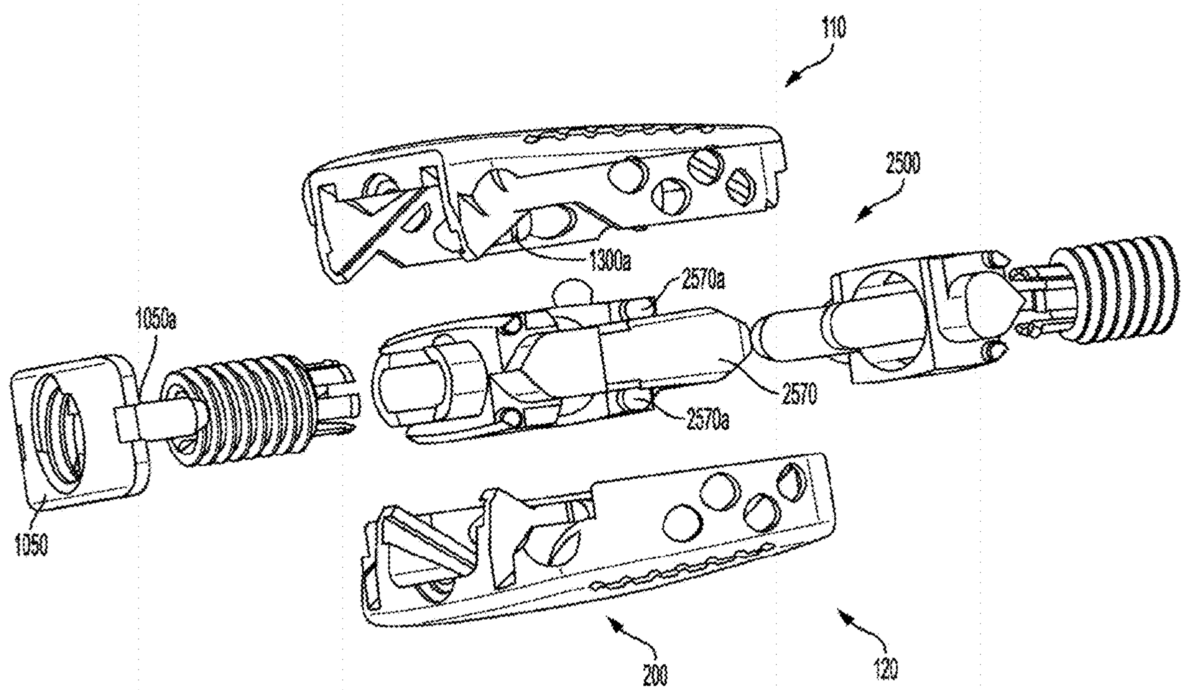


FIG. 29B

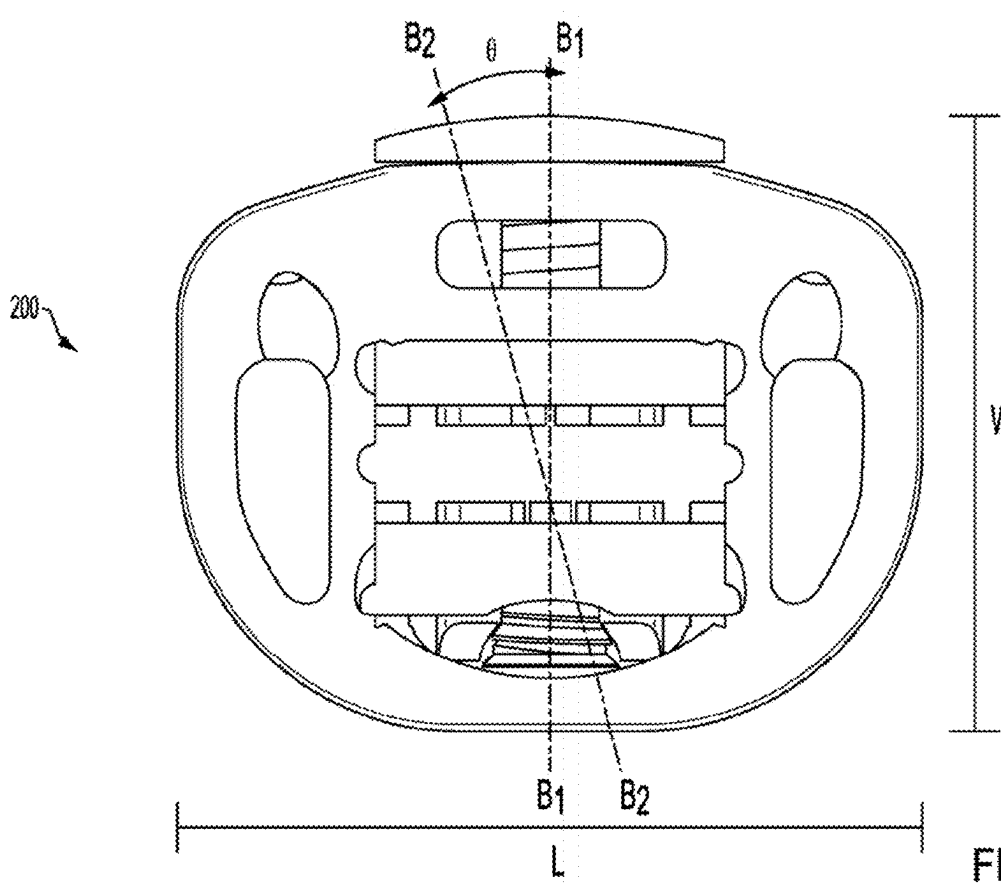


FIG. 30A

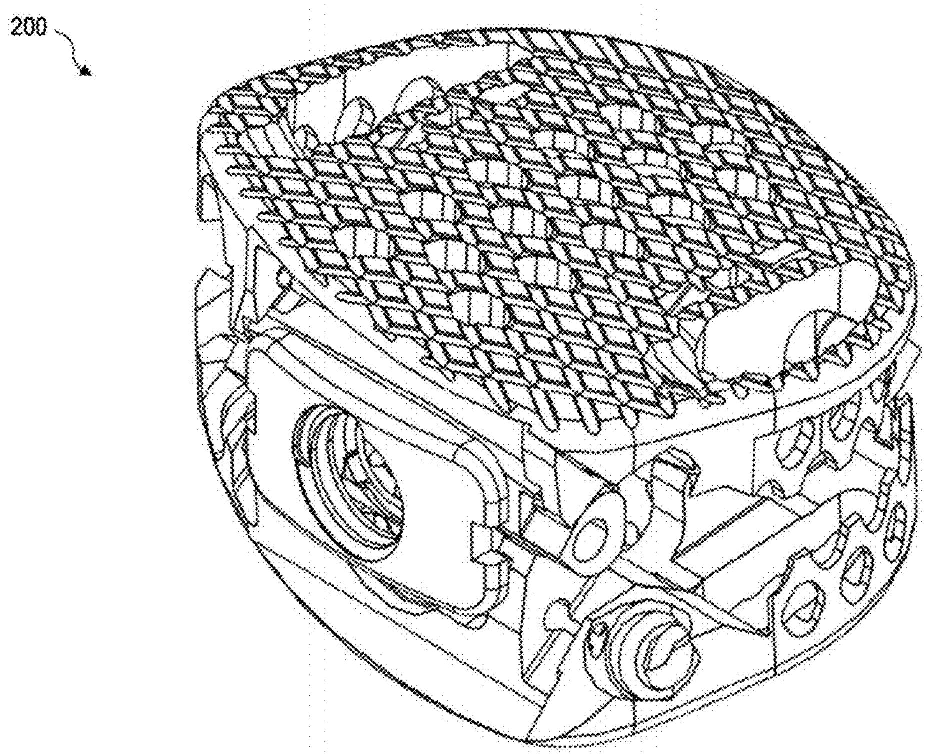


FIG. 30B

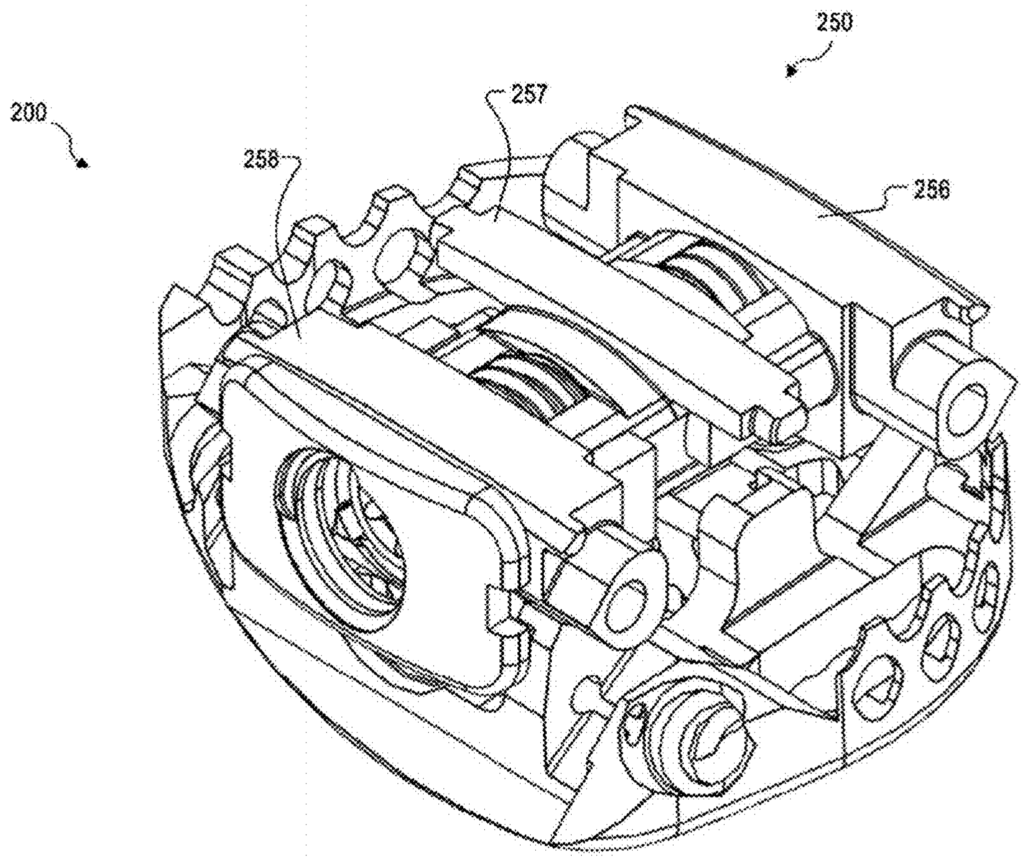


FIG. 30C

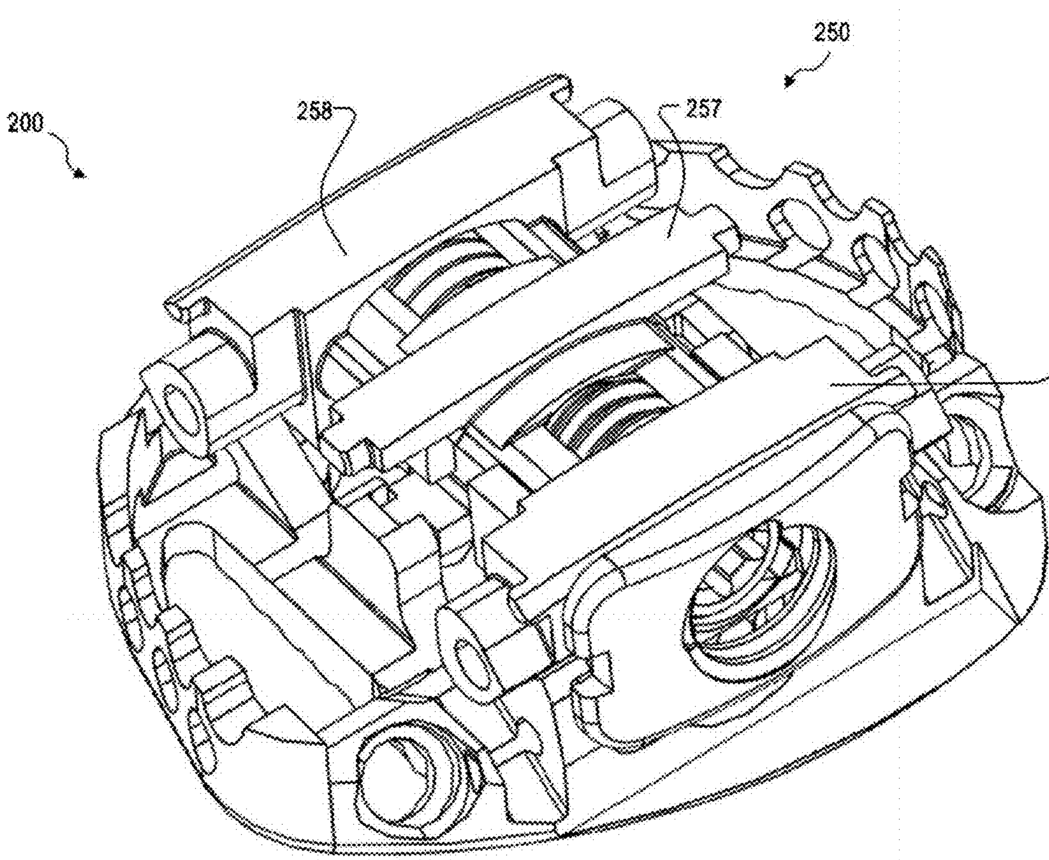


FIG. 30D

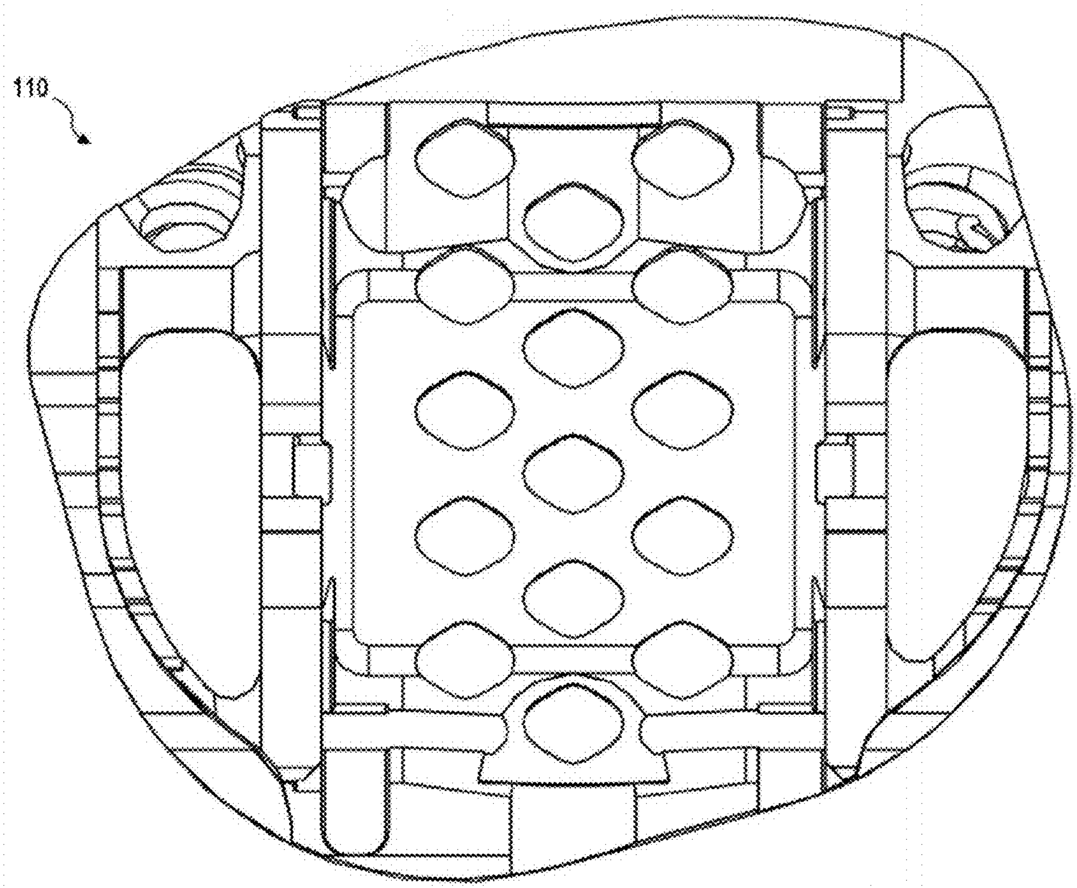


FIG. 30E

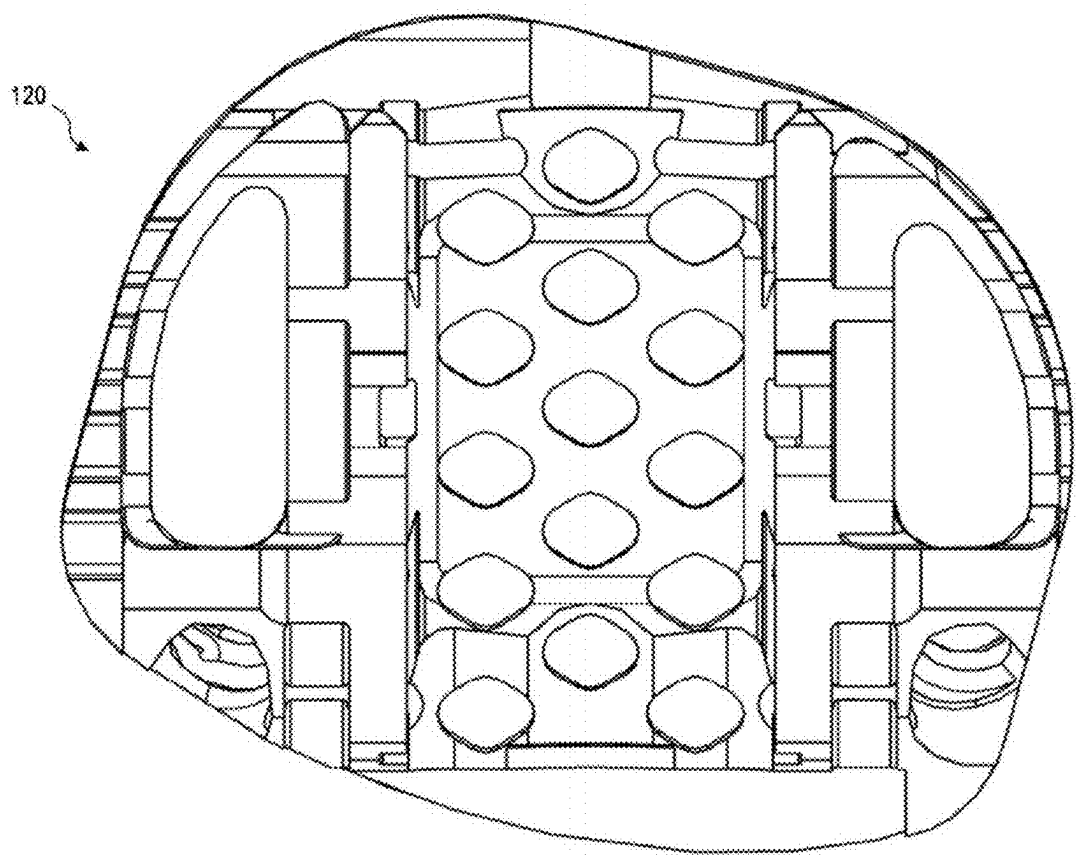


FIG. 30F

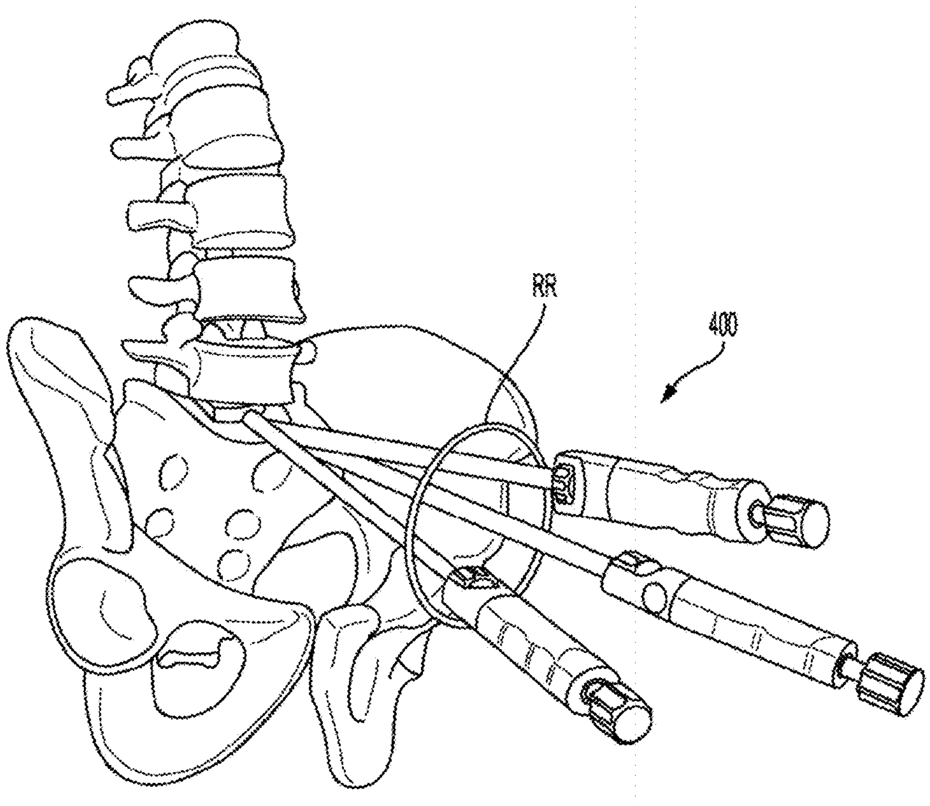


FIG. 31

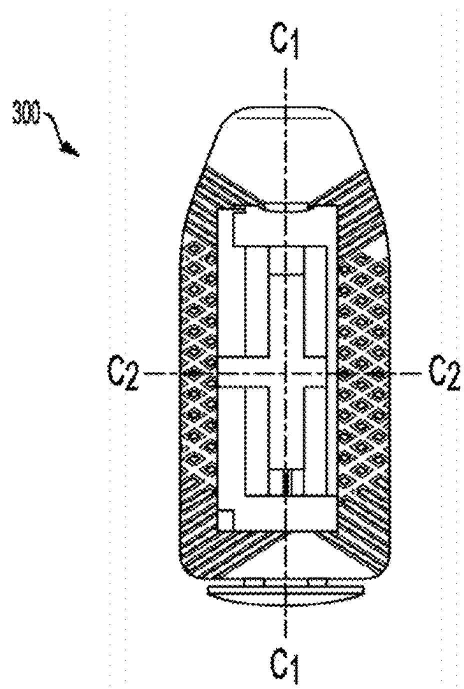


FIG. 32A

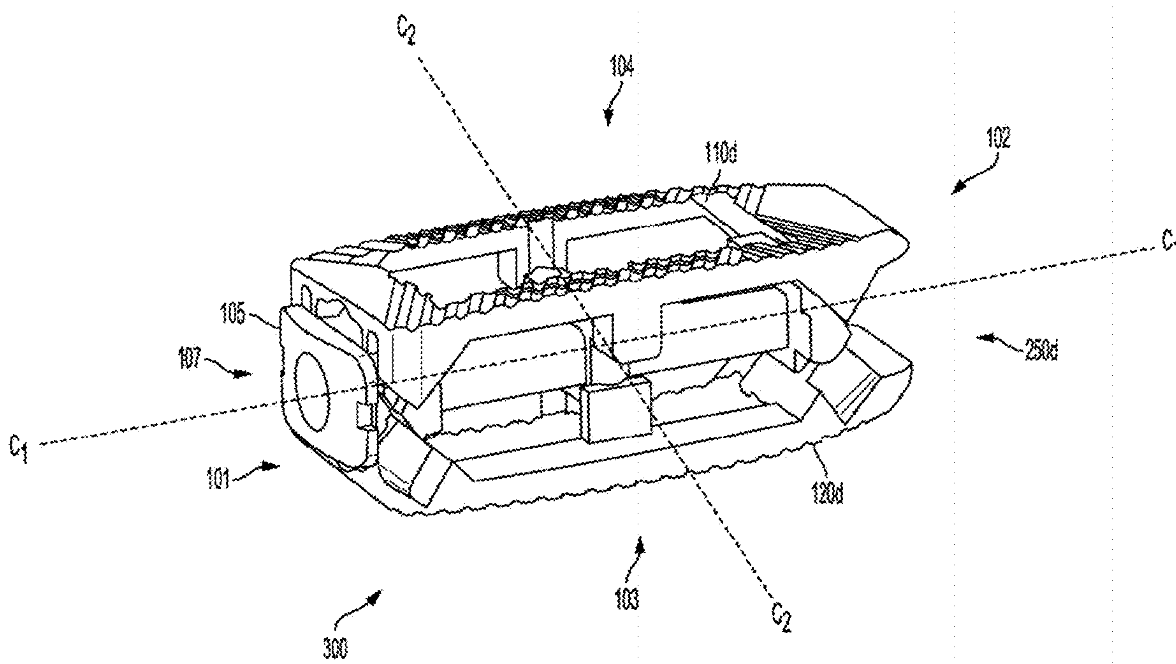


FIG. 32B

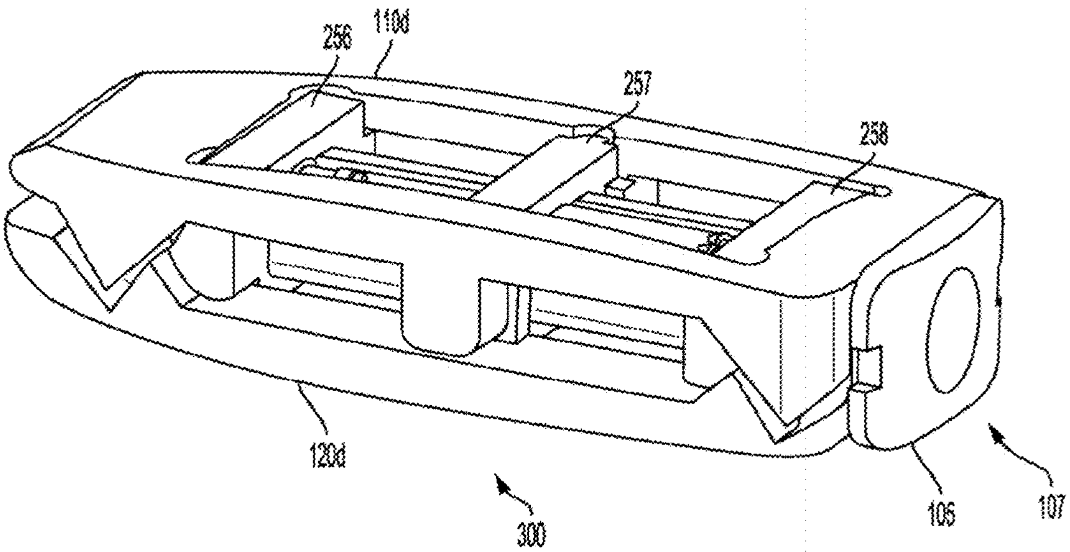


FIG. 33A

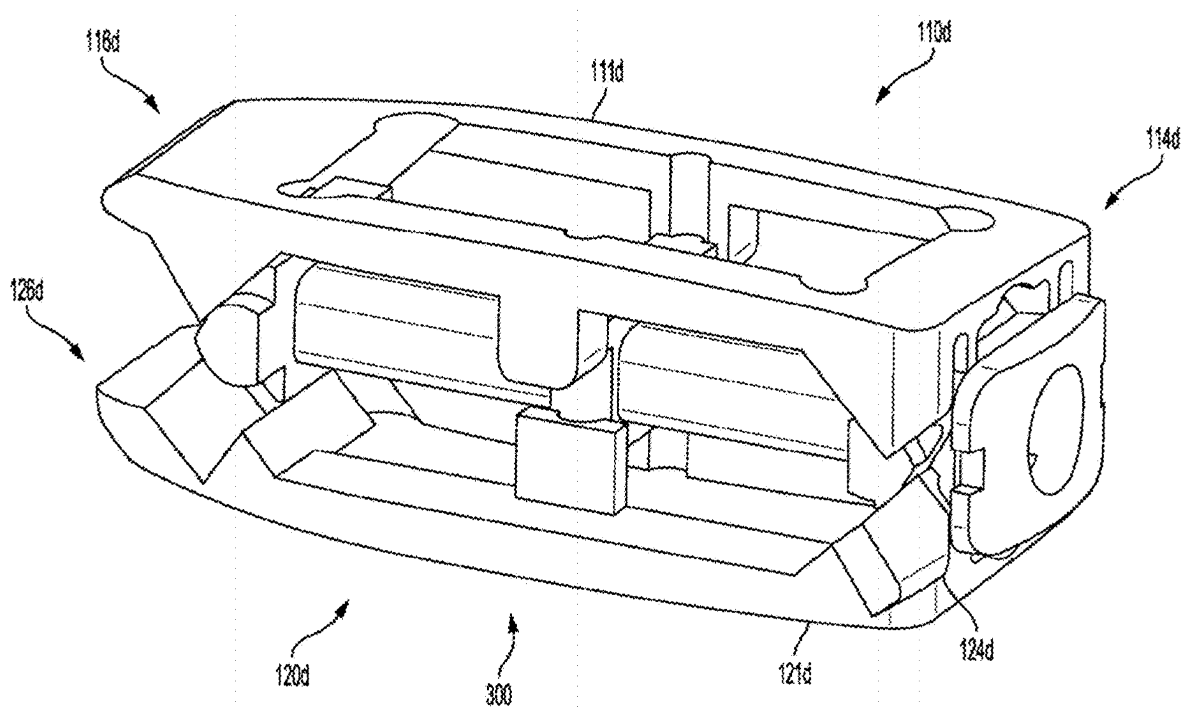


FIG. 33B

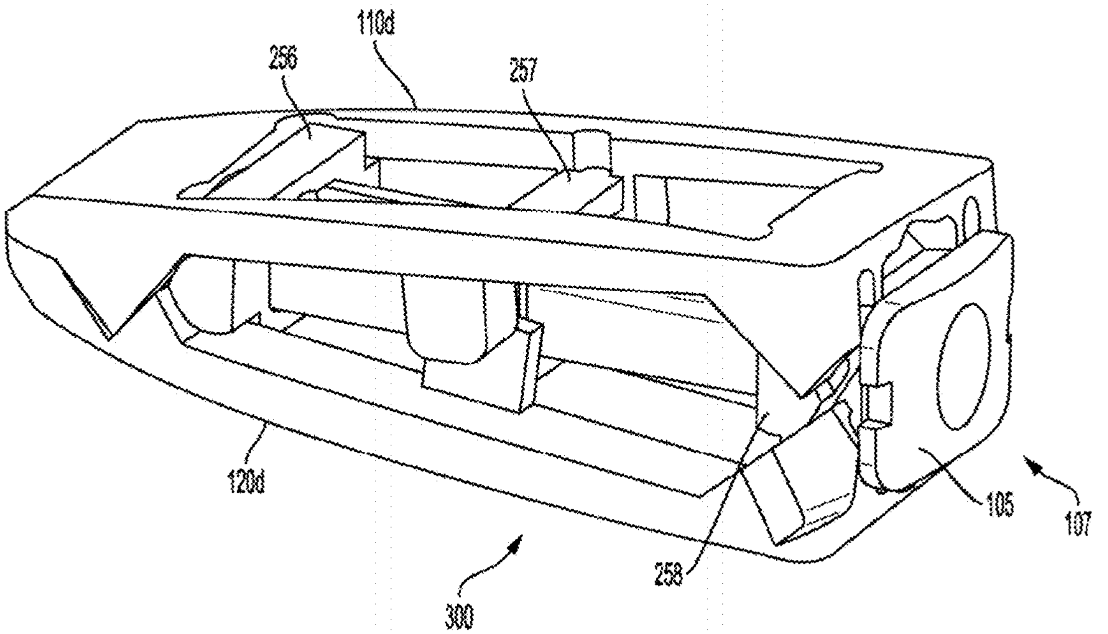


FIG. 33C

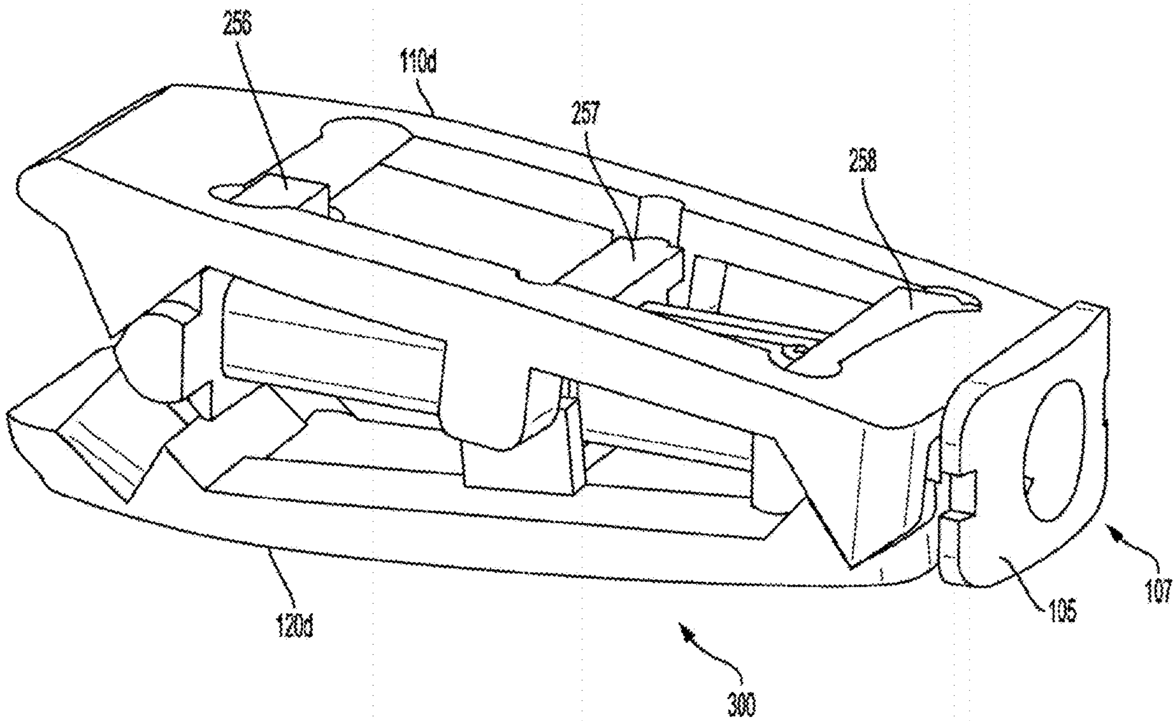


FIG. 33D

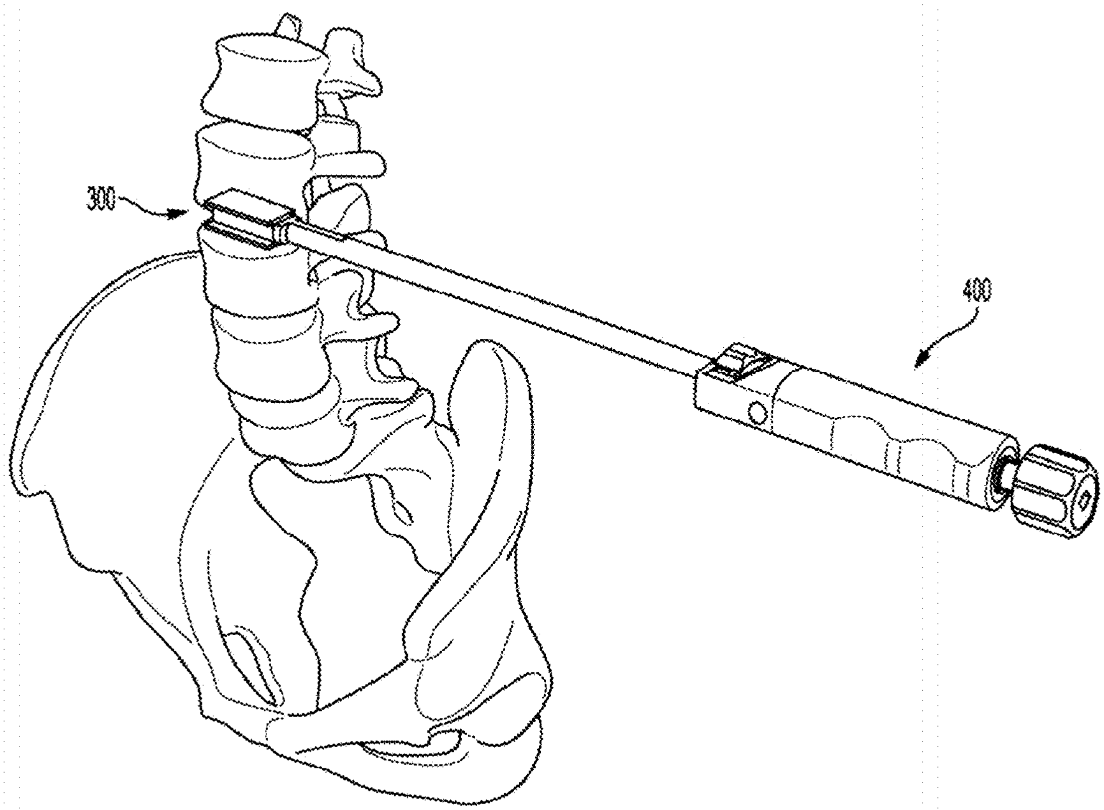


FIG. 34

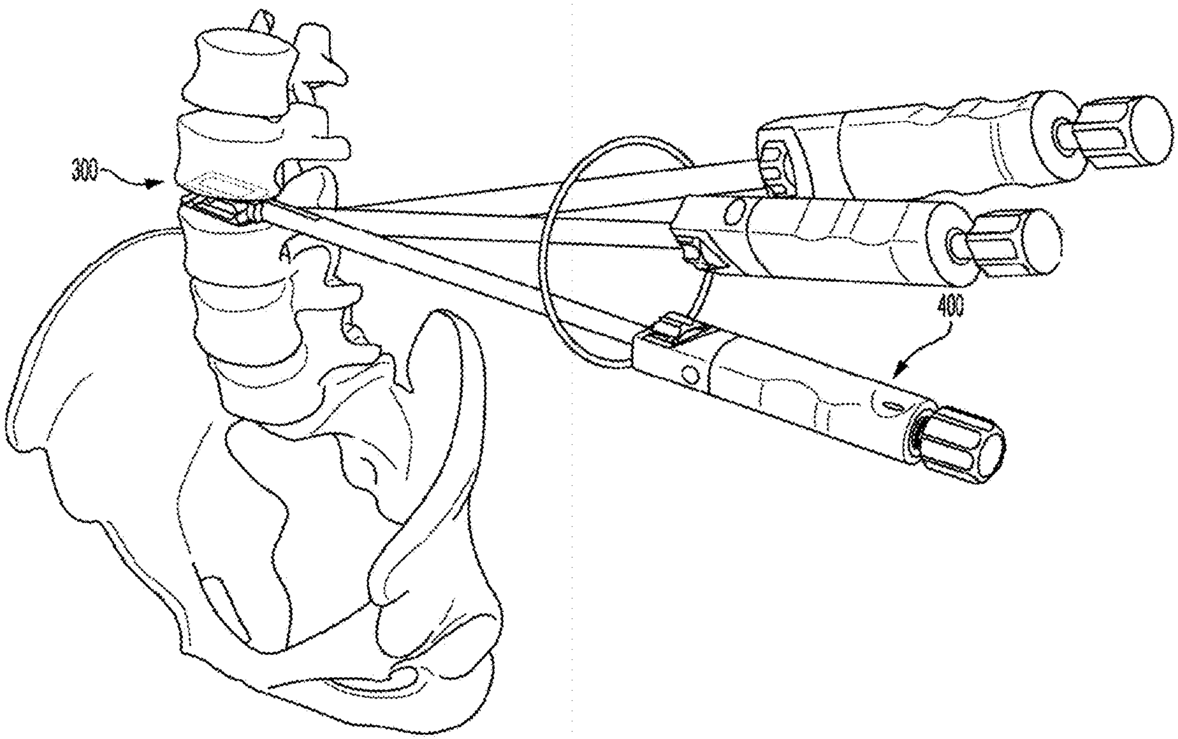


FIG. 35

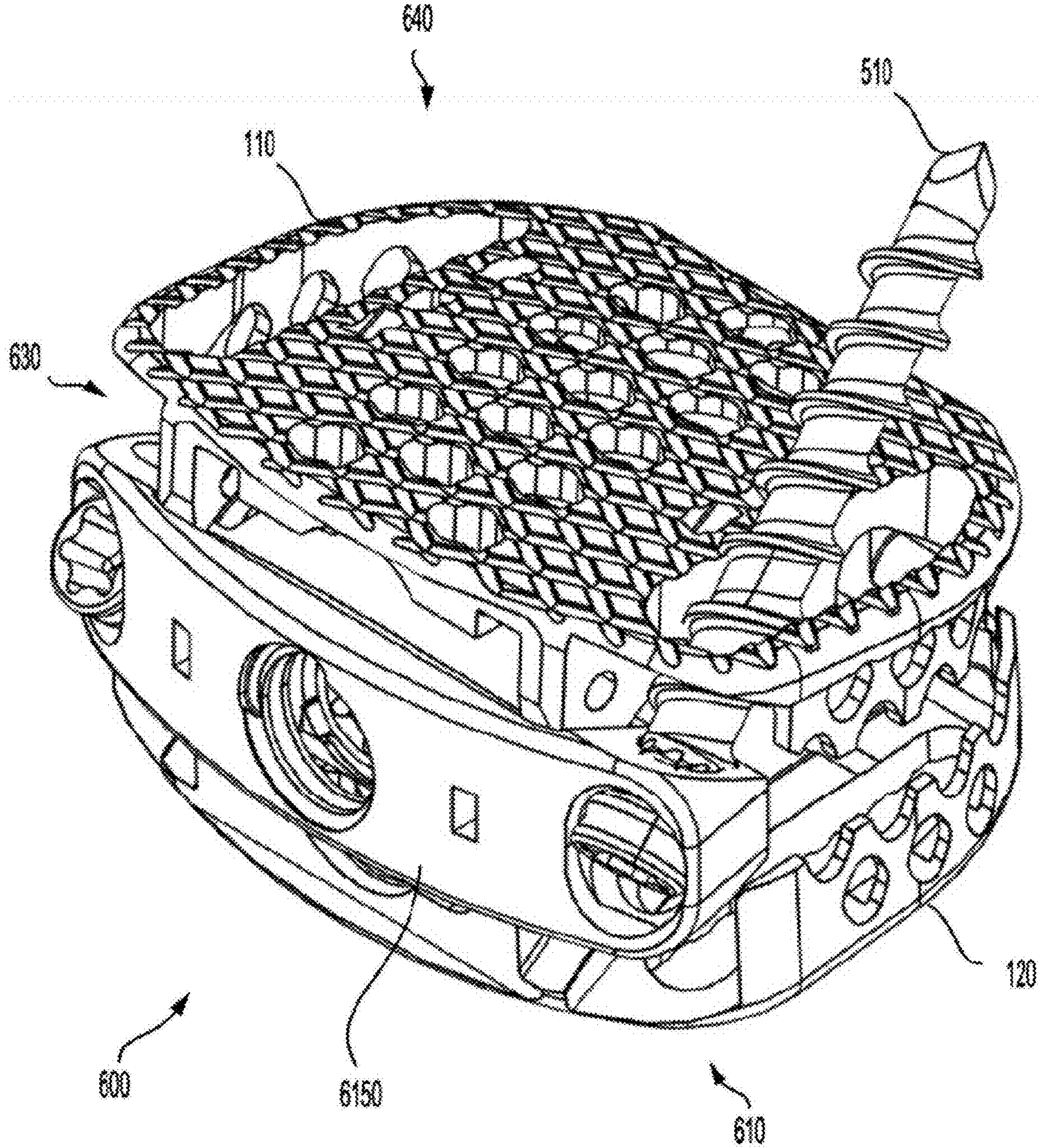


FIG. 36

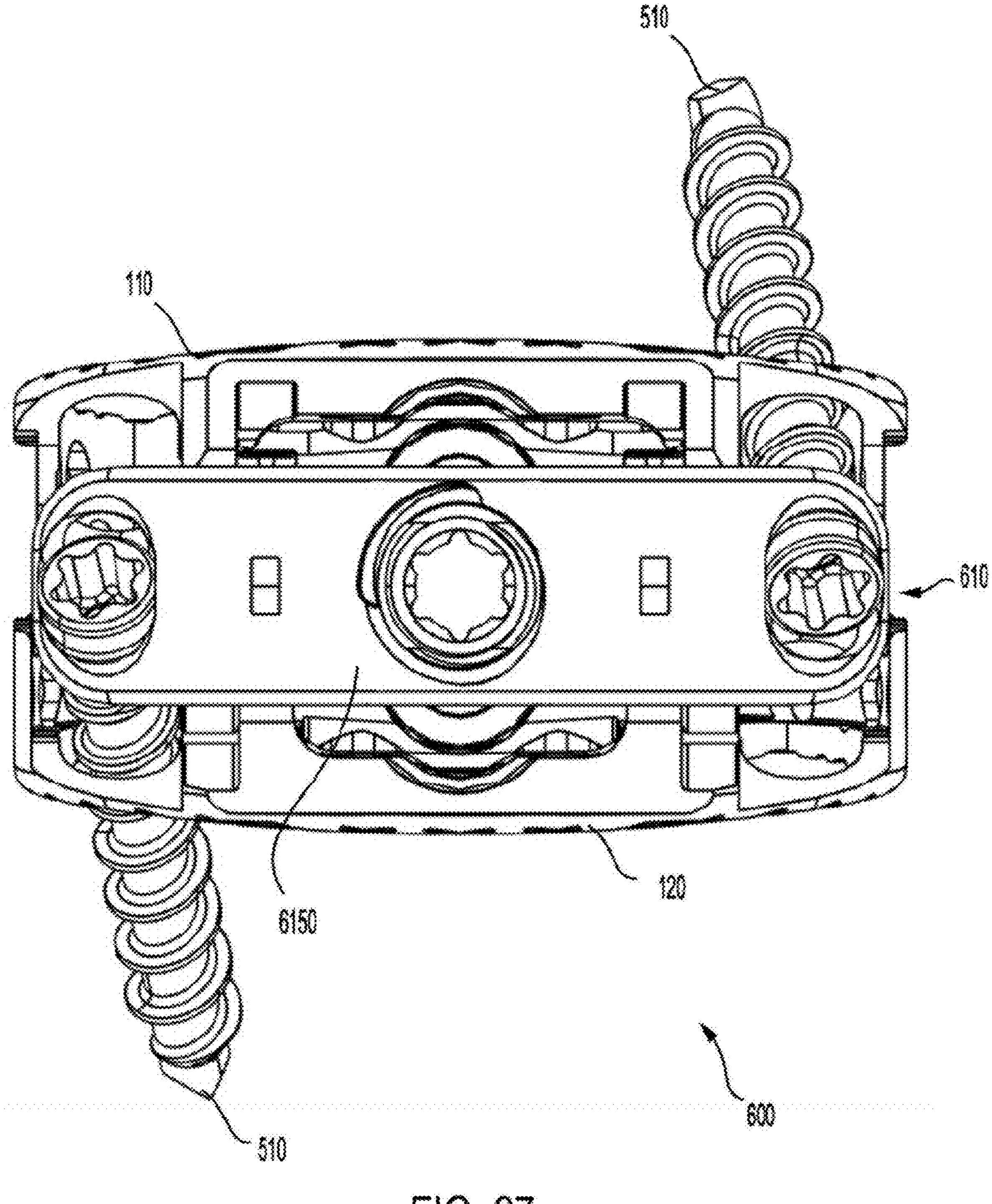


FIG. 37

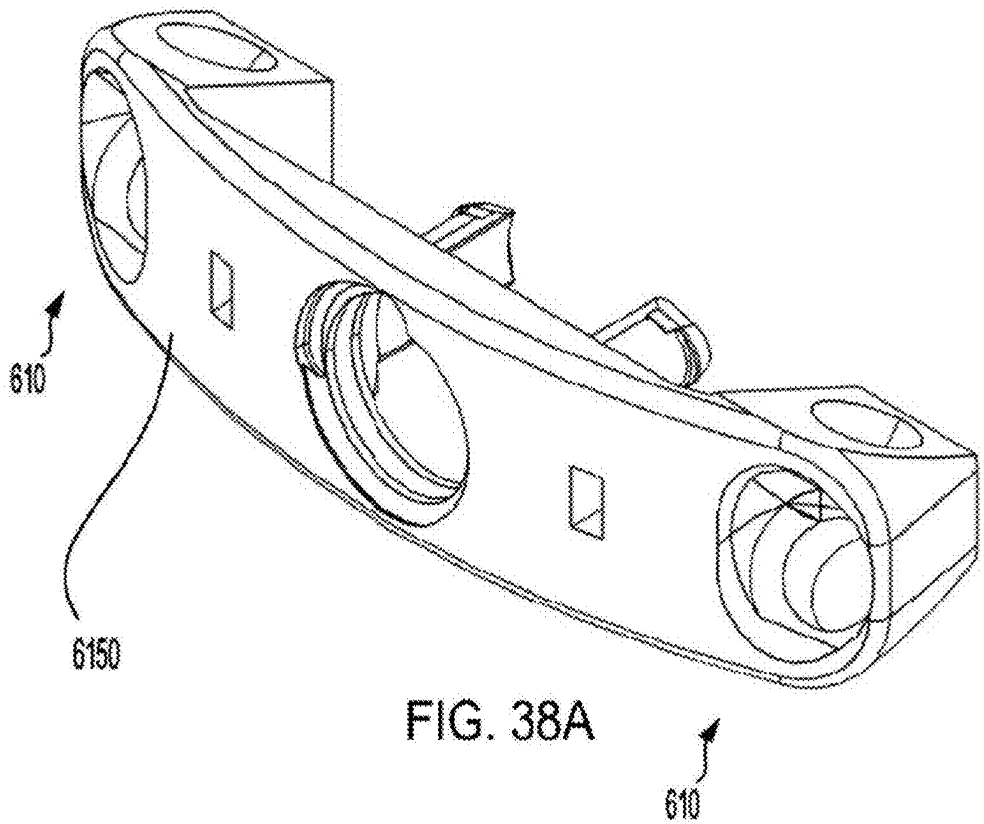


FIG. 38A

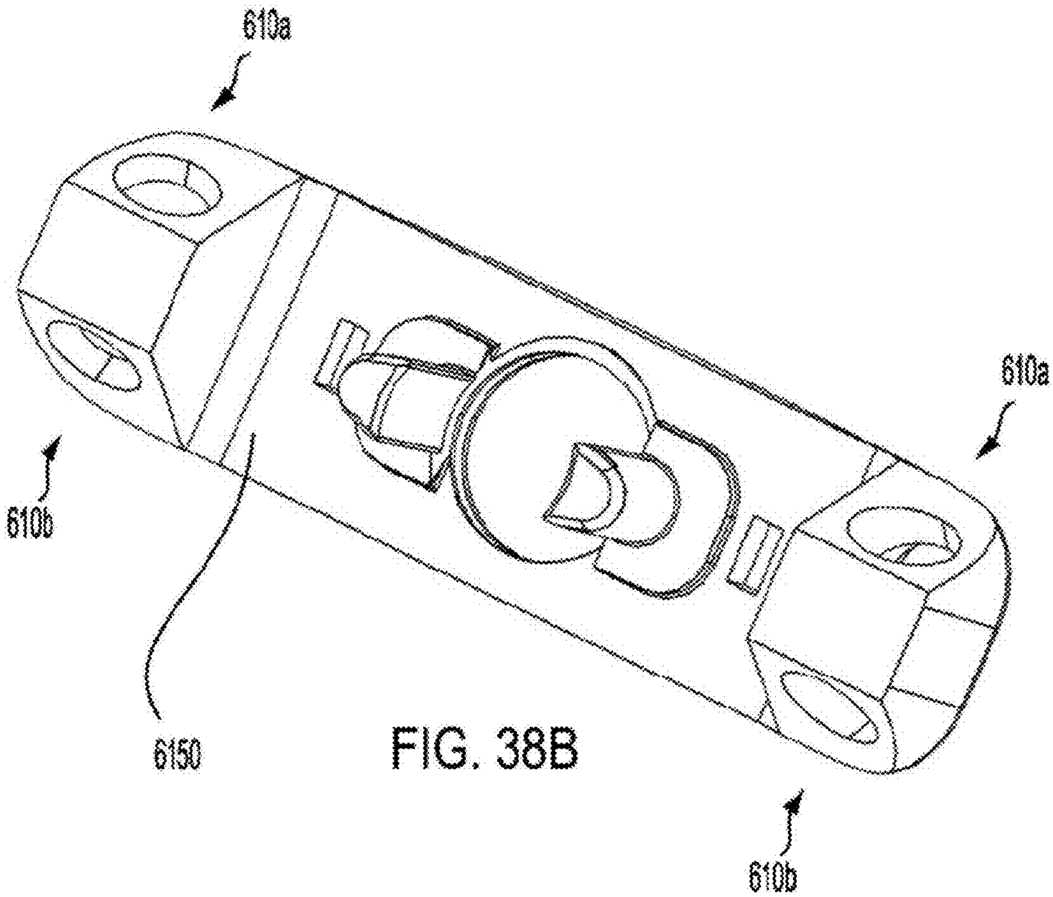


FIG. 38B

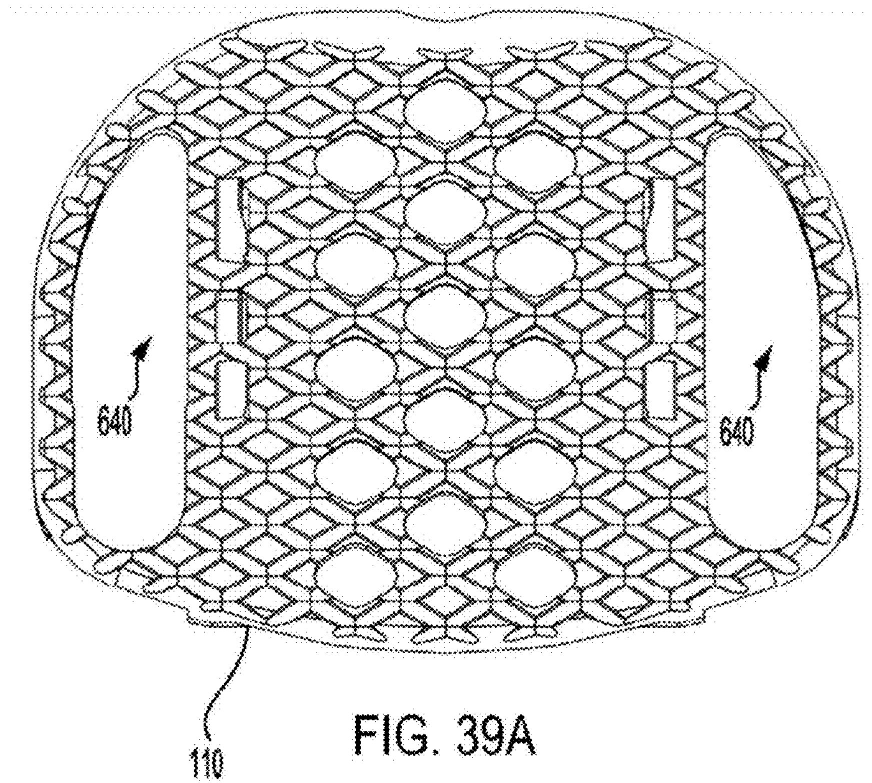


FIG. 39A

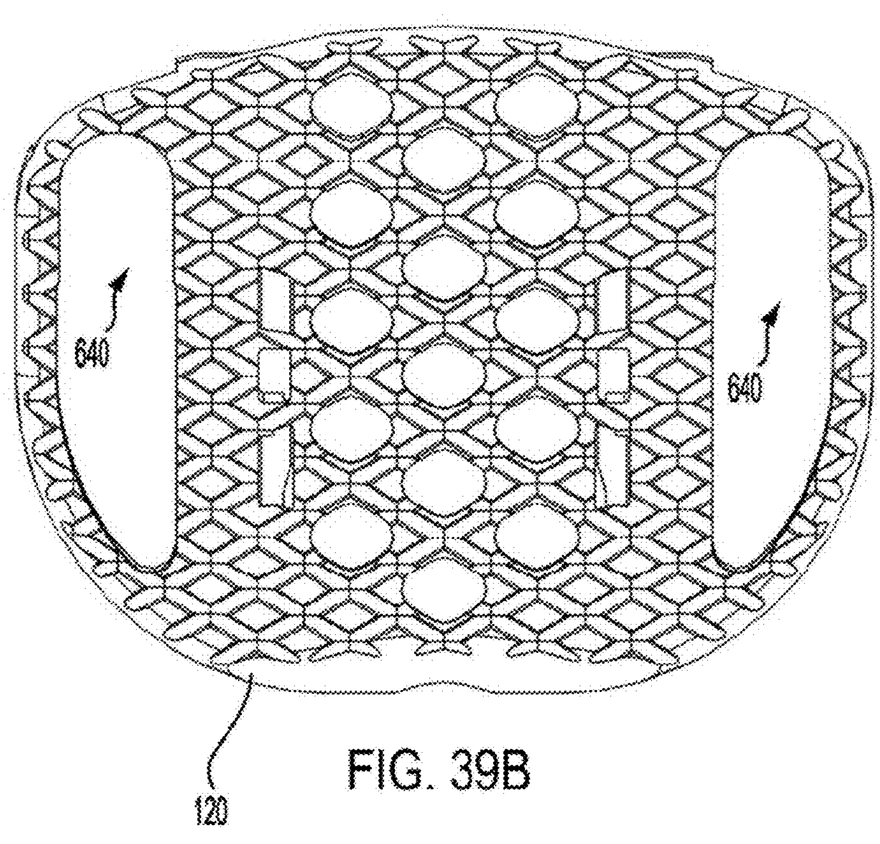


FIG. 39B

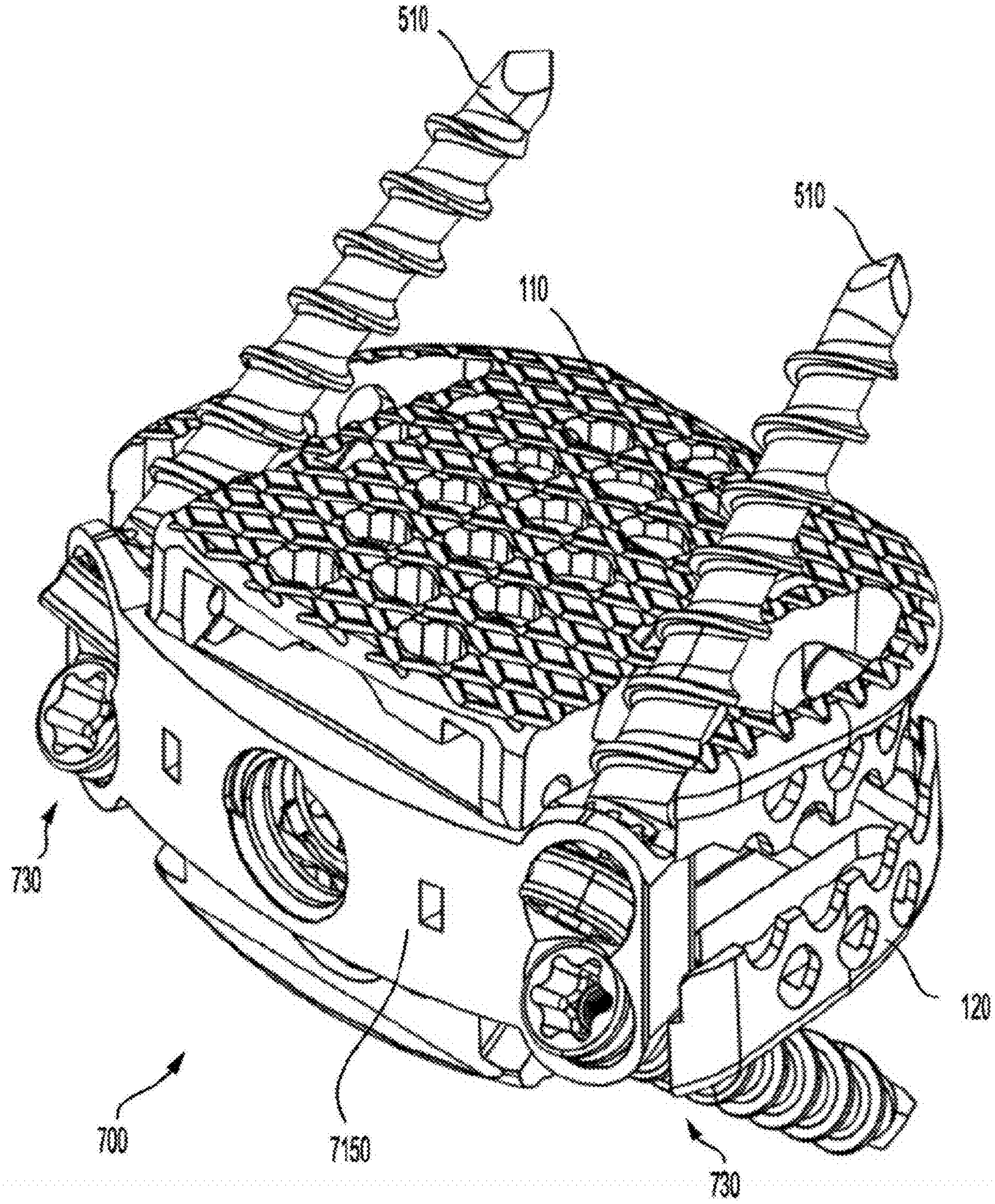


FIG. 40

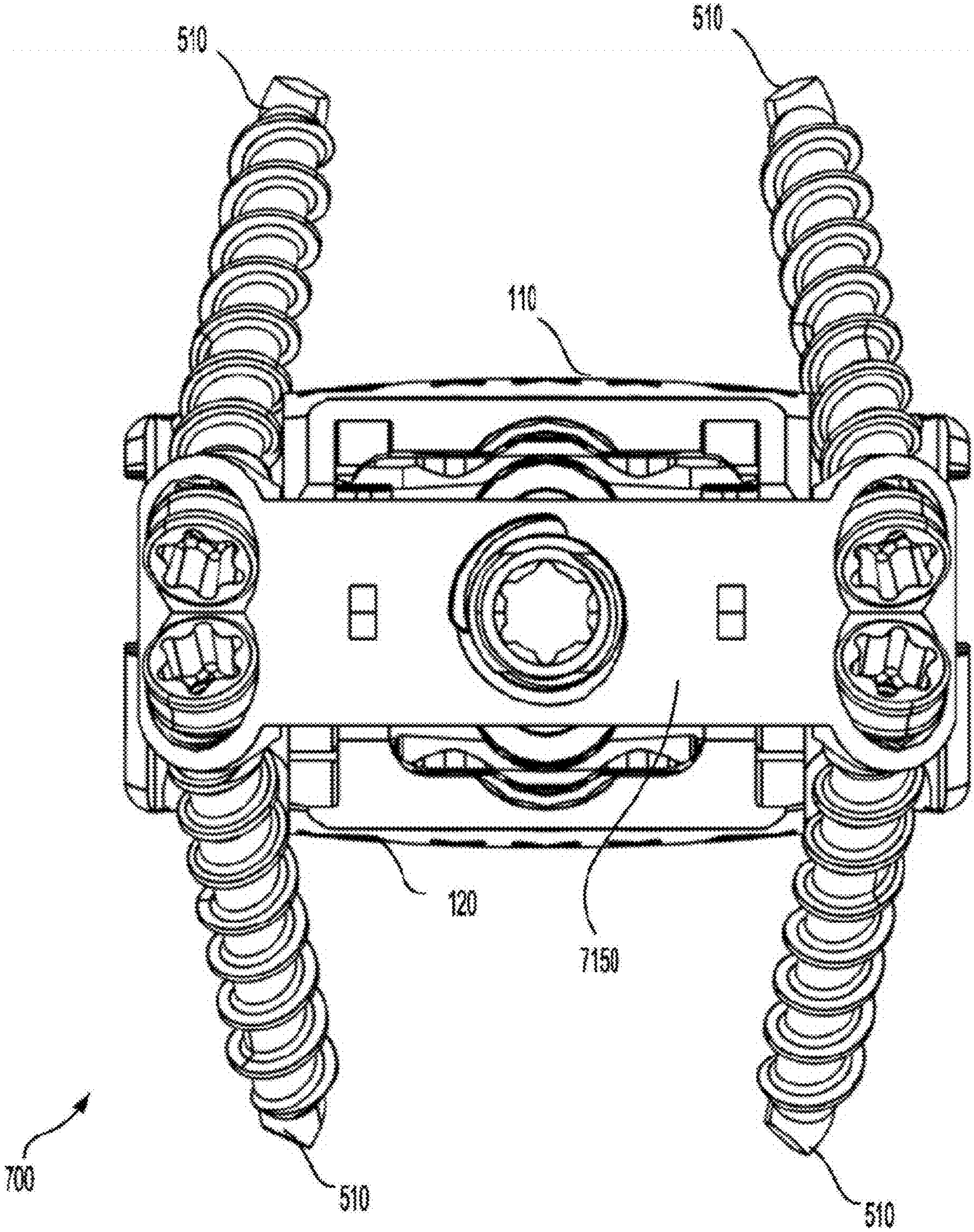


FIG. 41

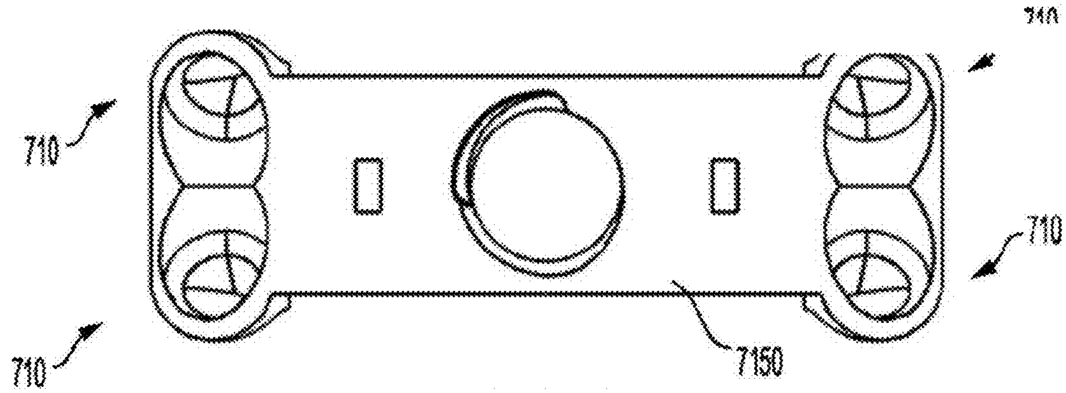


FIG. 42A

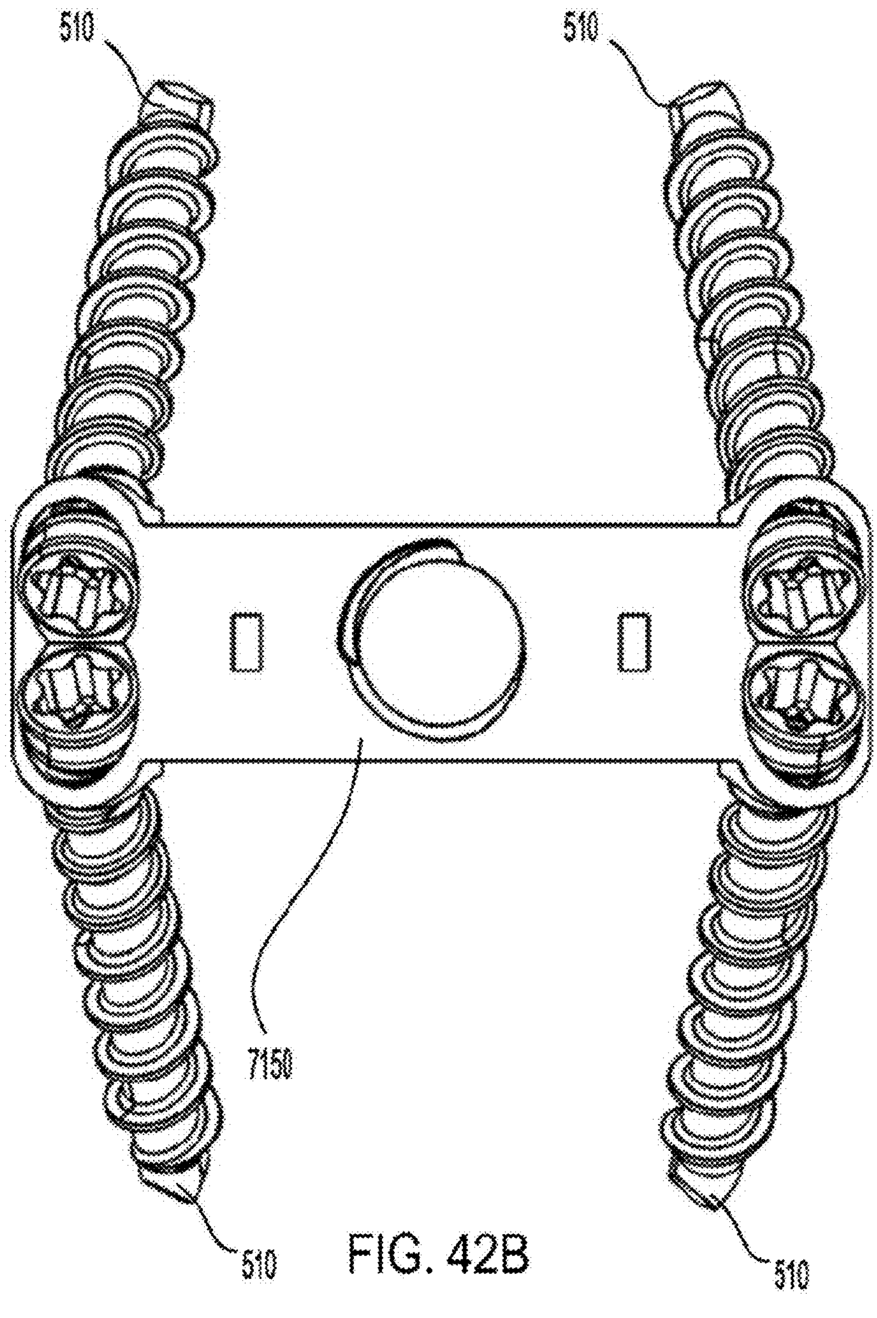


FIG. 42B

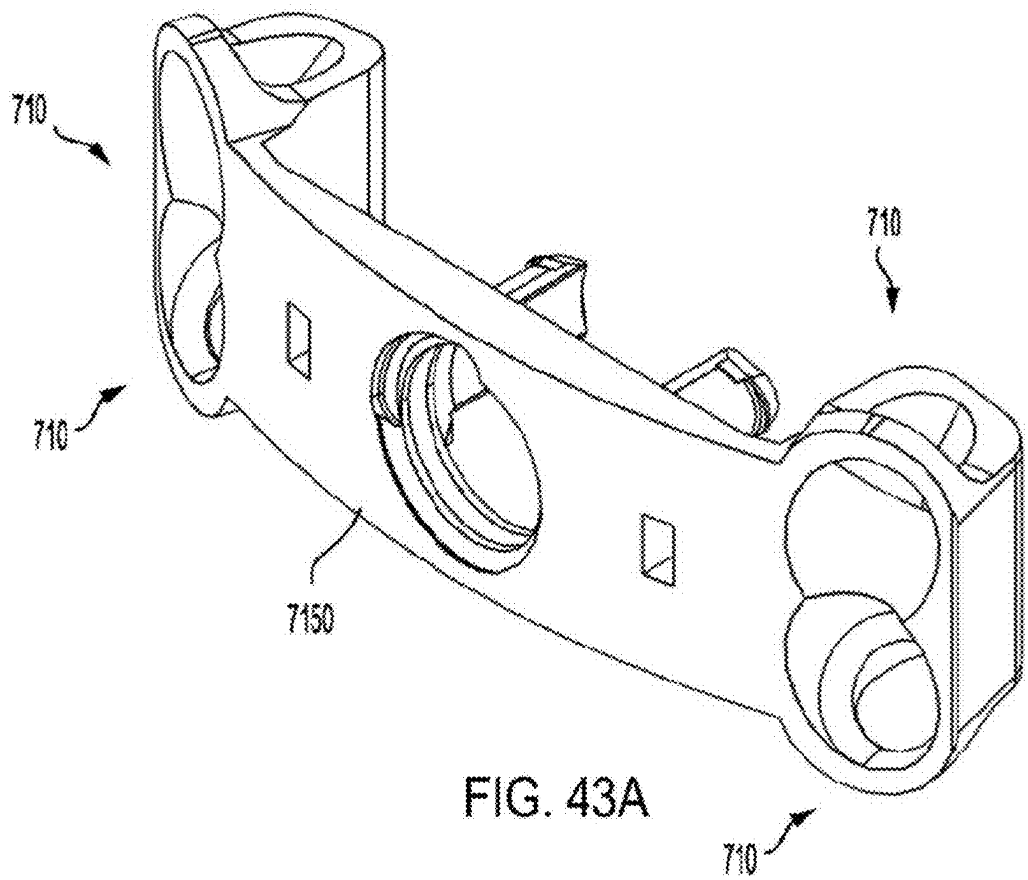


FIG. 43A

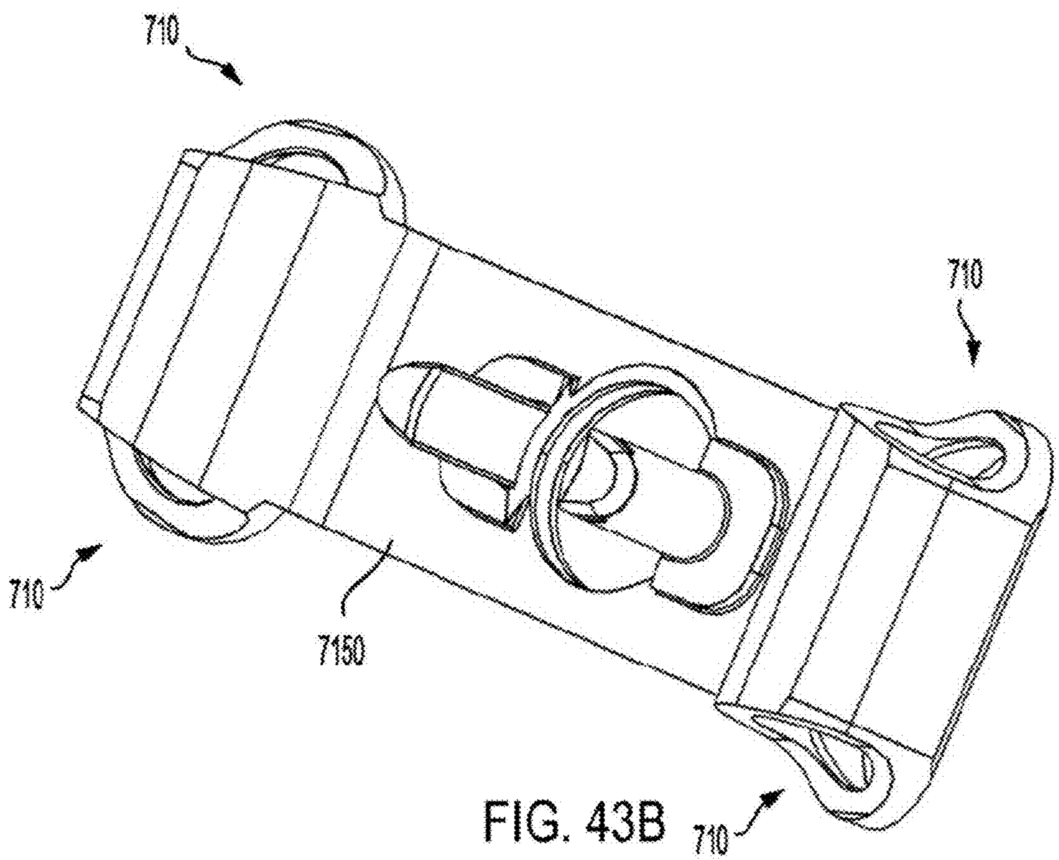


FIG. 43B

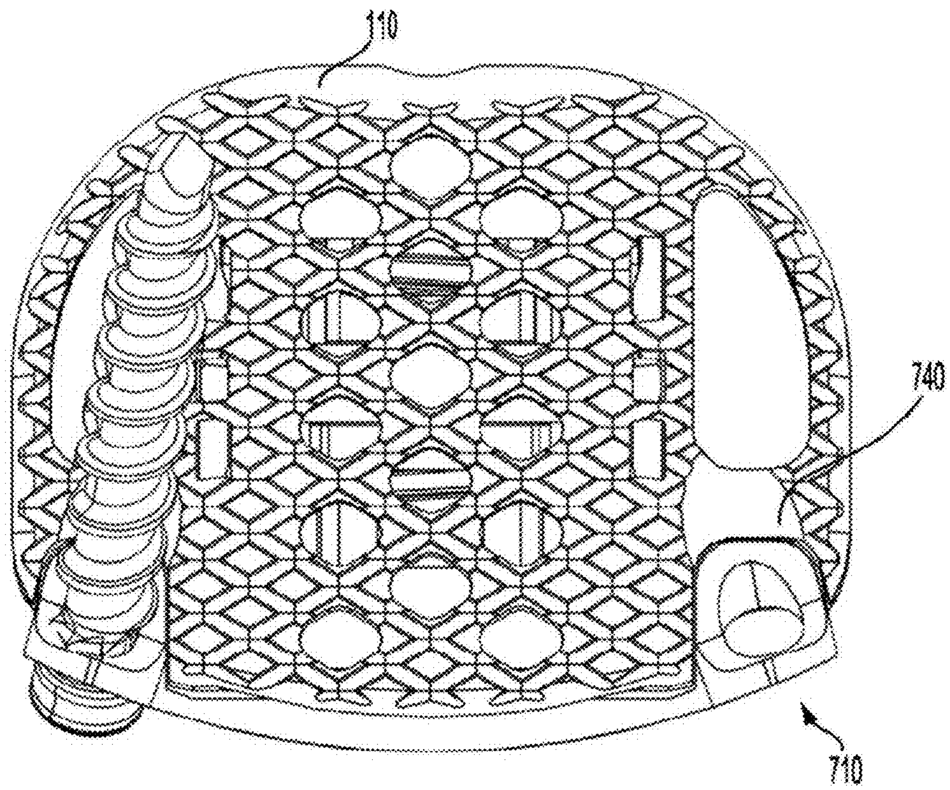


FIG. 44A

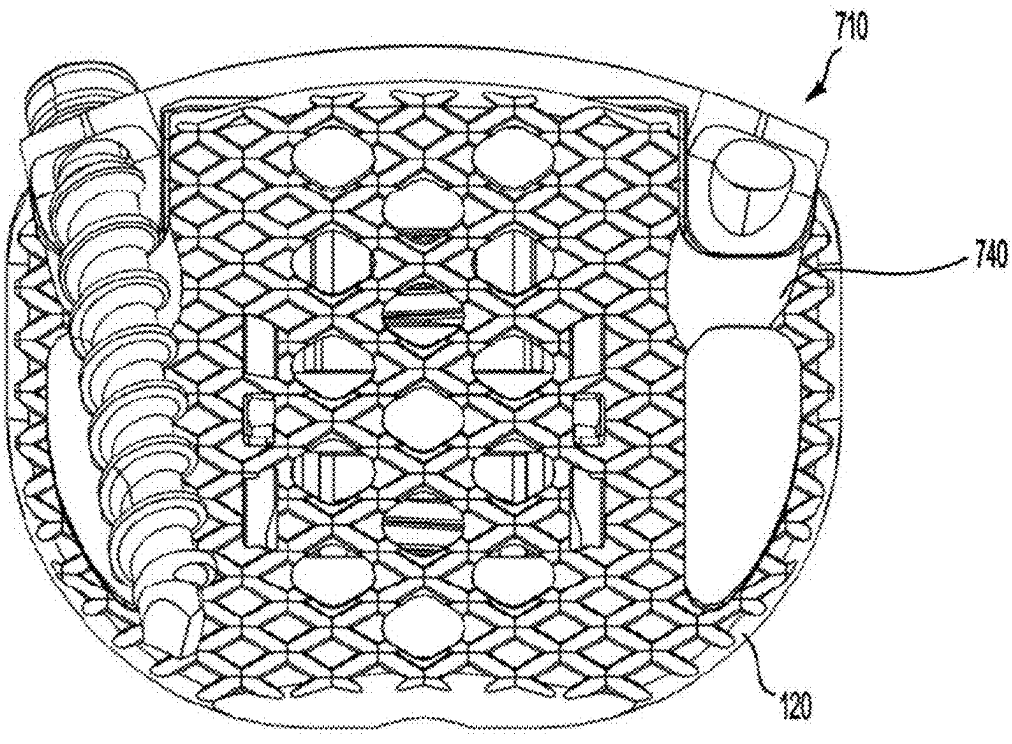


FIG. 44B

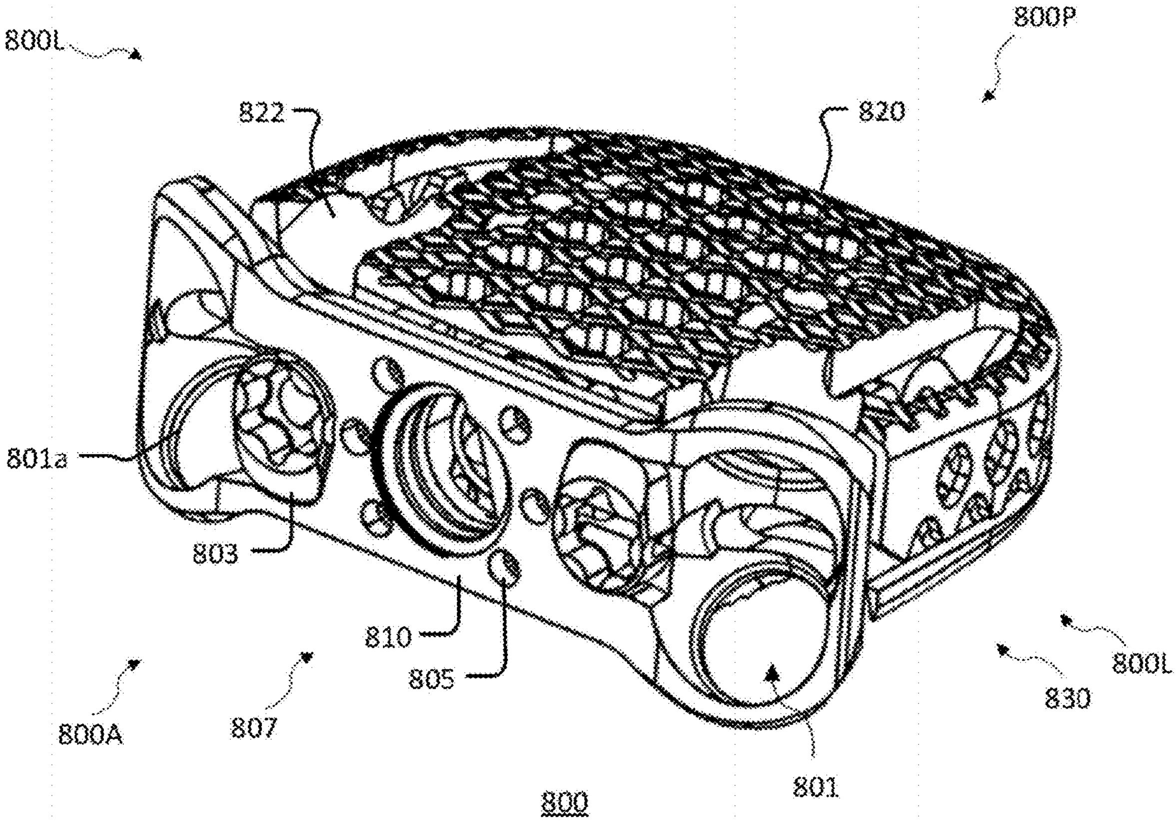


FIG. 45

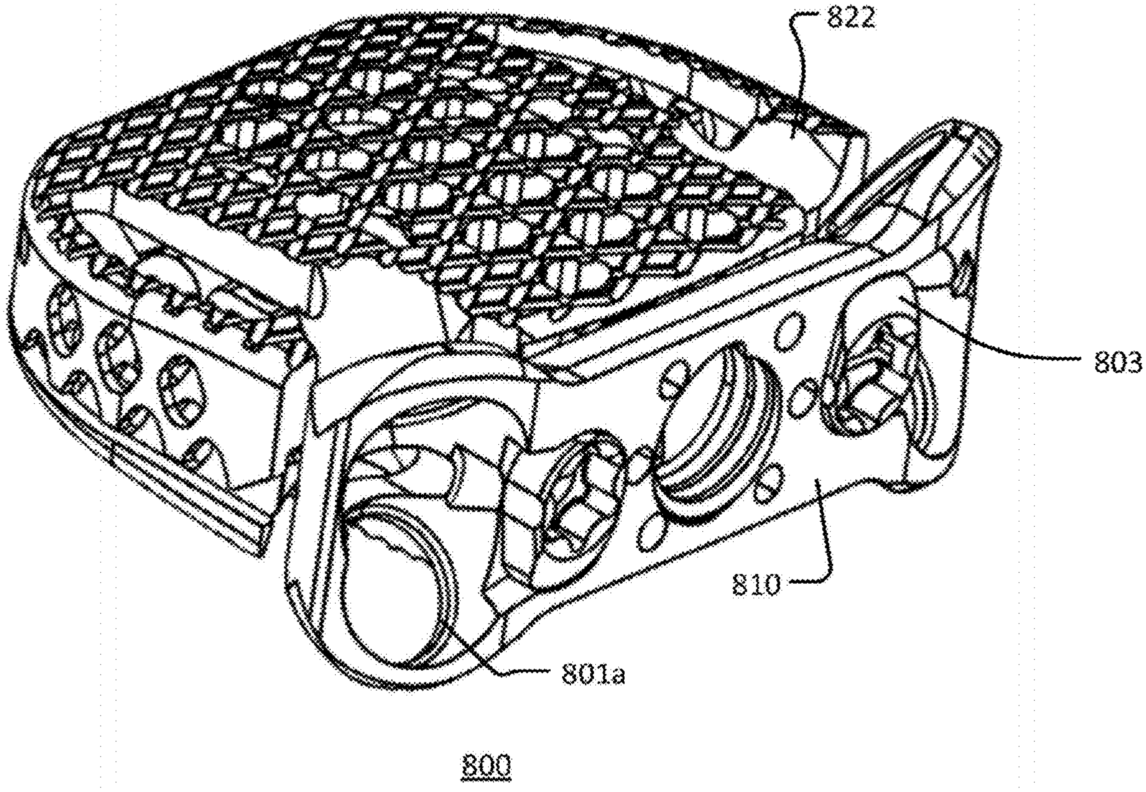


FIG. 46

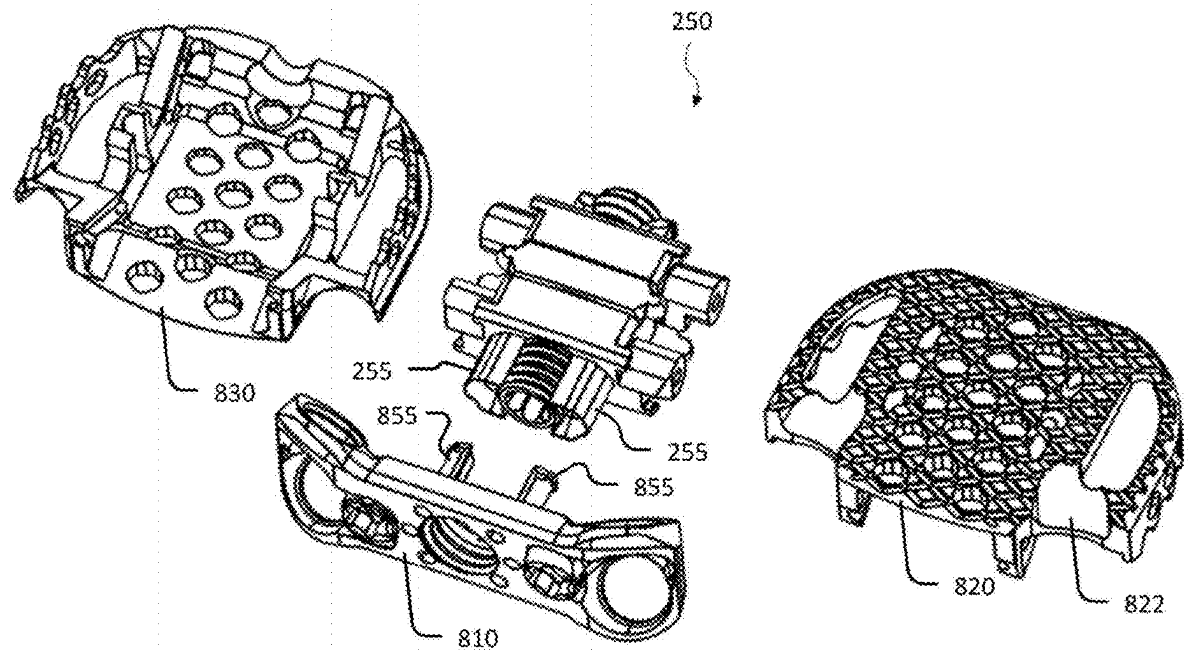


FIG. 47

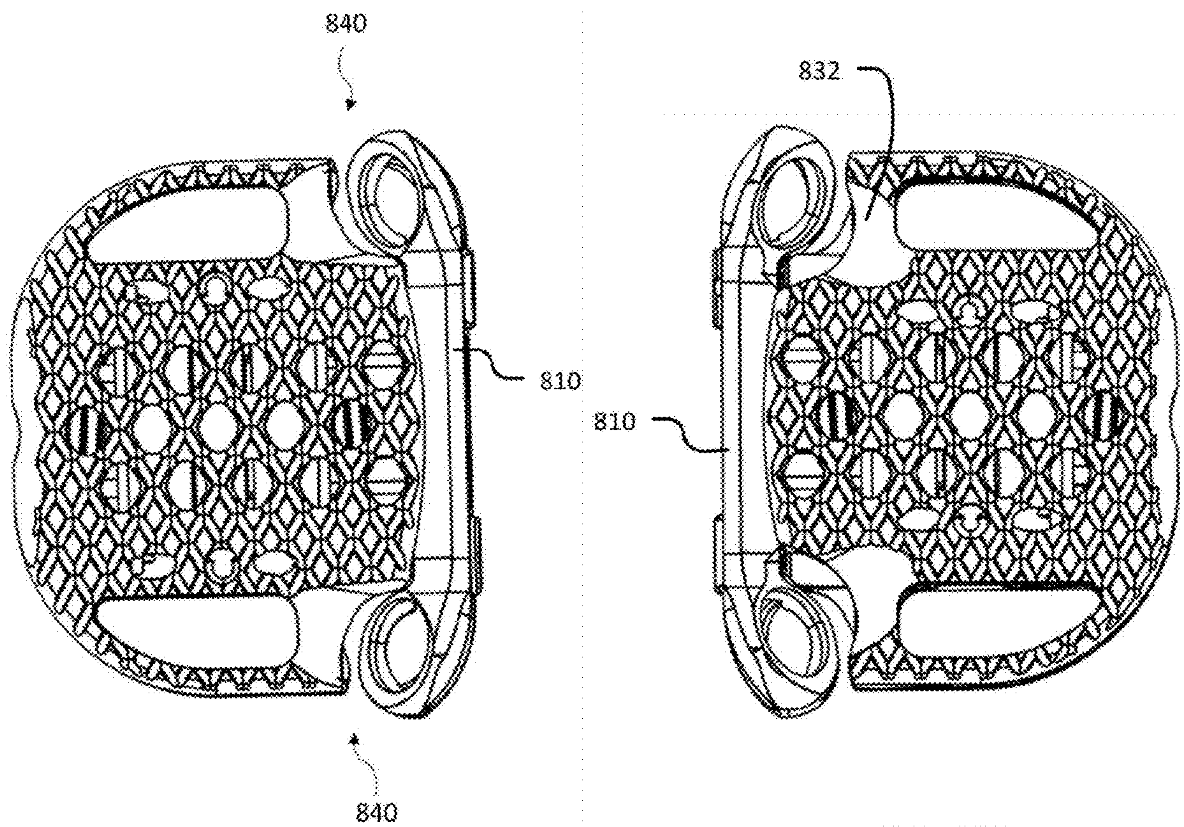


FIG. 48A

FIG. 48B

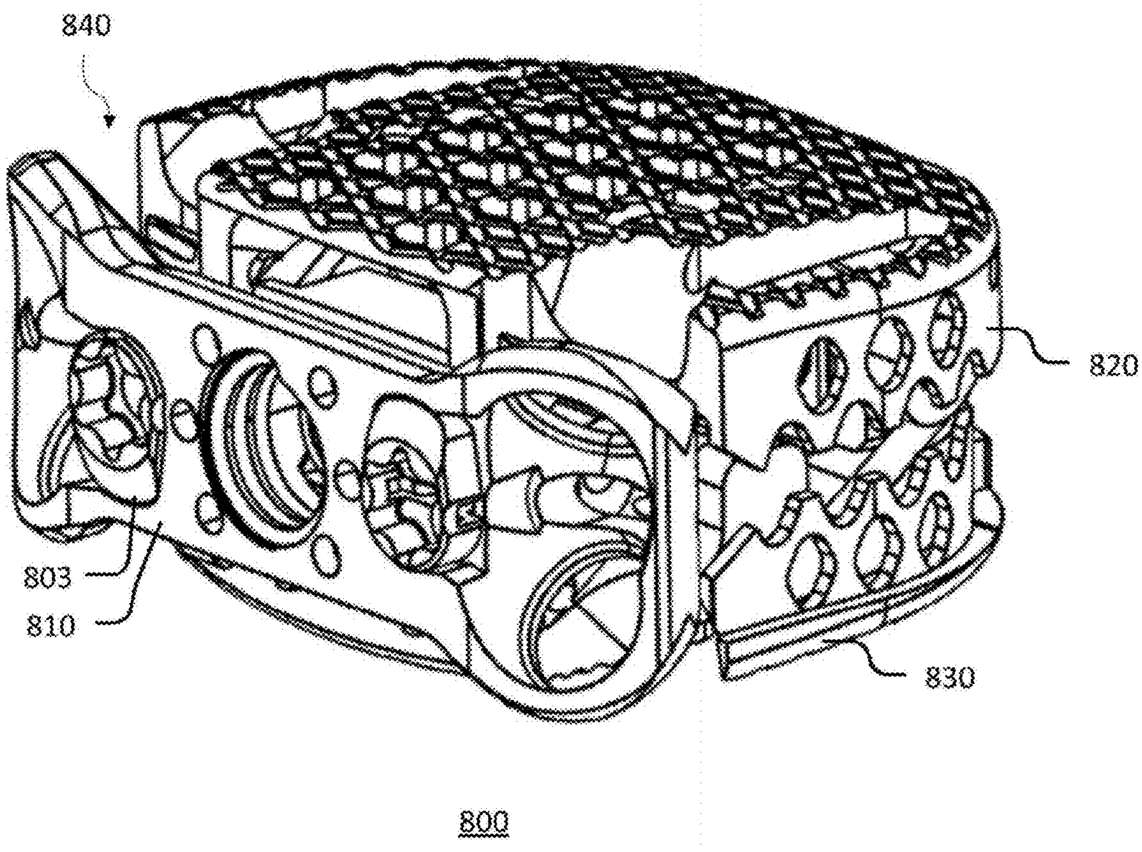
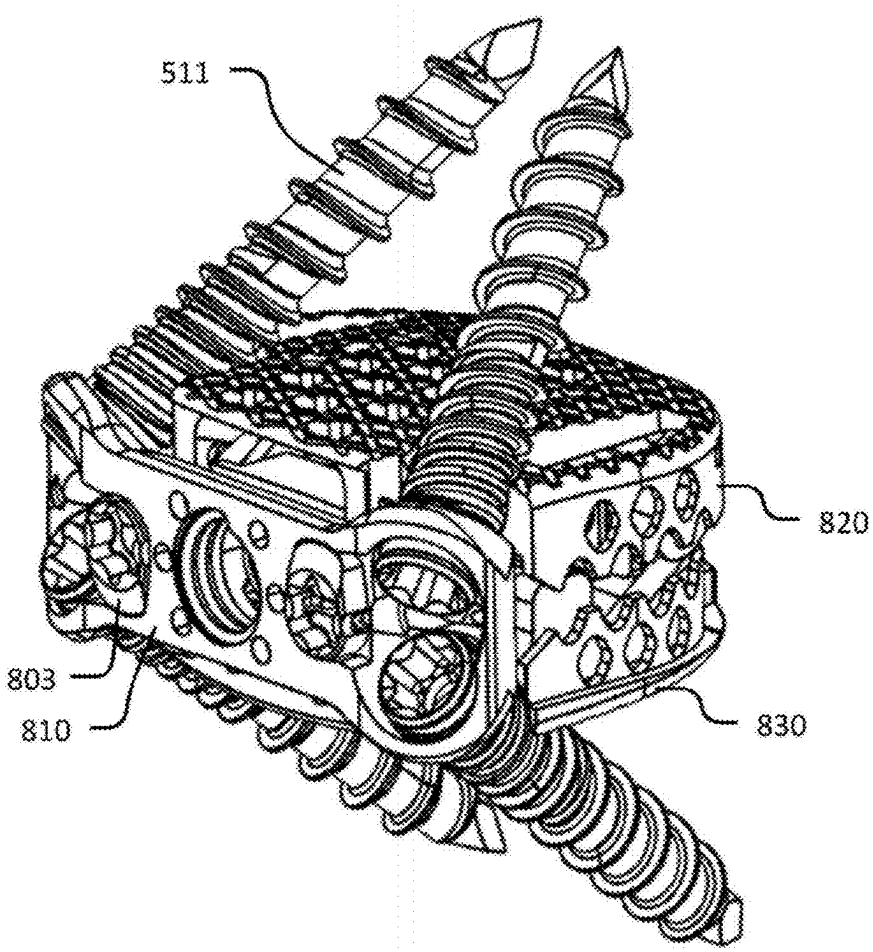
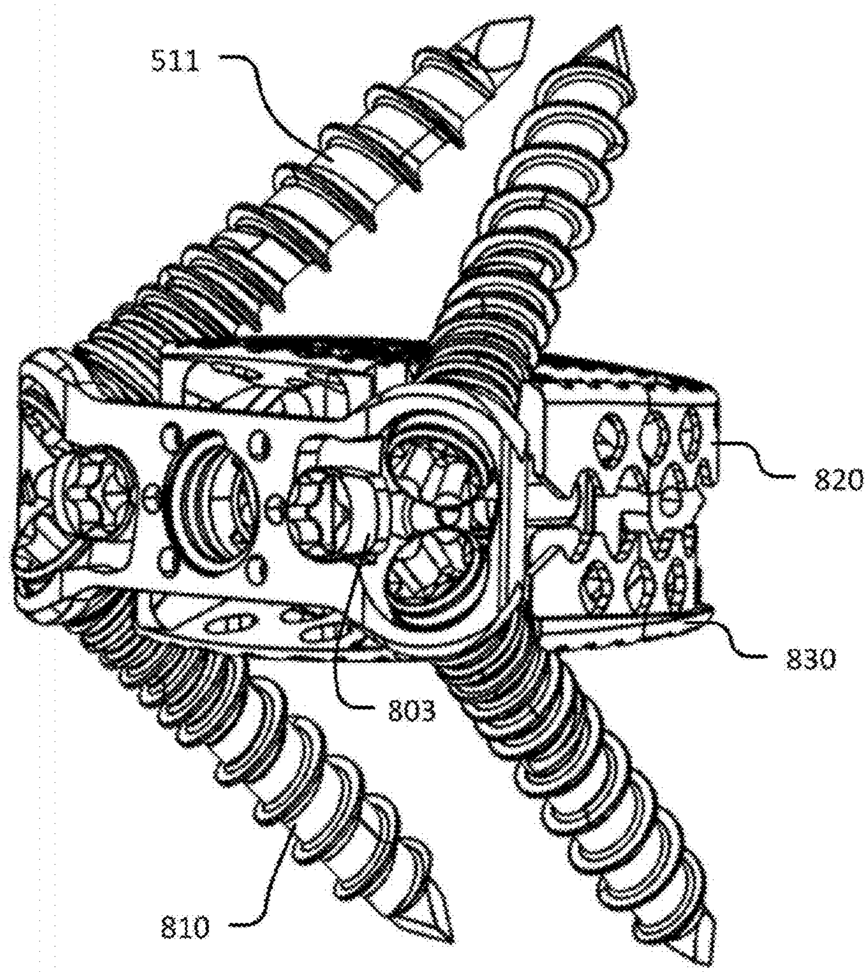


FIG. 48C



800

FIG. 49



800
FIG. 50

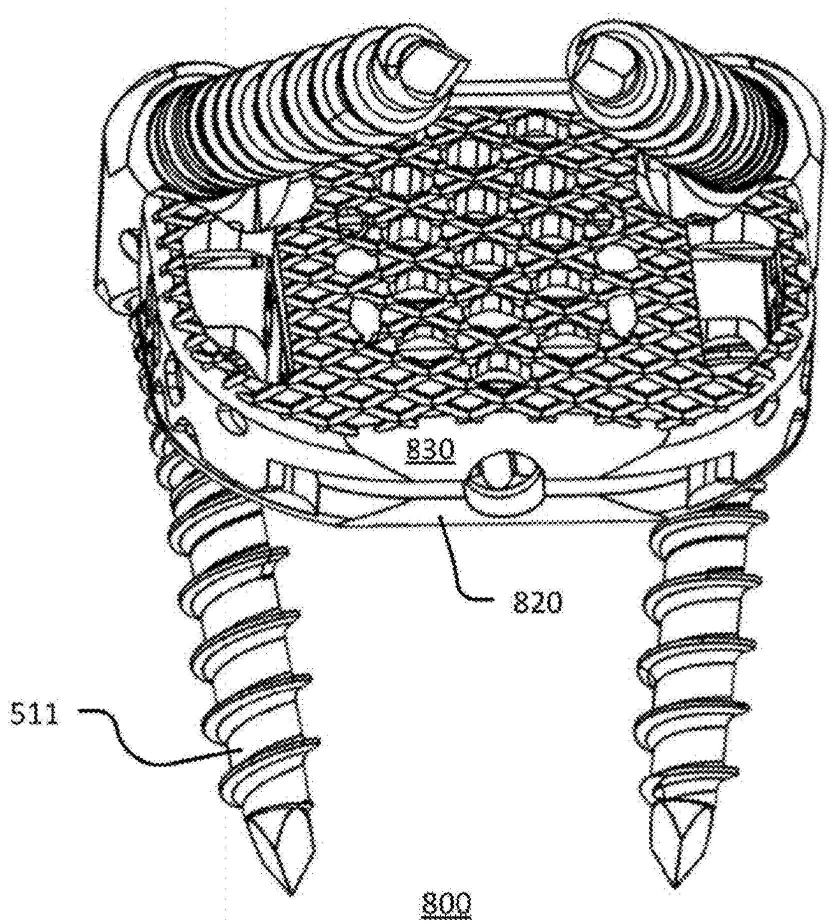


FIG. 51

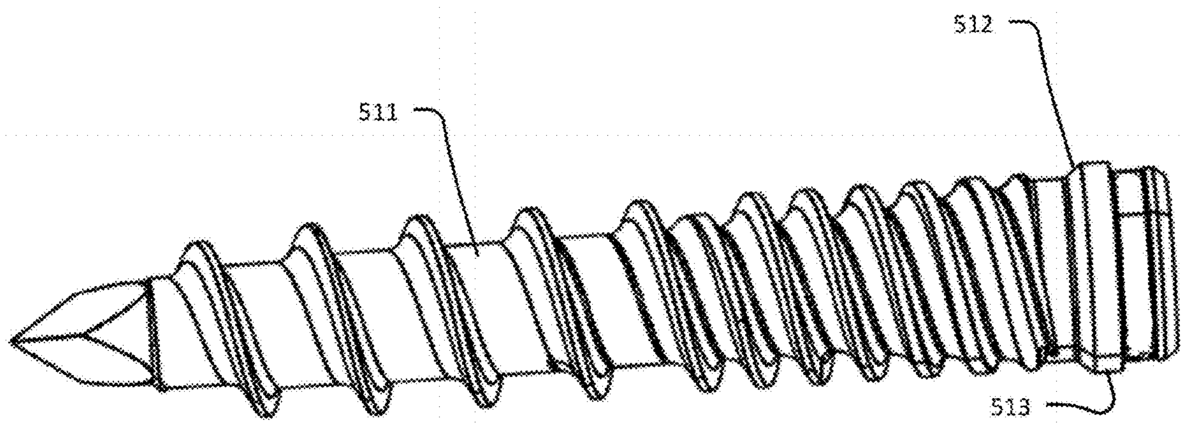


FIG. 52

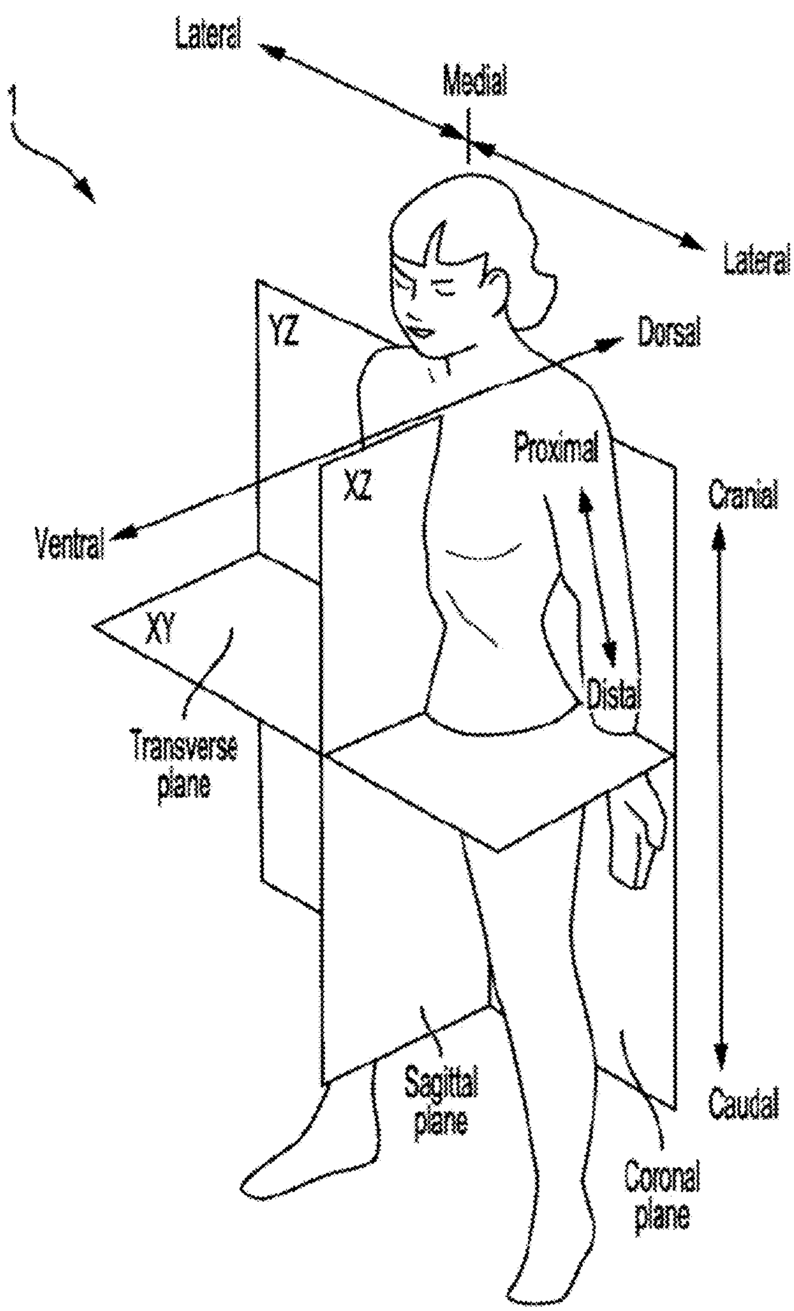
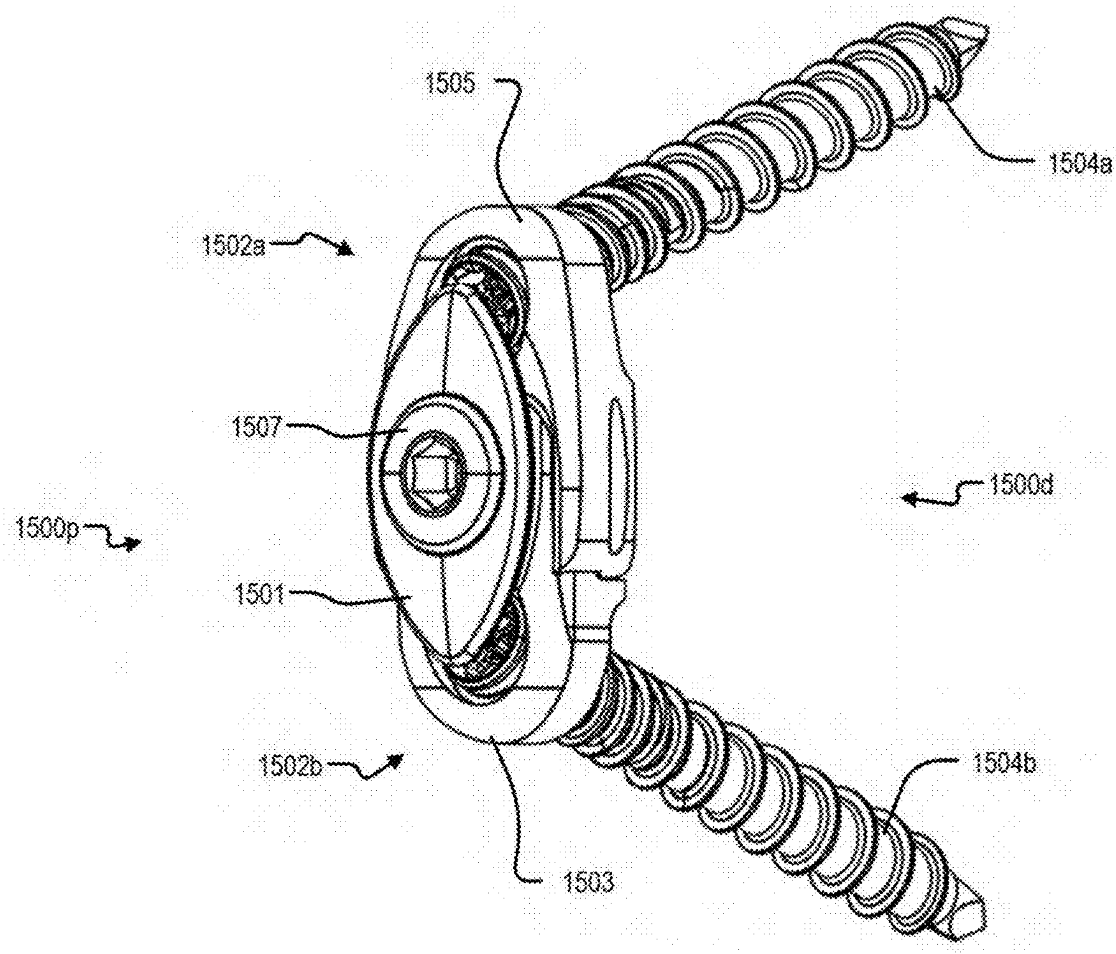

1
Lateral
Medial
Lateral
YZ
Dorsal
Proximal
XZ
Cranial
Ventral
XY
Distal
Transverse plane
Sagittal plane
Caudal
Coronal plane

FIG. 53



1500

FIG. 54

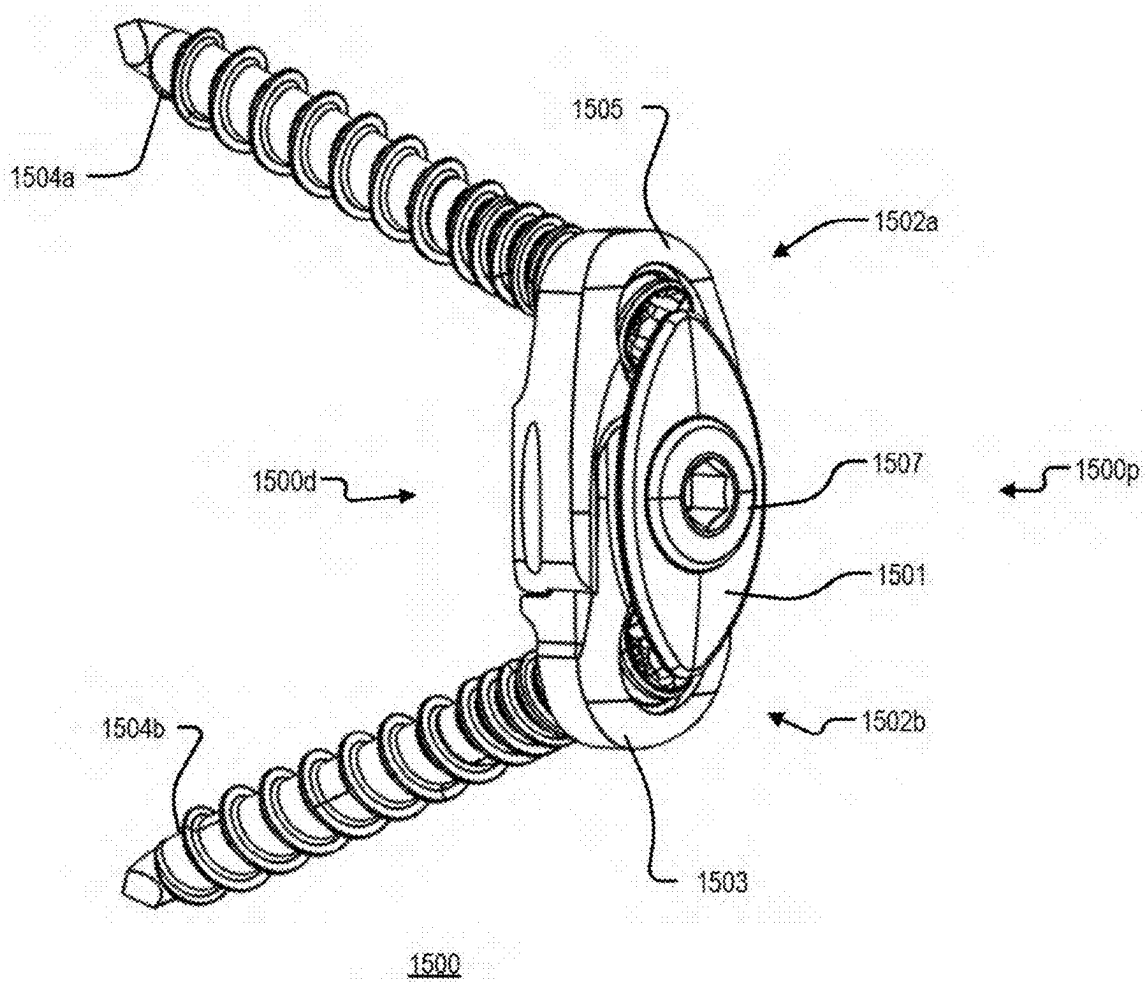

1505
1504a
1502a
1500d
1507
1500p
1501
1504b
1502b
1503
1500

FIG. 55

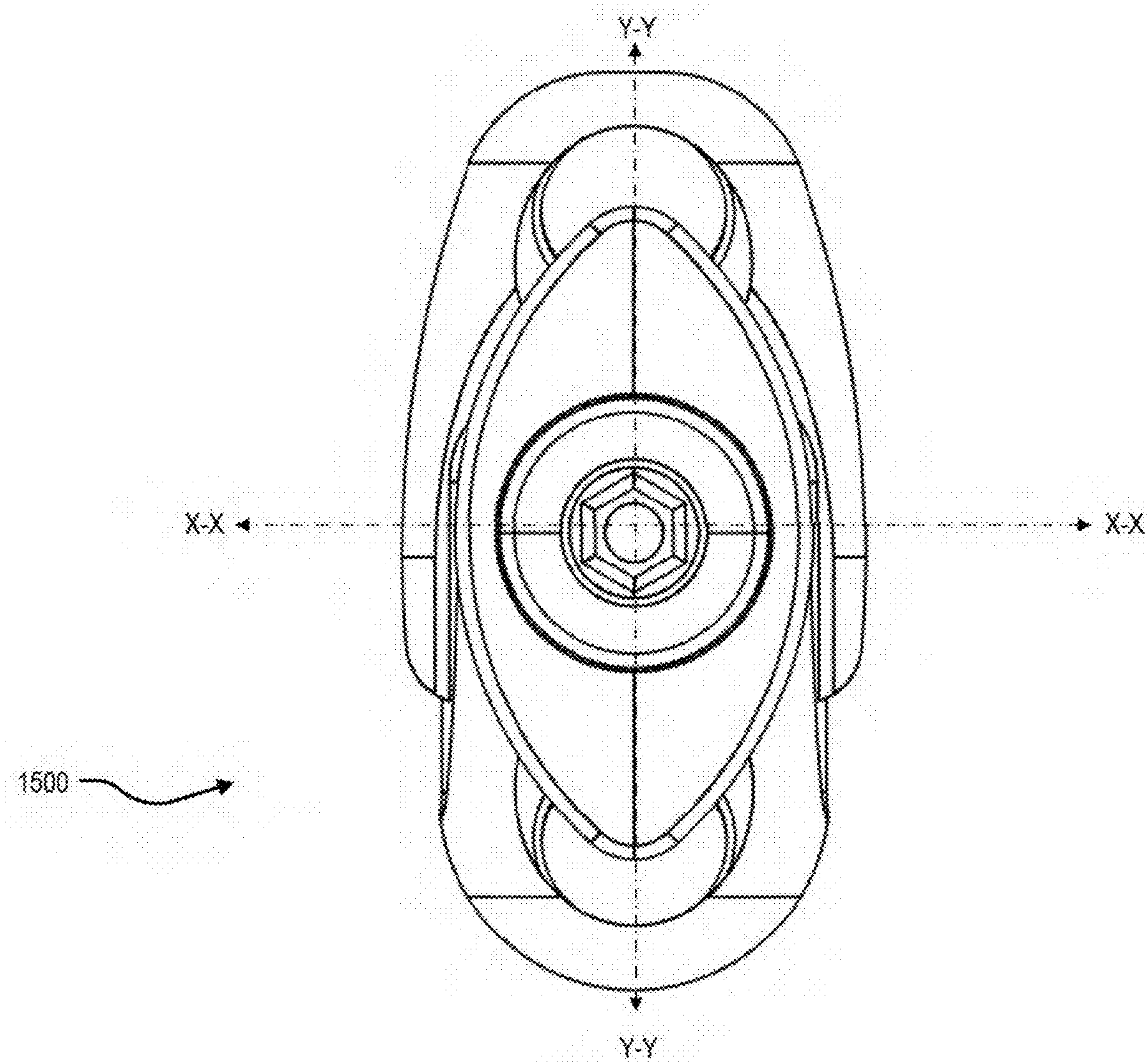


FIG. 56

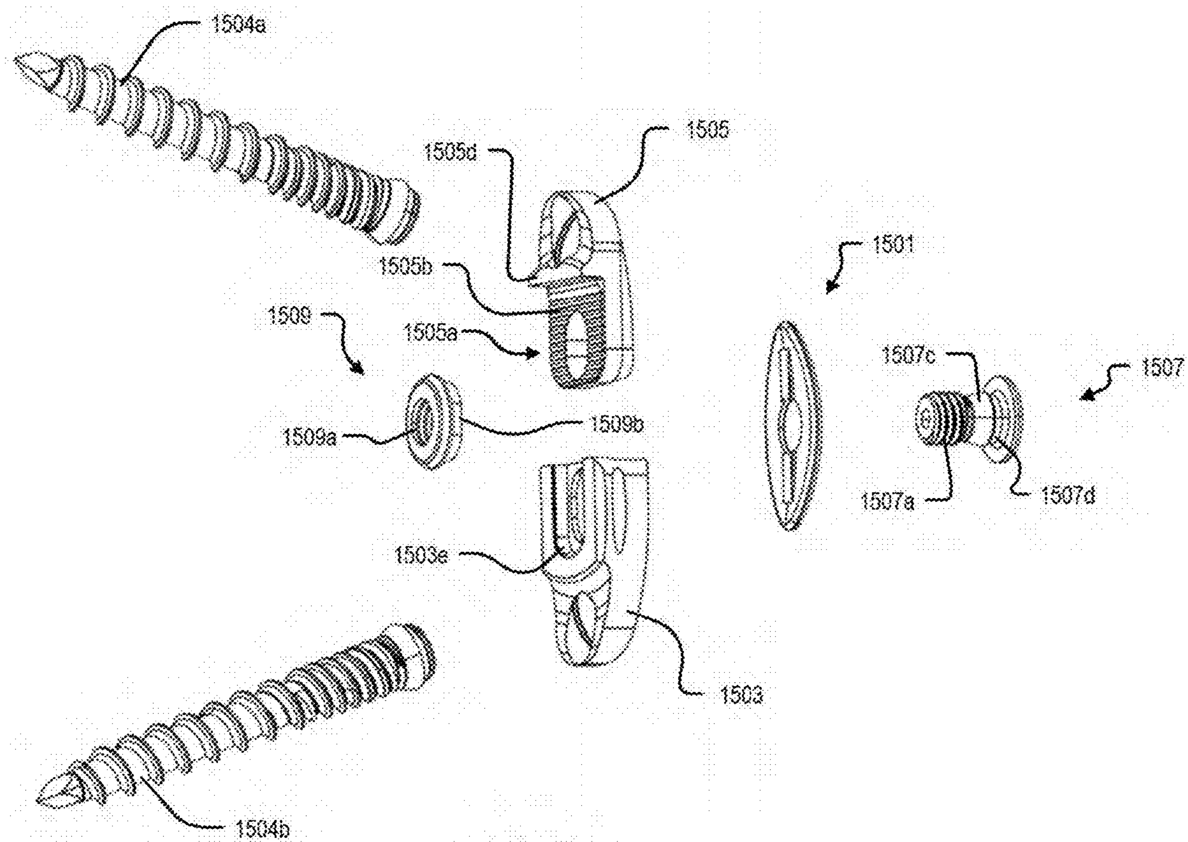

1504a
1505d
1505
1501
1505b
1509
1505a
1507c
1507
1509a
1509b
1507a
1507d
1503e
1503
1504b

FIG. 57

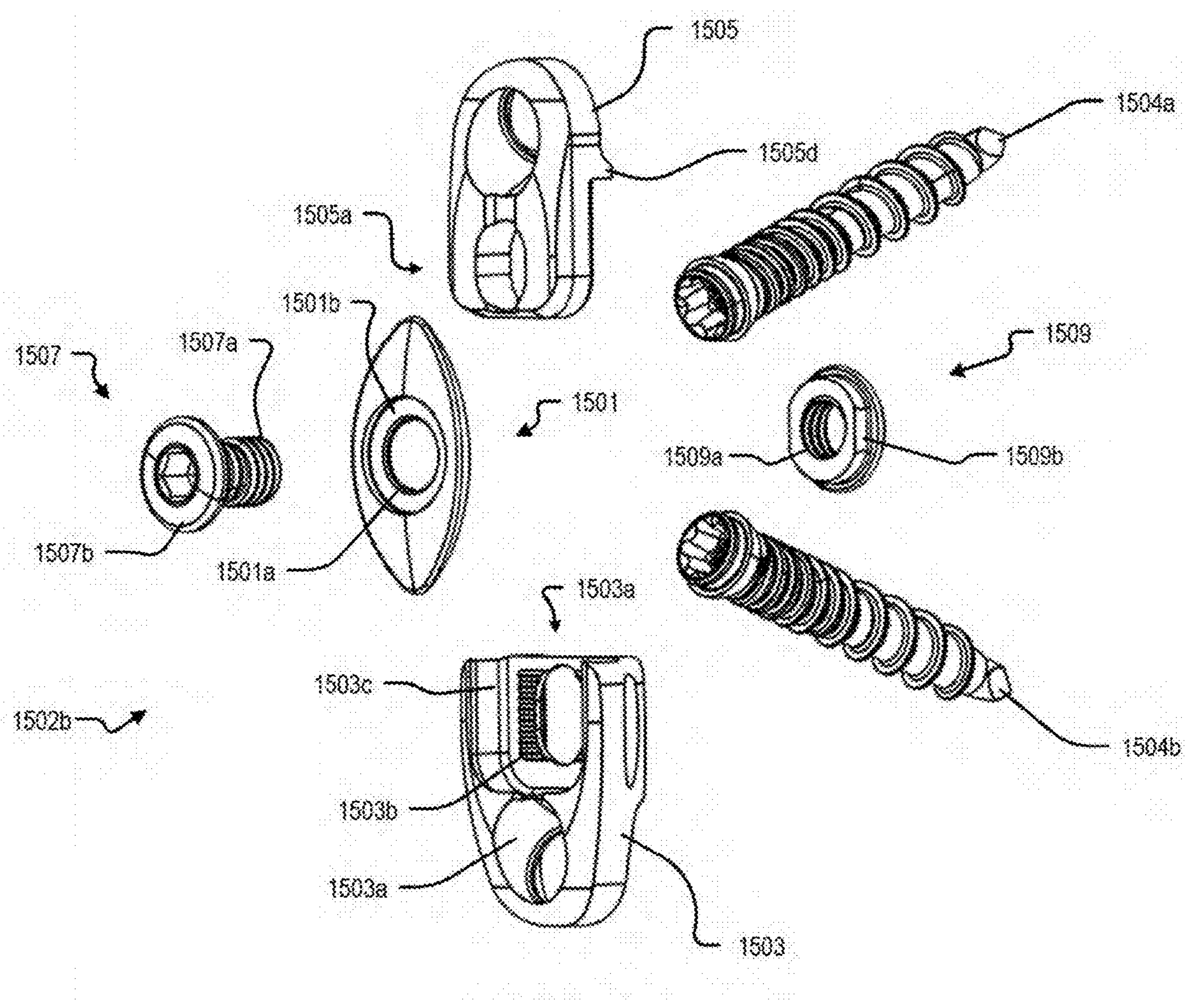

1505
1504a
1505d
1505a
1501b
1509
1507a
1507
1501
1509a
1509b
1507b
1501a
1503a
1503c
1502b
1504b
1503b
1503a
1503

FIG. 58

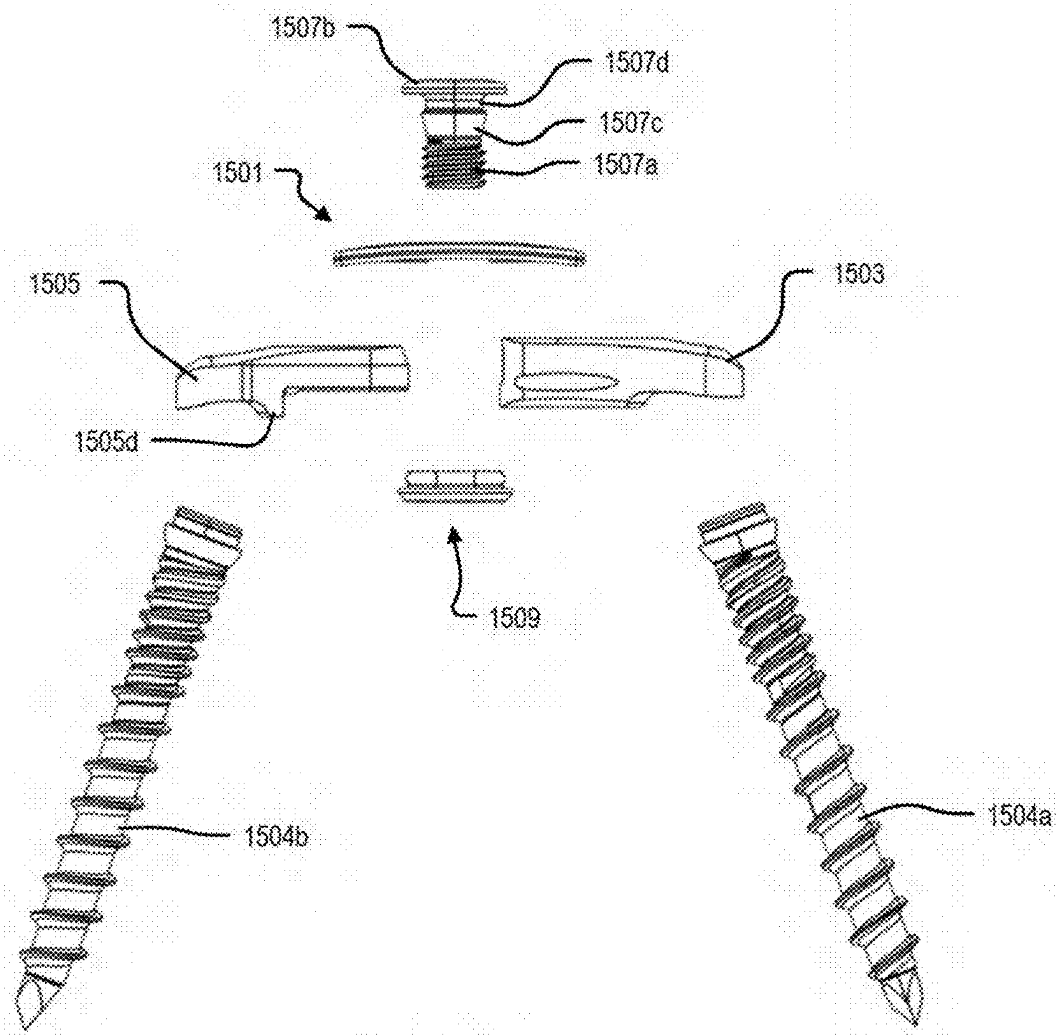

1507b
1507d
1507c
1507a
1501
1505
1503
1505d
1509
1504b
1504a

FIG. 59

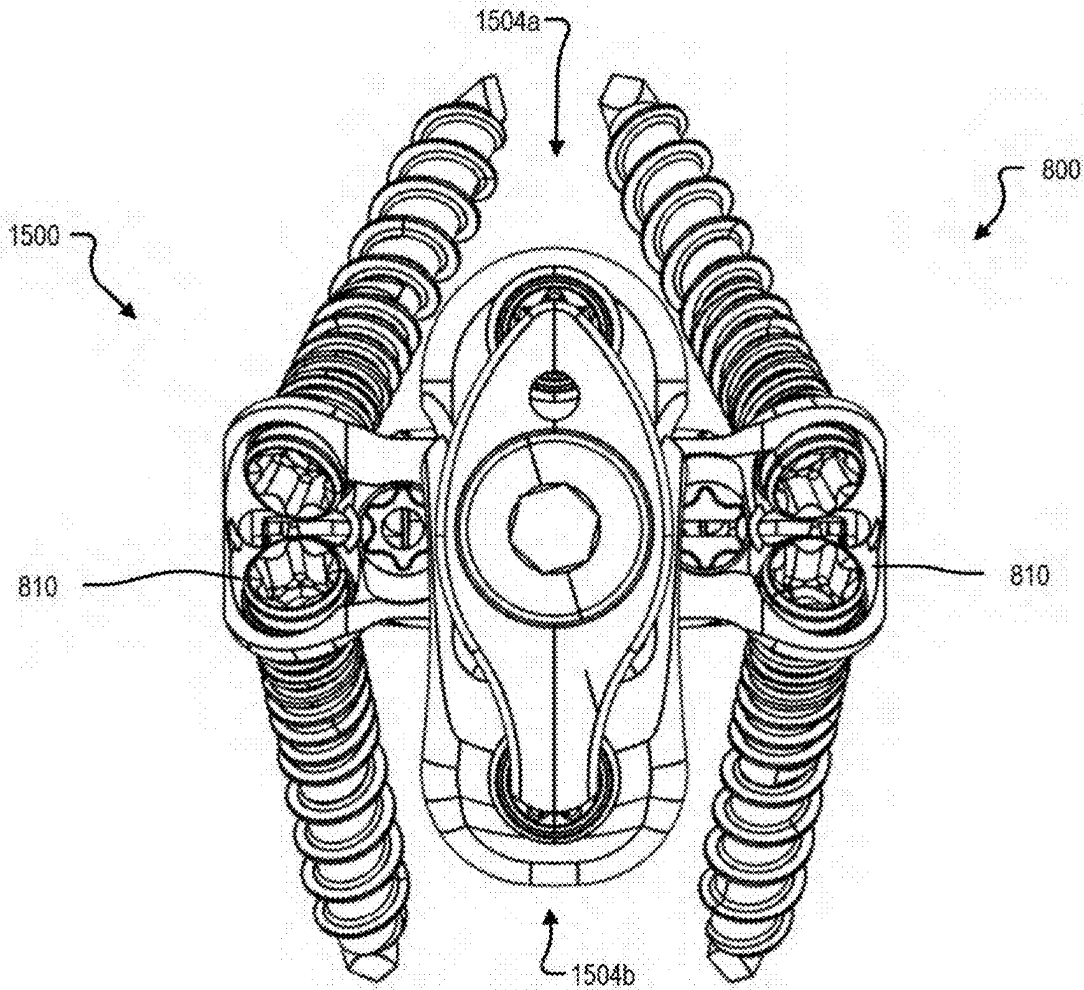


FIG. 60

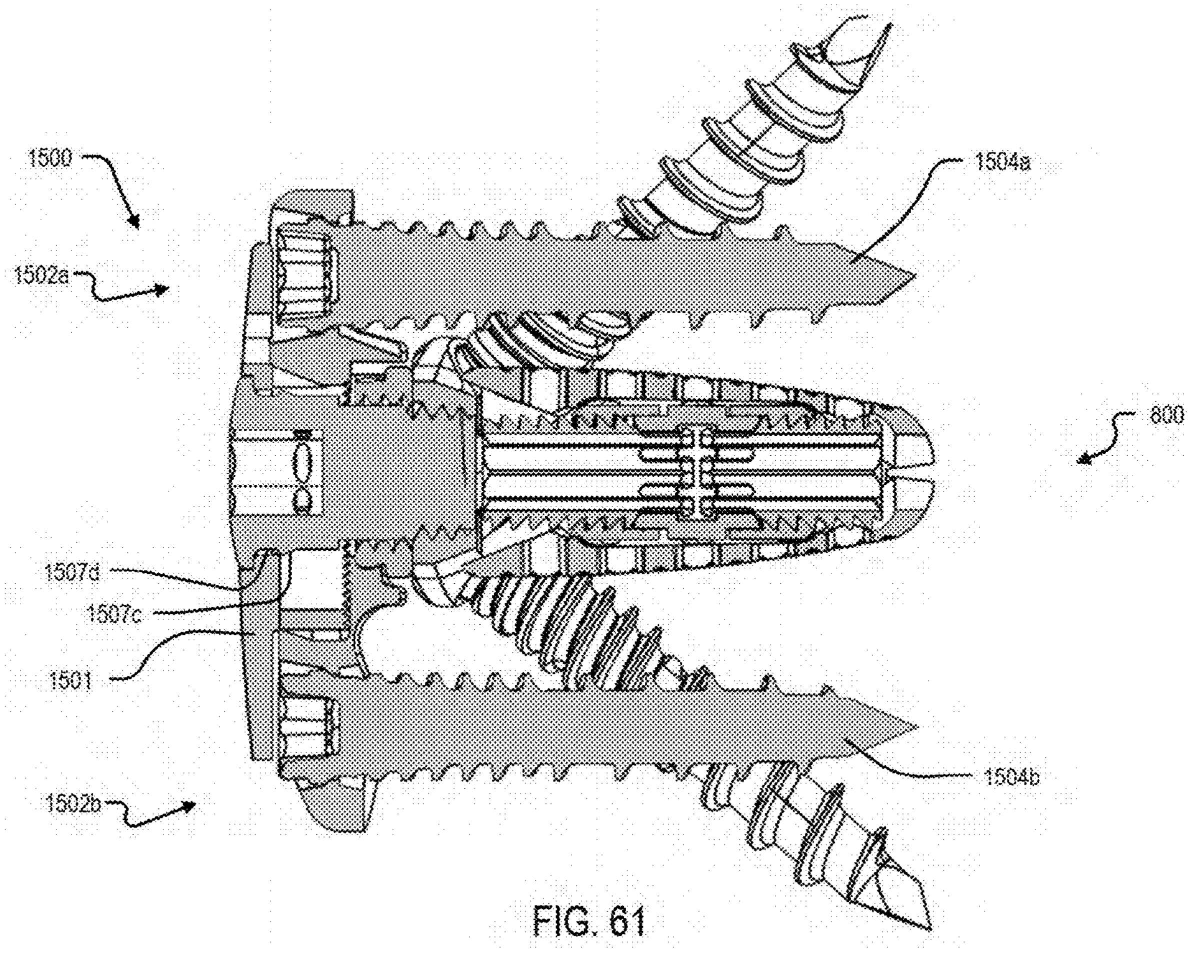
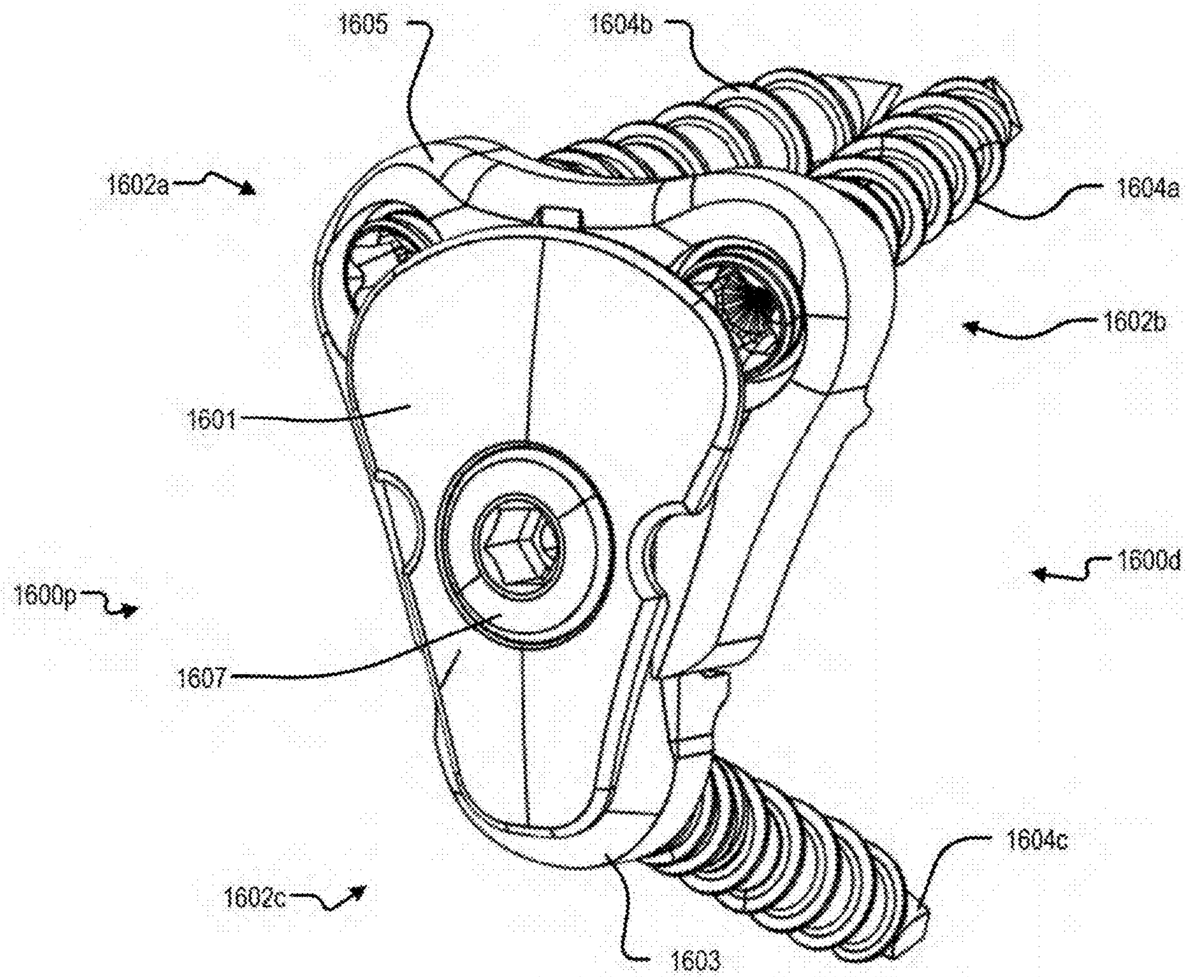


FIG. 61


1605
1604b
1602a
1604a
1602b
1601
1600d
1600p
1607
1604c
1602c
1603

1600

FIG. 62

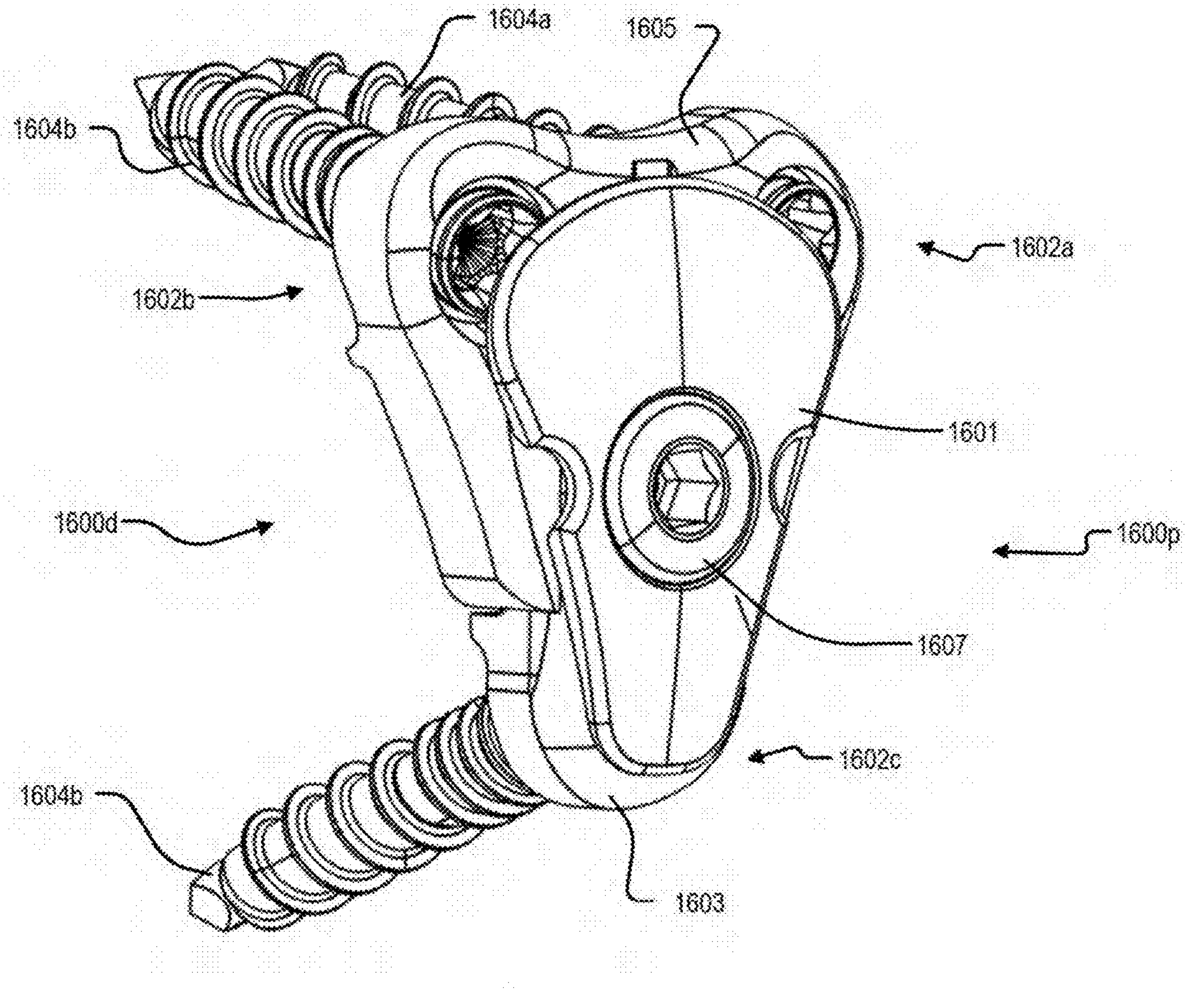

1604a
1605
1604b
1602a
1602b
1601
1600d
1600p
1607
1602c
1604b
1603
1600

FIG. 63

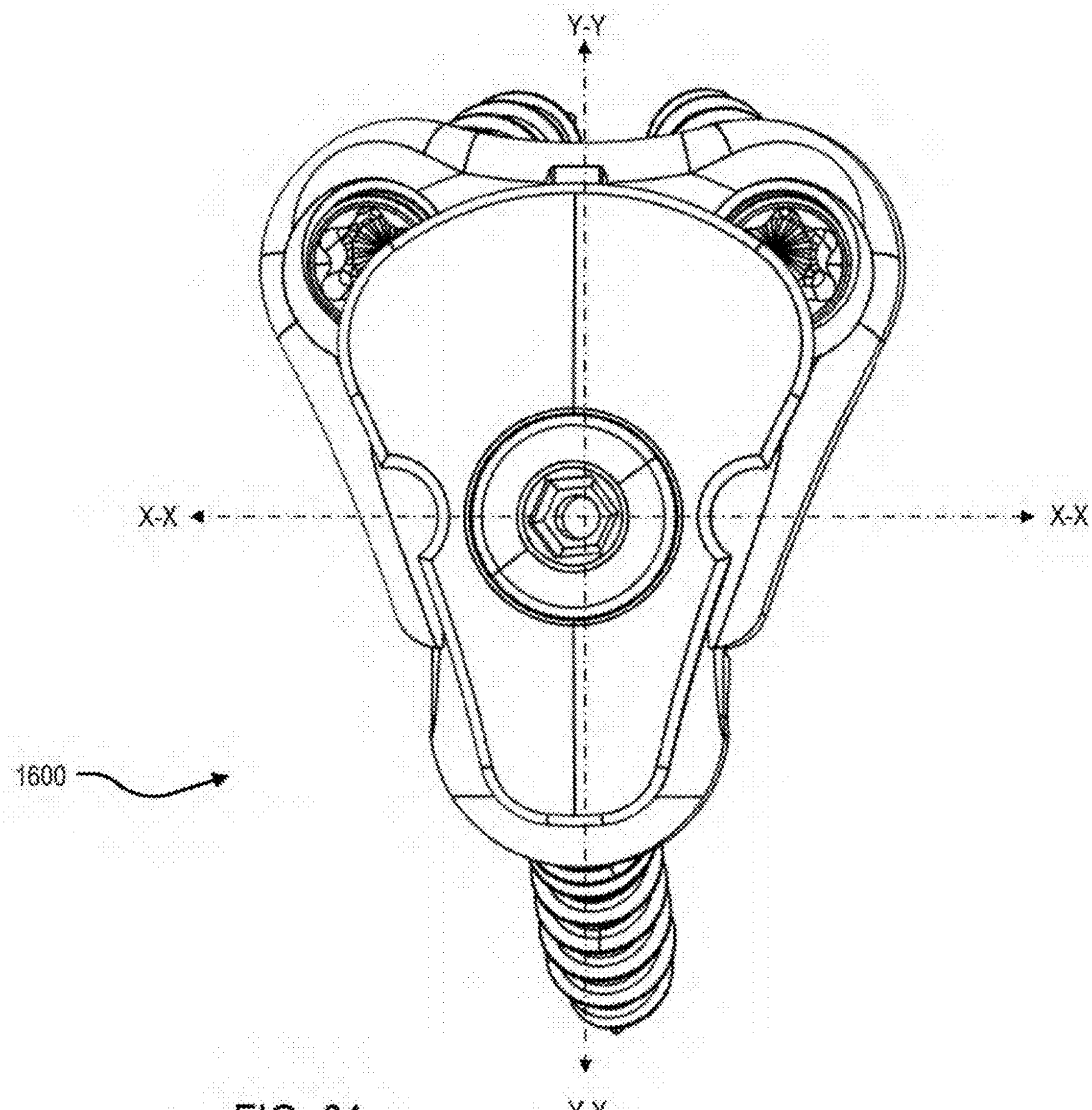


FIG. 64

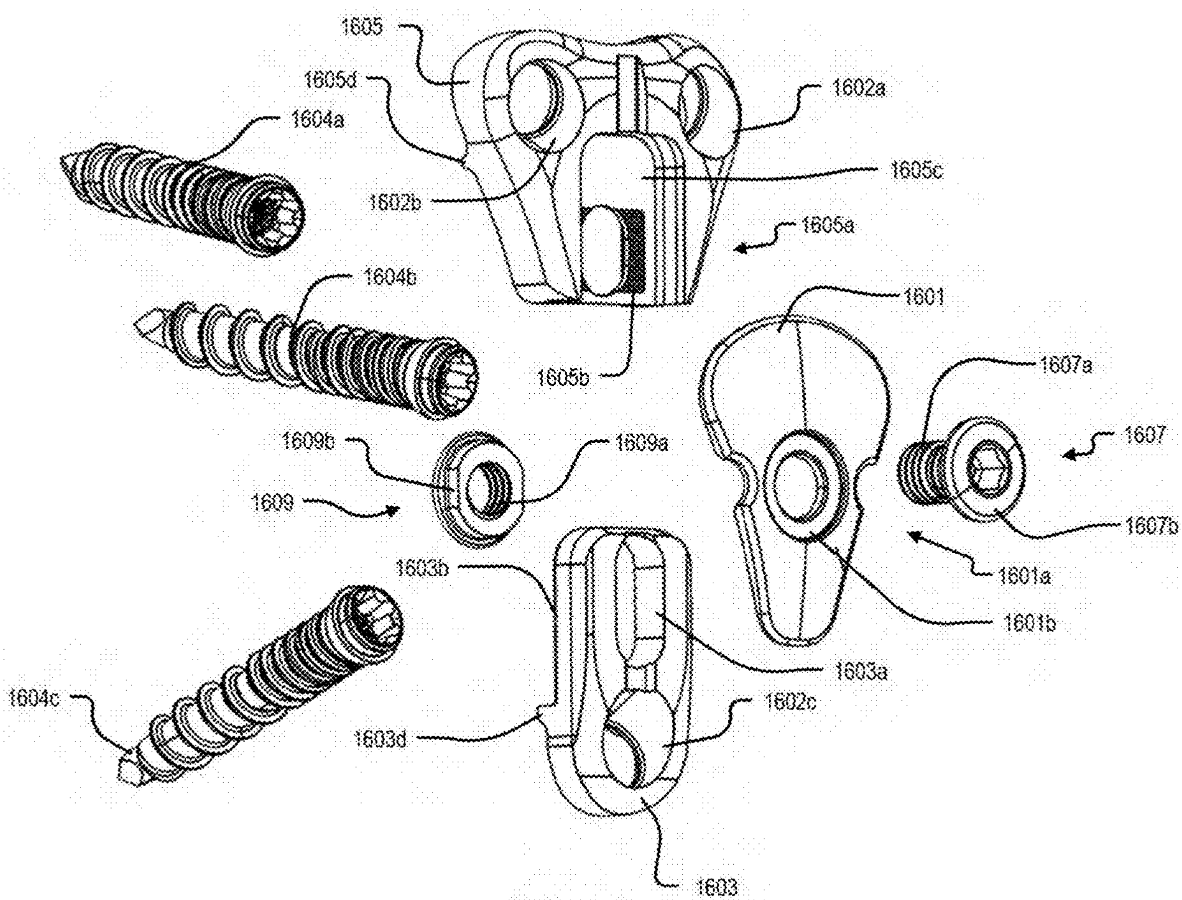

1605
1605d
1604a
1602a
1605c
1602b
1605a
1604b
1601
1605b
1607a
1609b
1609a
1607
1609
1607b
1603b
1601a
1601b
1603a
1604c
1602c
1603d
1603

FIG. 65

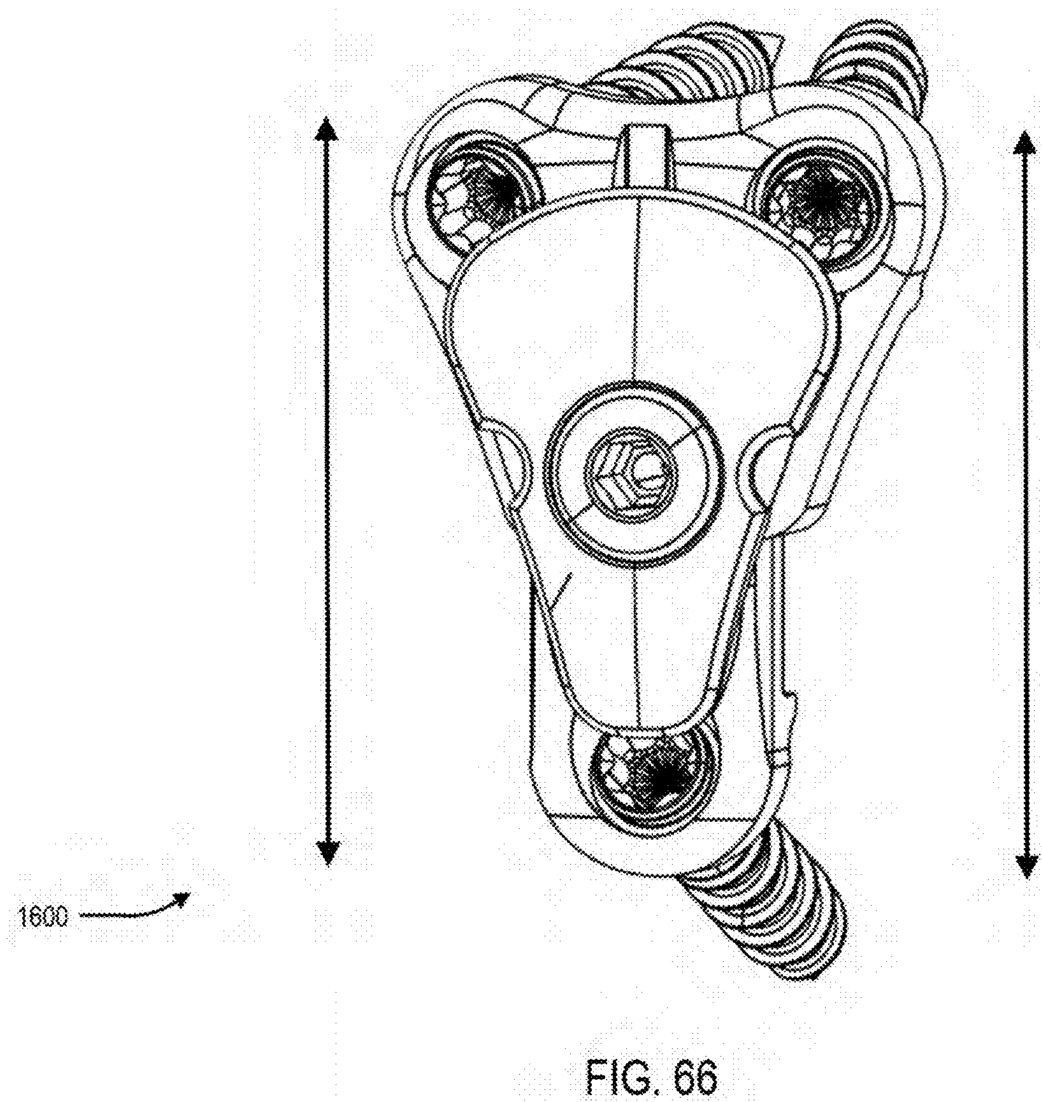


FIG. 66

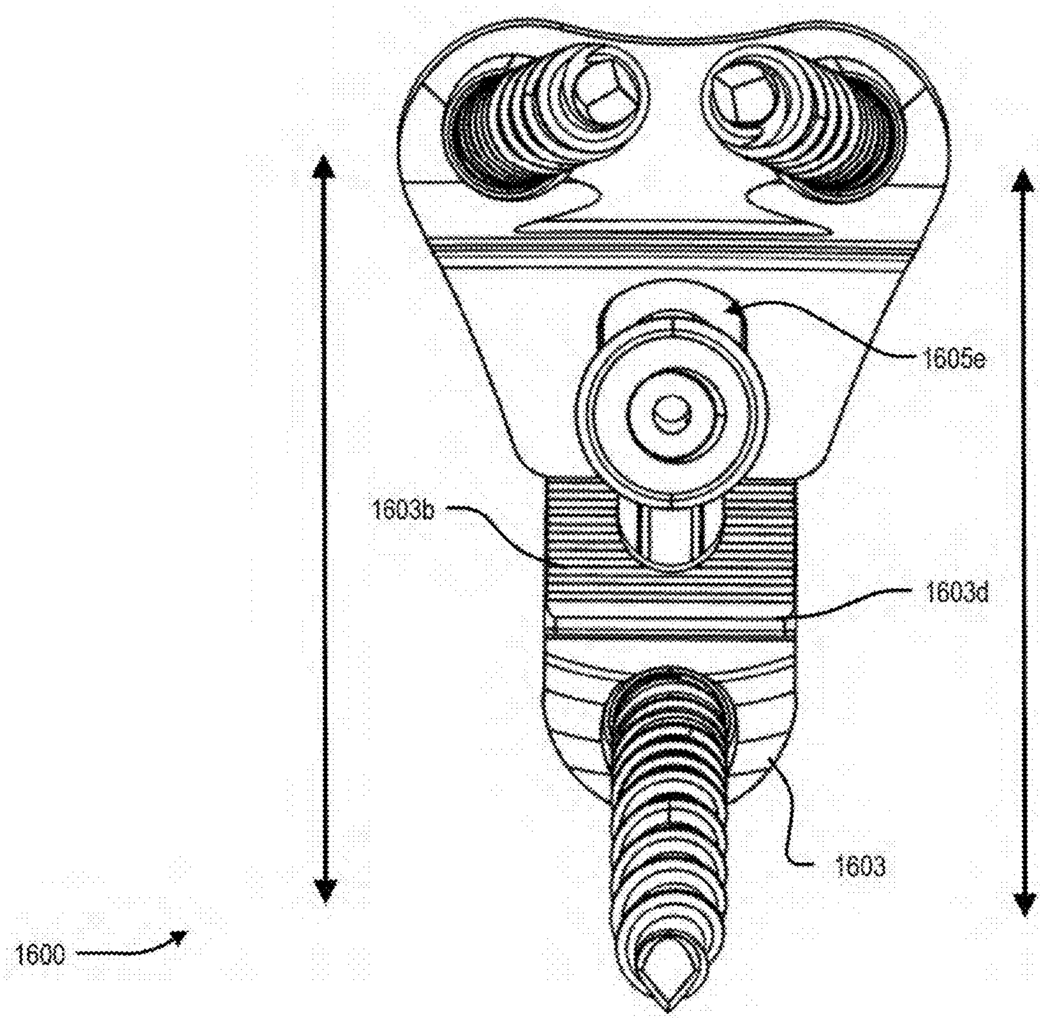


FIG. 67

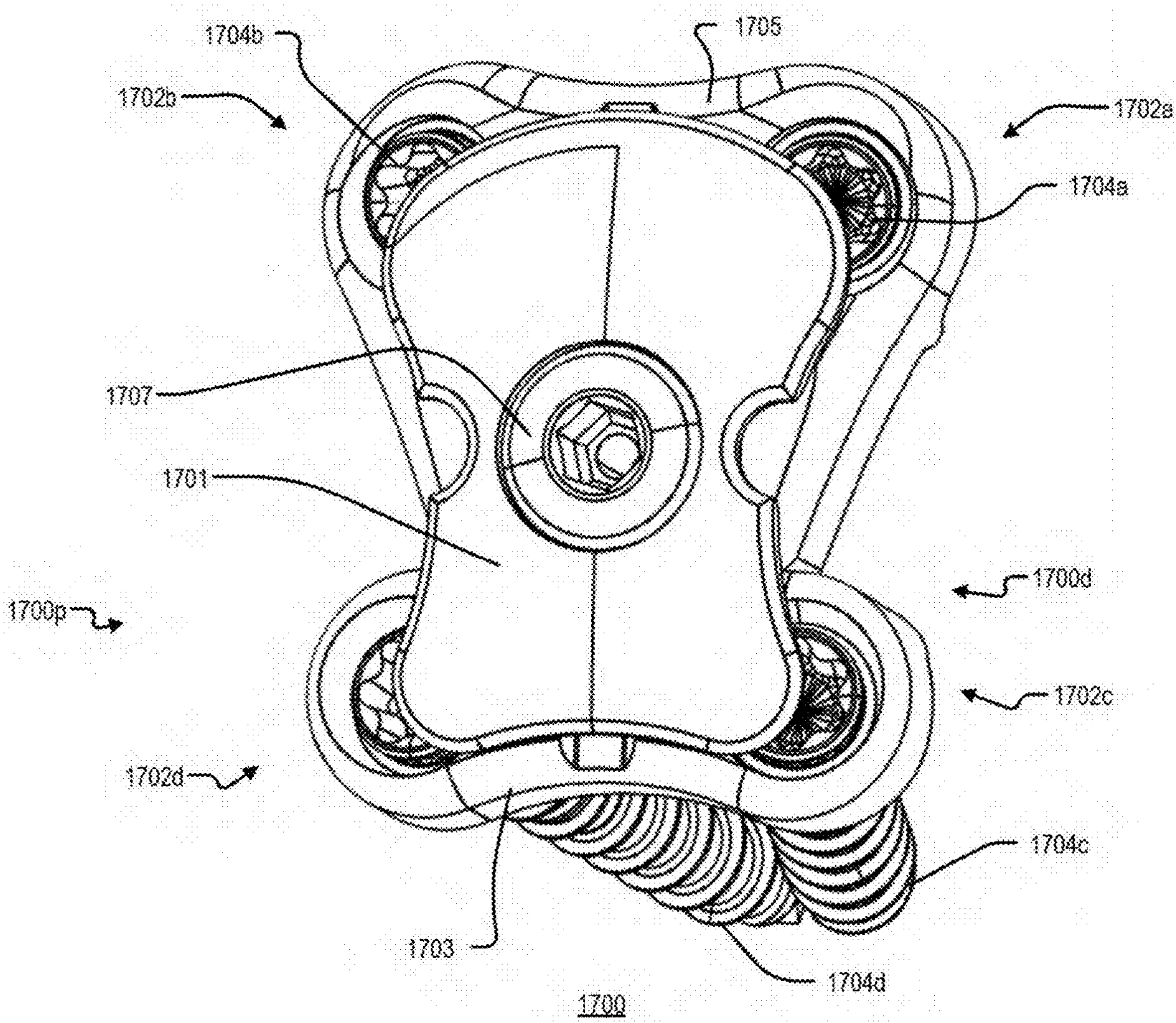

1704b
1705
1702b
1702a
1704a
1707
1701
1700d
1700p
1702c
1702d
1704c
1703
1704d
1700

FIG. 68

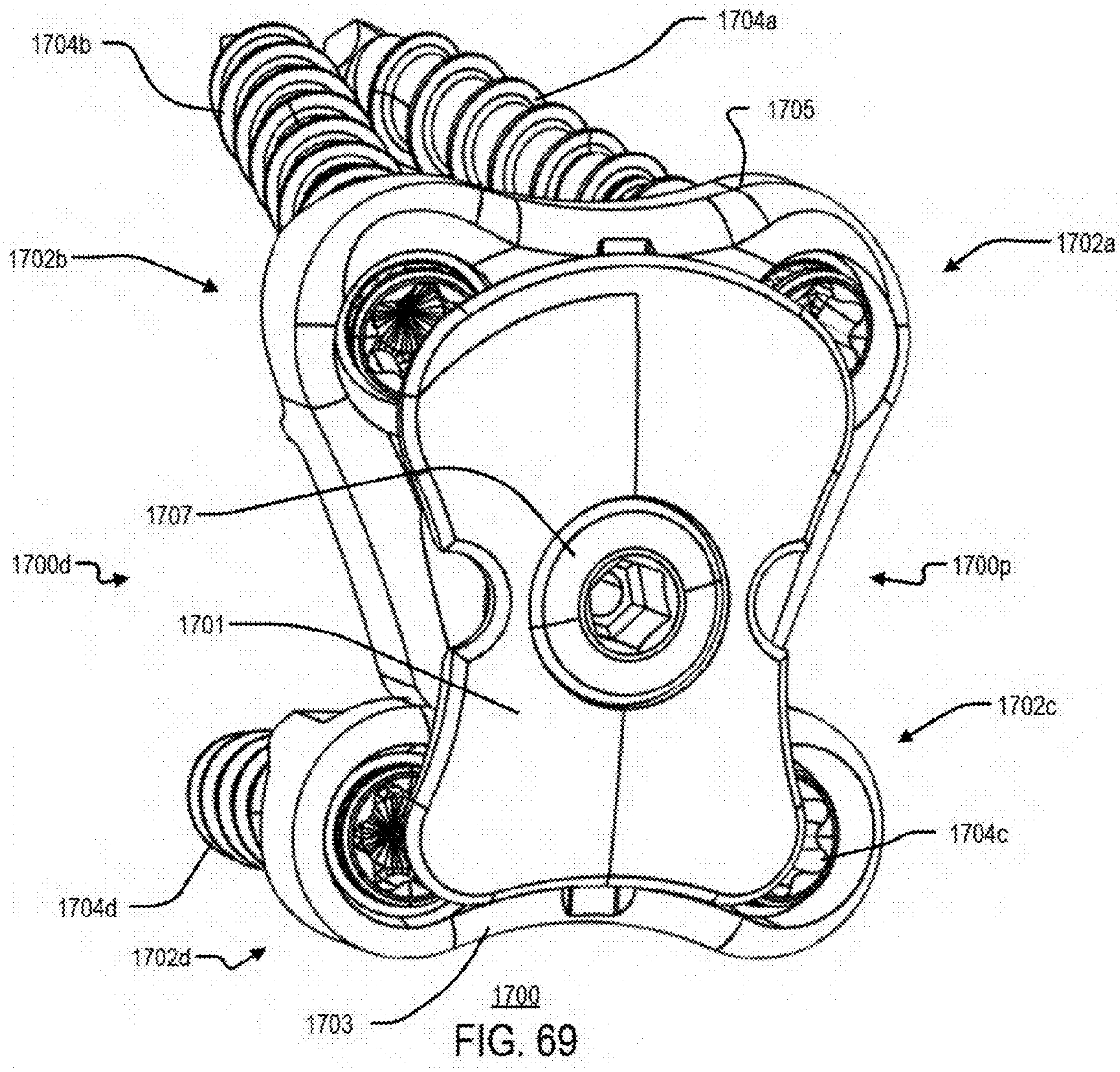

1704b
1704a
1705
1702b
1702a
1707
1700d
1700p
1701
1702c
1704c
1704d
1702d
1700
1703

FIG. 69

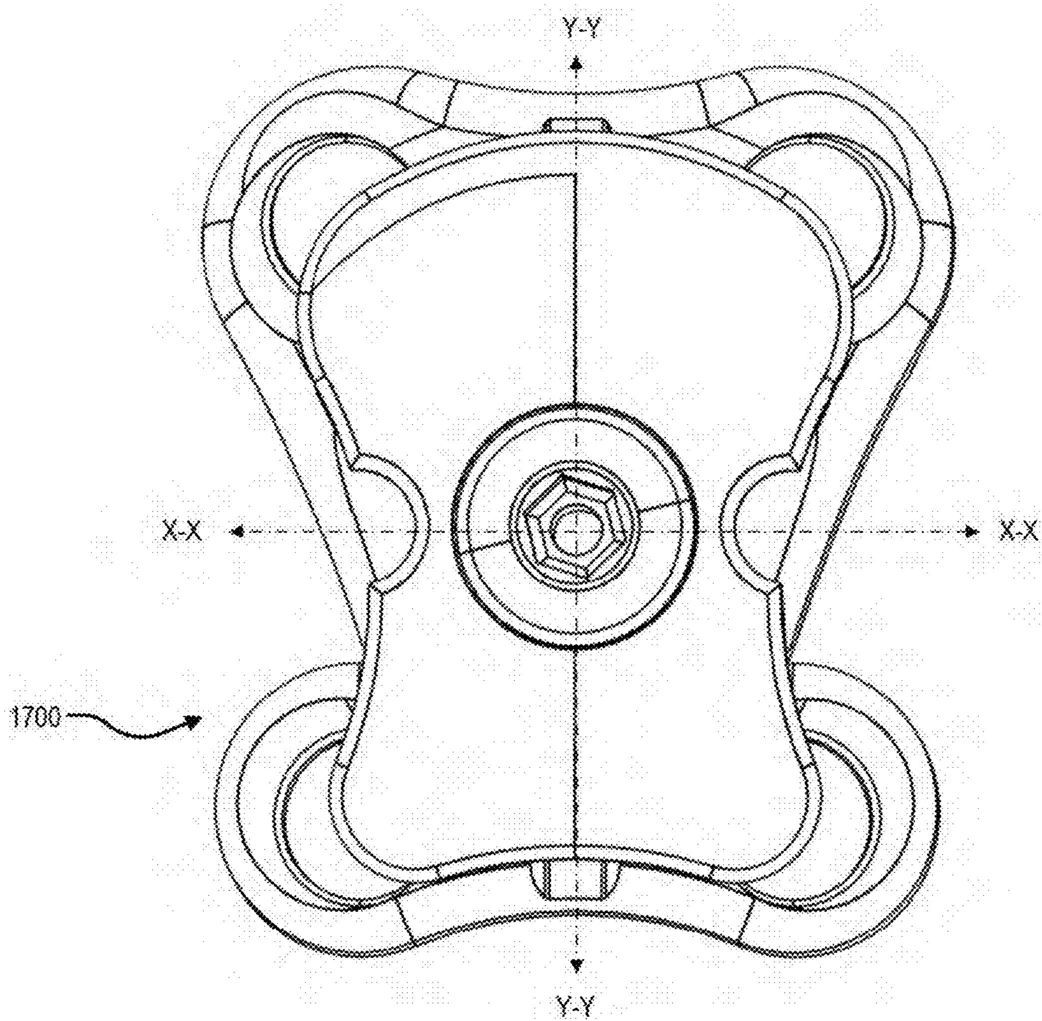


FIG. 70

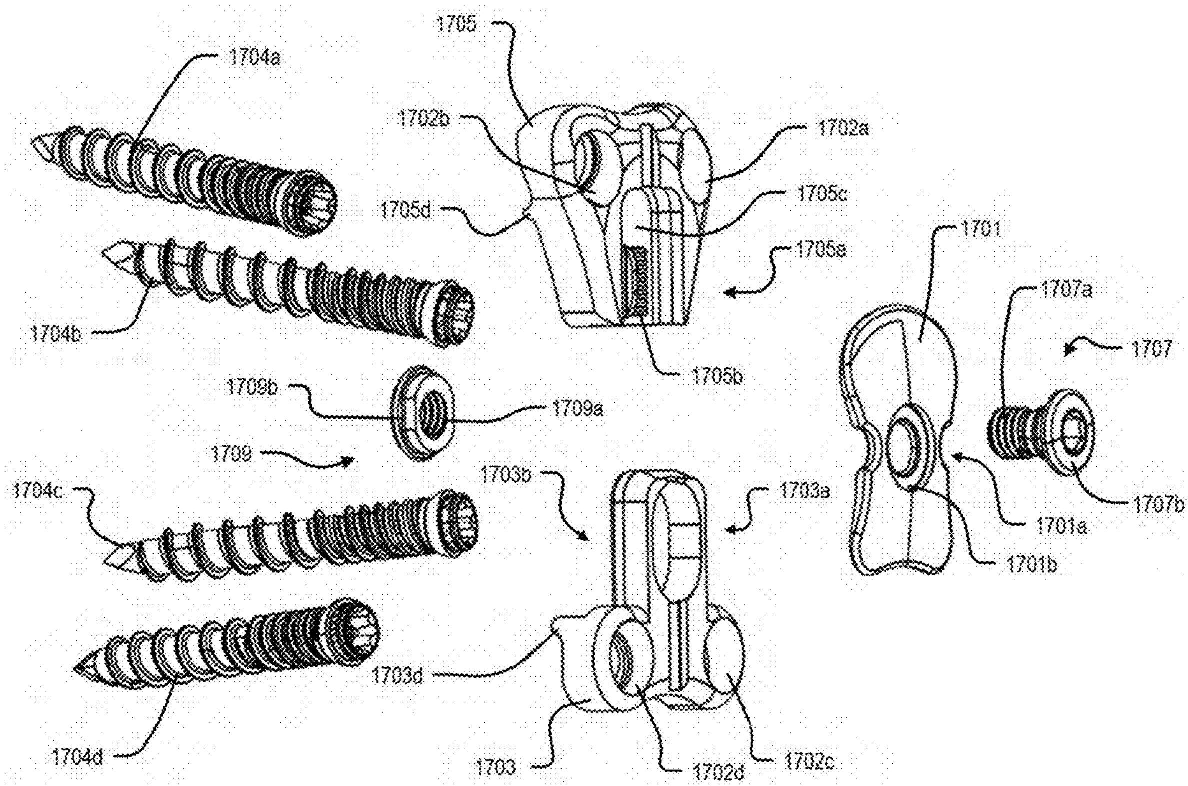

1705
1704a
1702b
1702a
1705d
1705c
1705a
1701
1704b
1707a
1707
1705b
1709b
1709a
1709
1703b
1703a
1704c
1701a
1707b
1701b
1703d
1704d
1703
1702d
1702c

FIG. 71

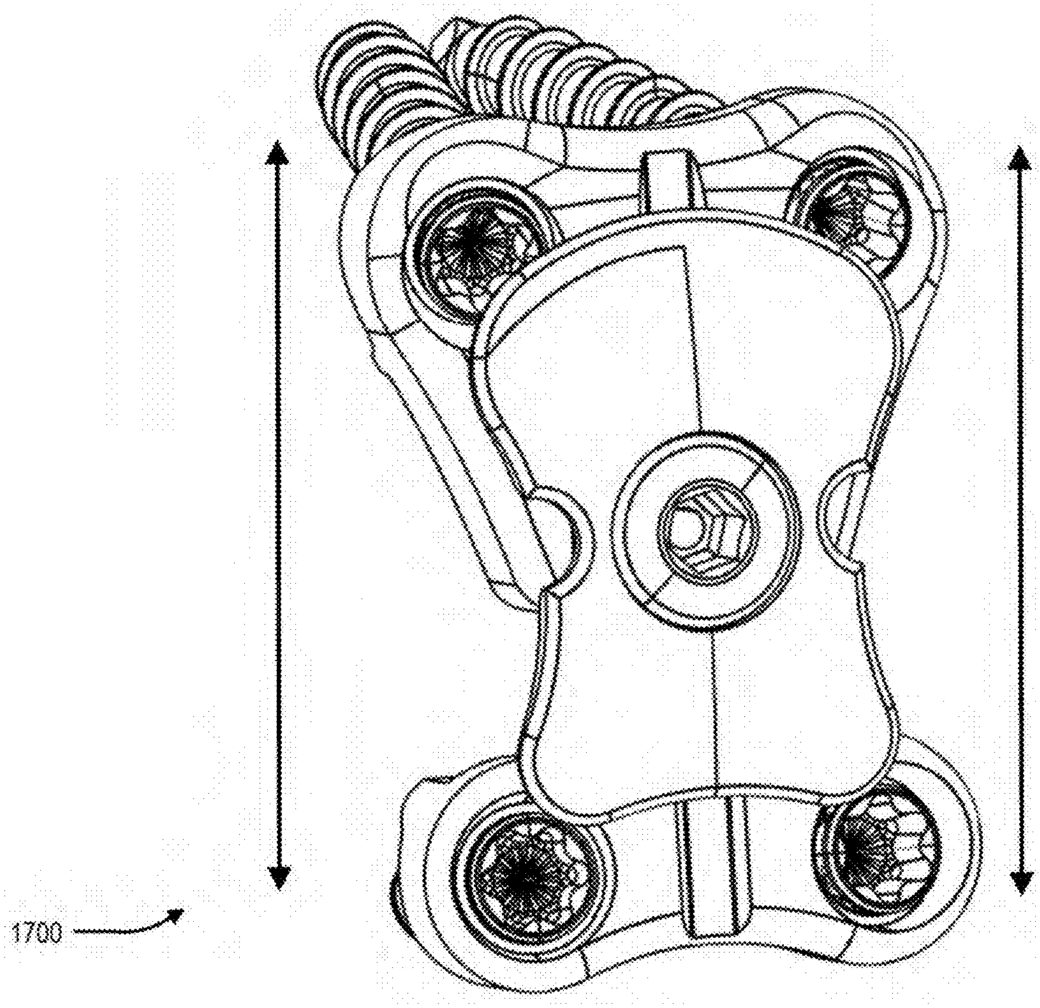


FIG. 72

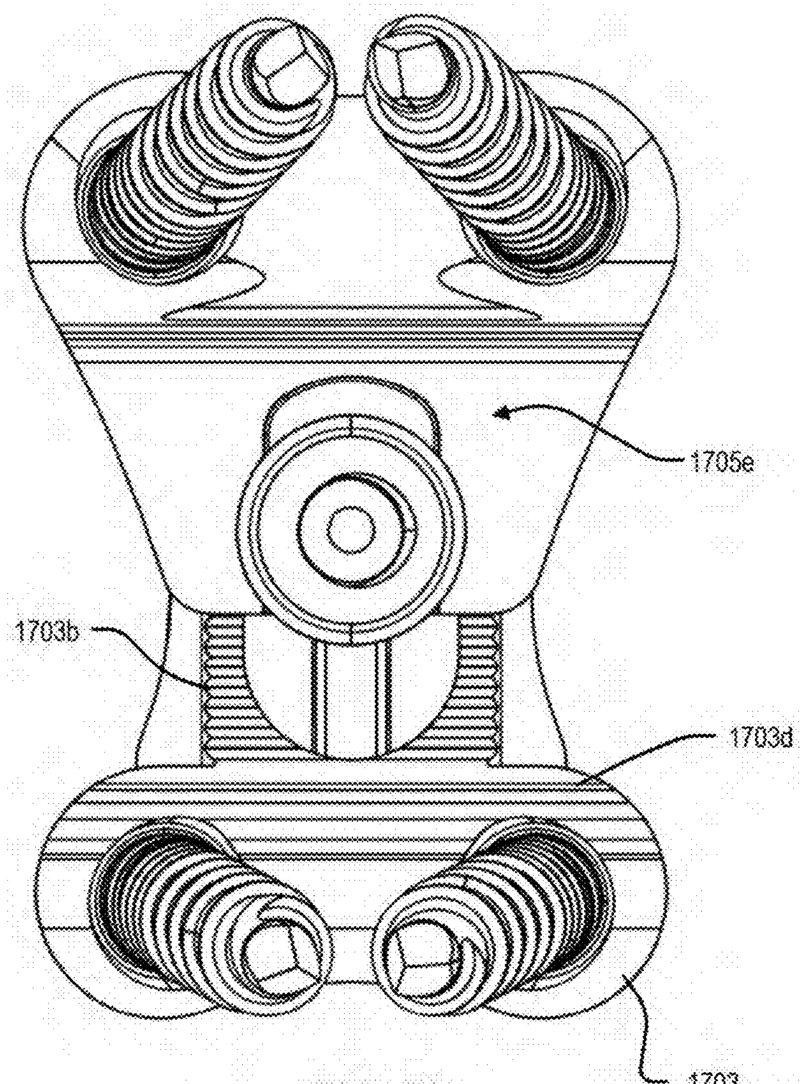
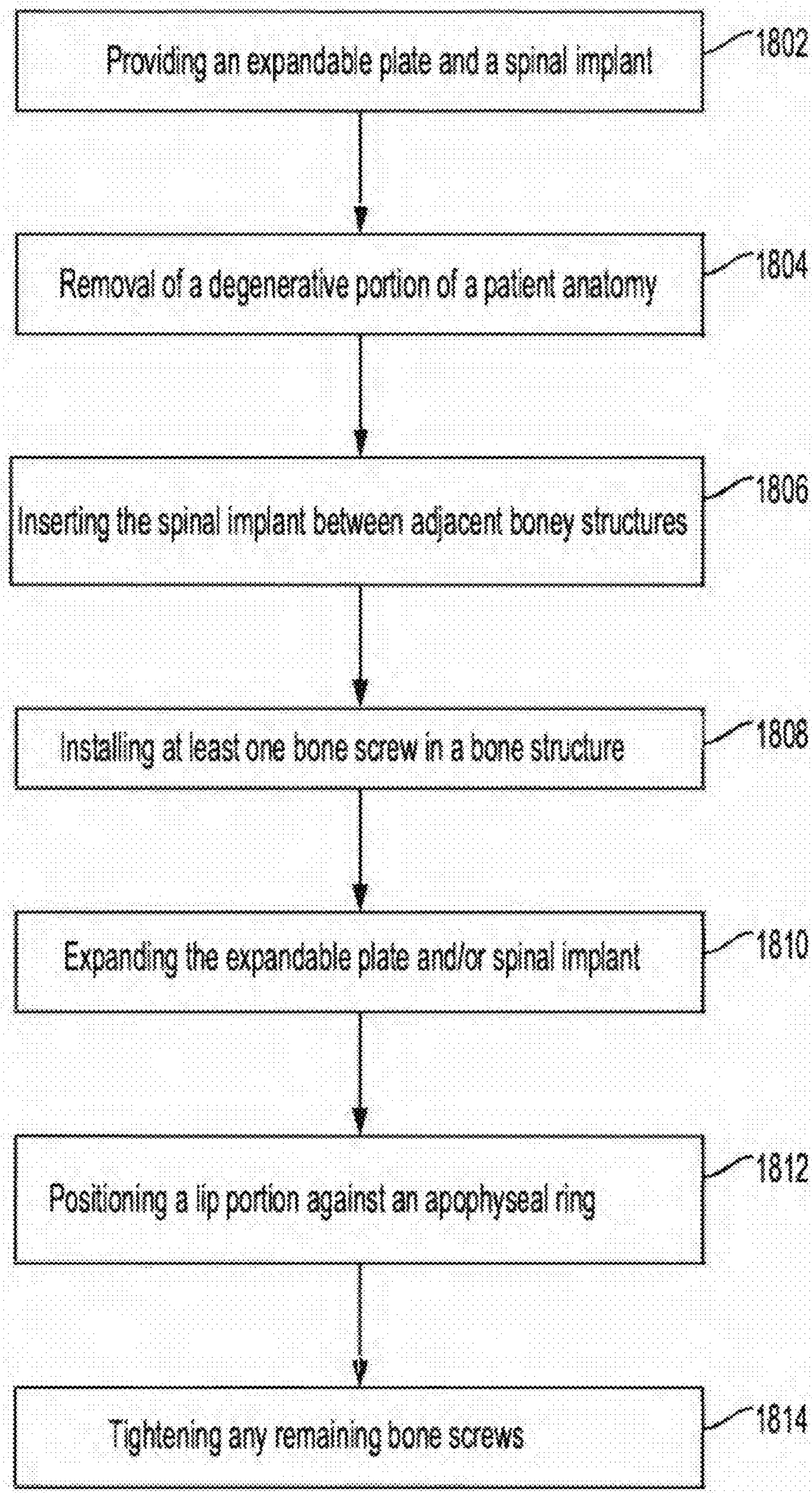
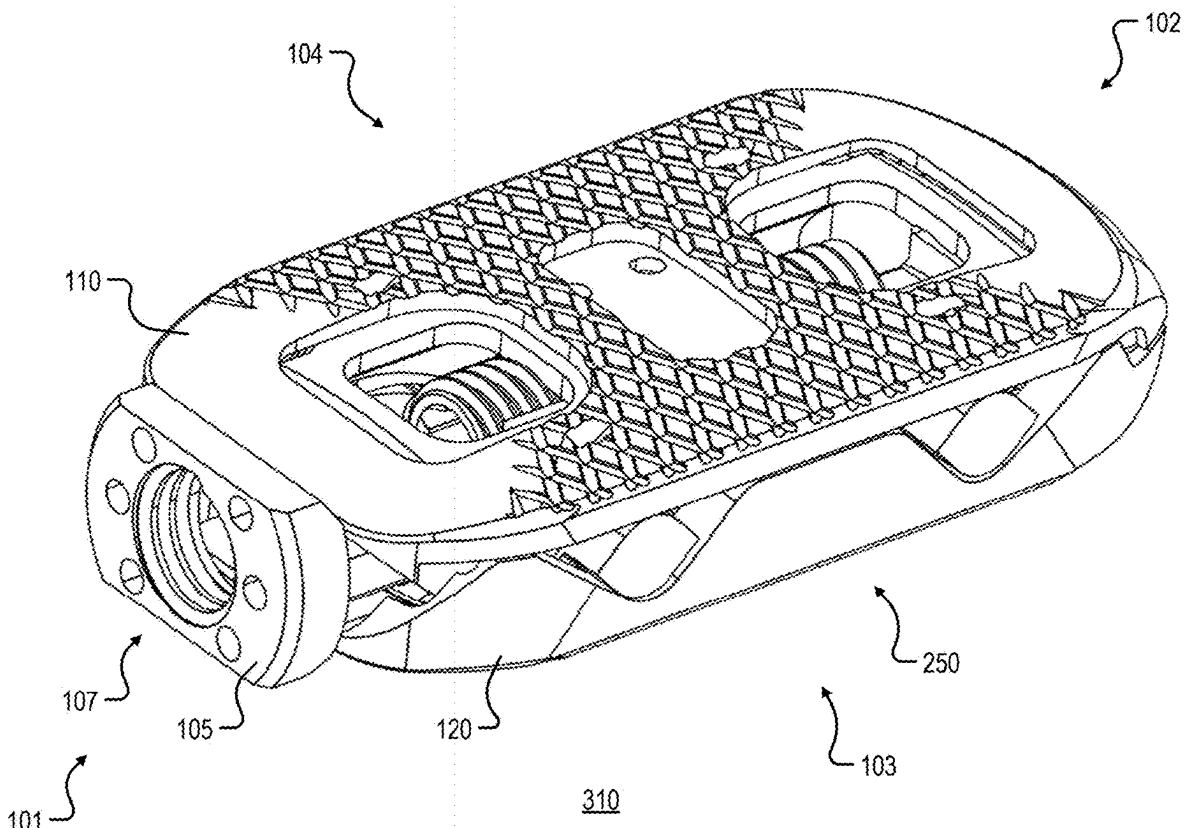


FIG. 73


Providing an expandable plate and a spinal implant
1802
Removal of a degenerative portion of a patient anatomy
1804
Inserting the spinal implant between adjacent boney structures
1806
Installing at least one bone screw in a bone structure
1808
Expanding the expandable plate and/or spinal implant
1810
Positioning a lip portion against an apophyseal ring
1812
Tightening any remaining bone screws
1814

1800

FIG. 74



310

FIG. 75

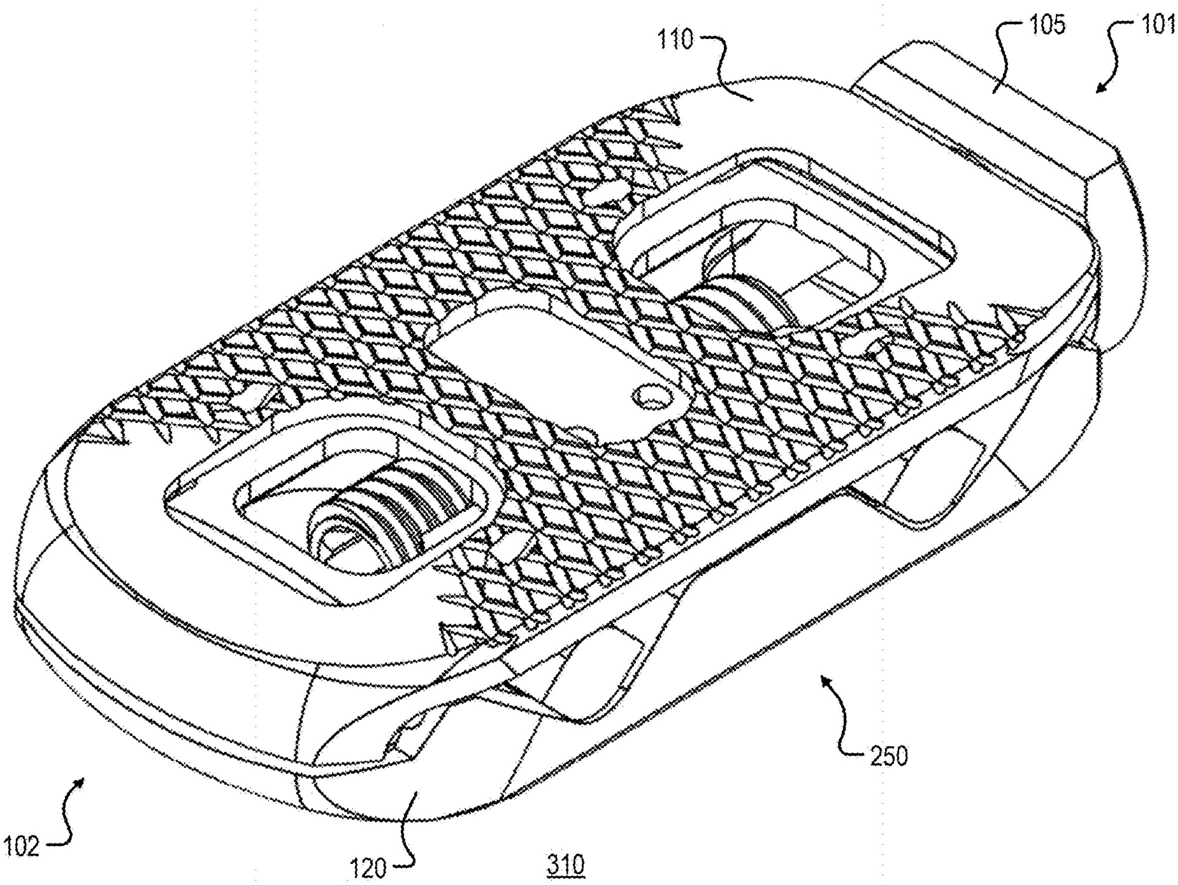


FIG. 76

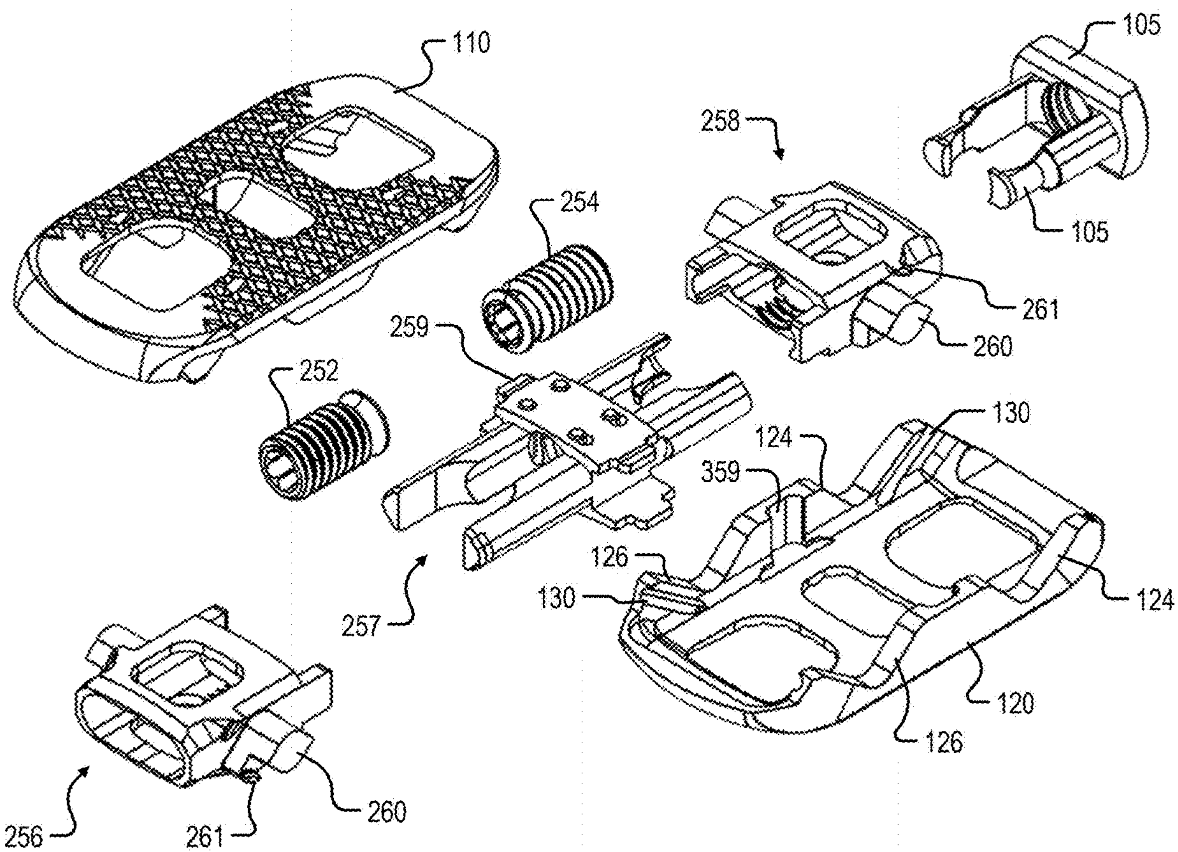

110
105
258
254
105
261
259
260
252
130
124
359
126
130
124
257
120
126
256
260
261

FIG. 77

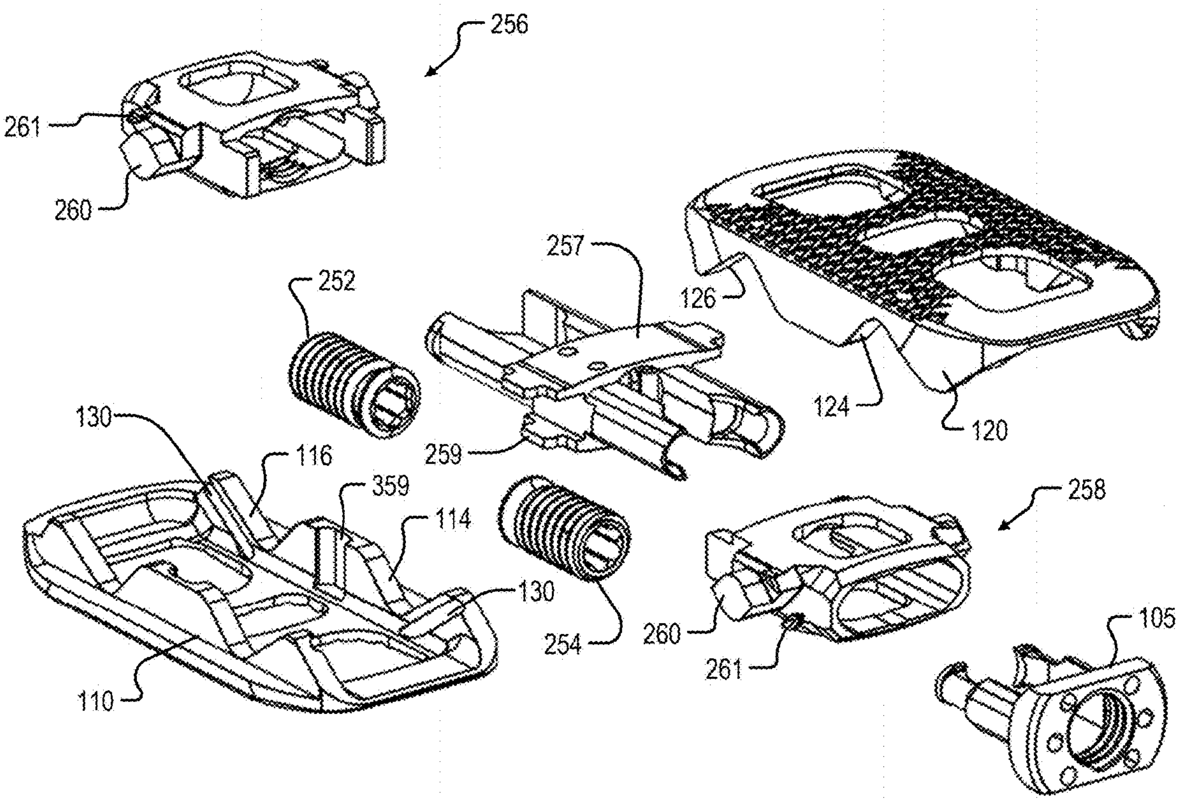

256
261
260
257
252
126
124
120
130
116
359
114
259
258
130
254
260
261
105
110

FIG. 78

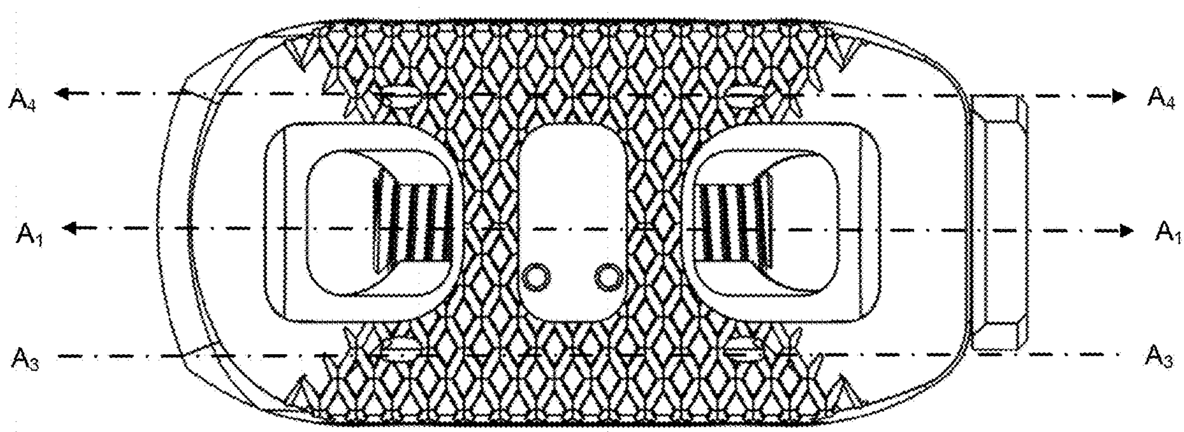


FIG. 79

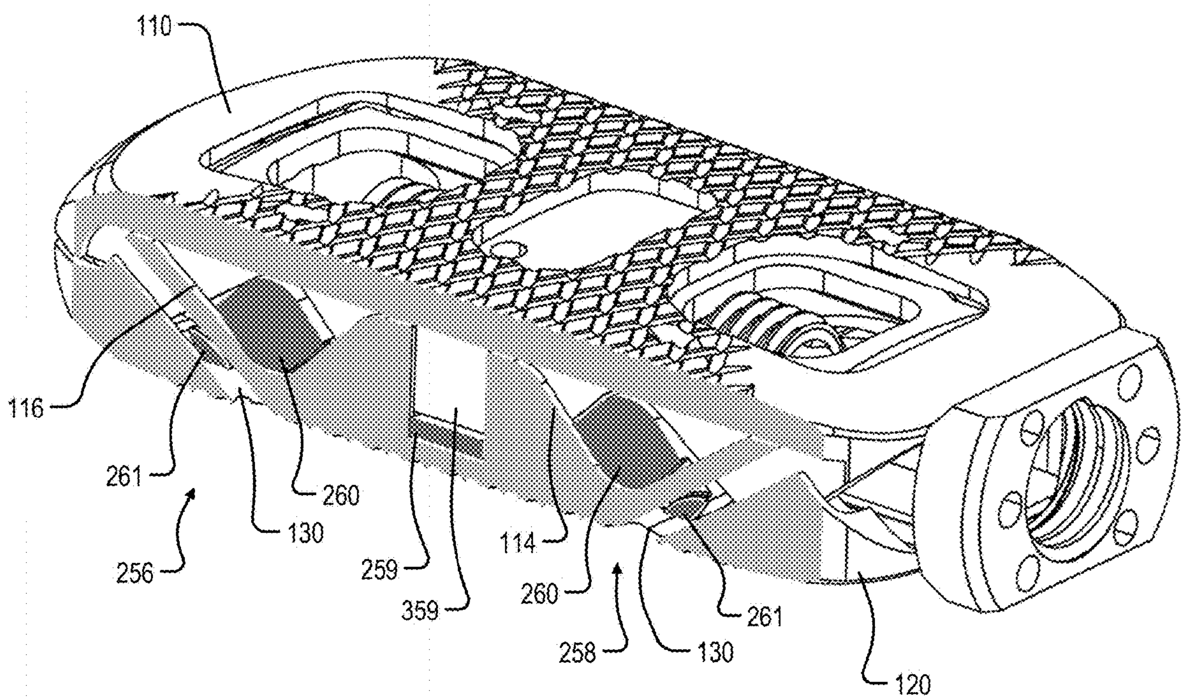


FIG. 80

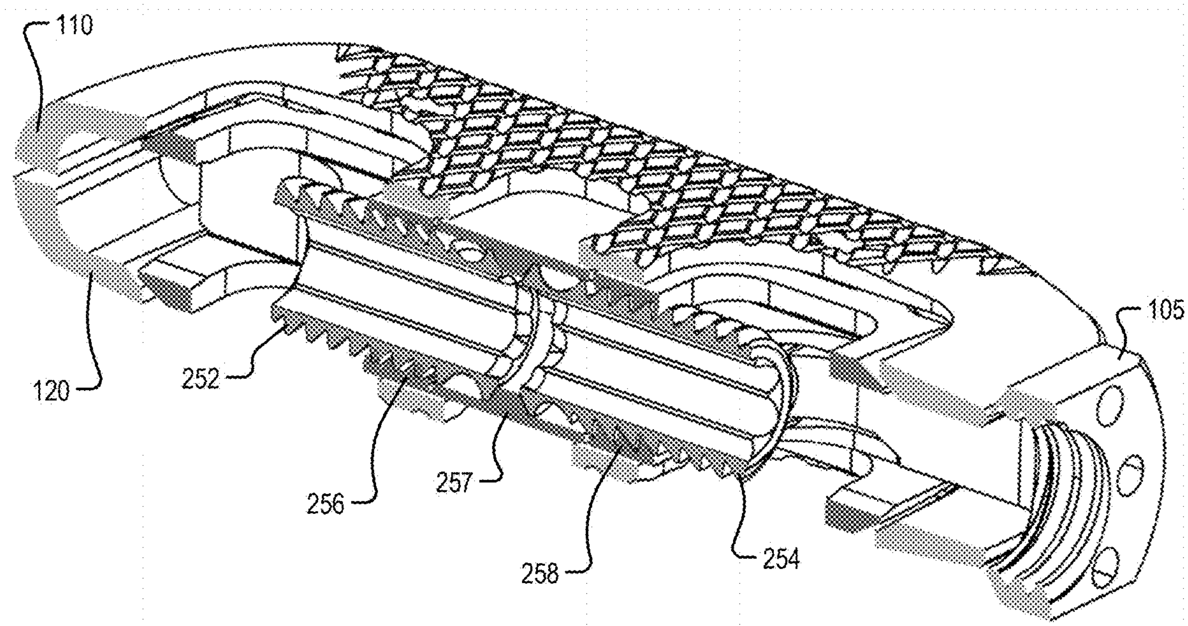


FIG. 81

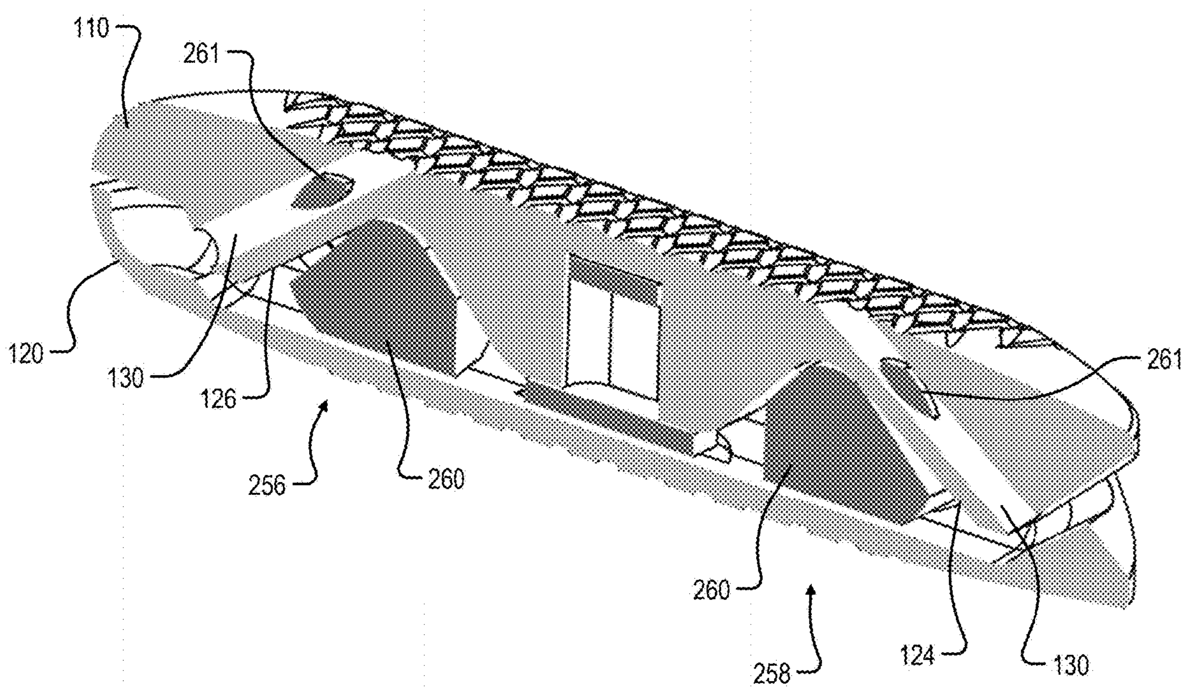


FIG. 82

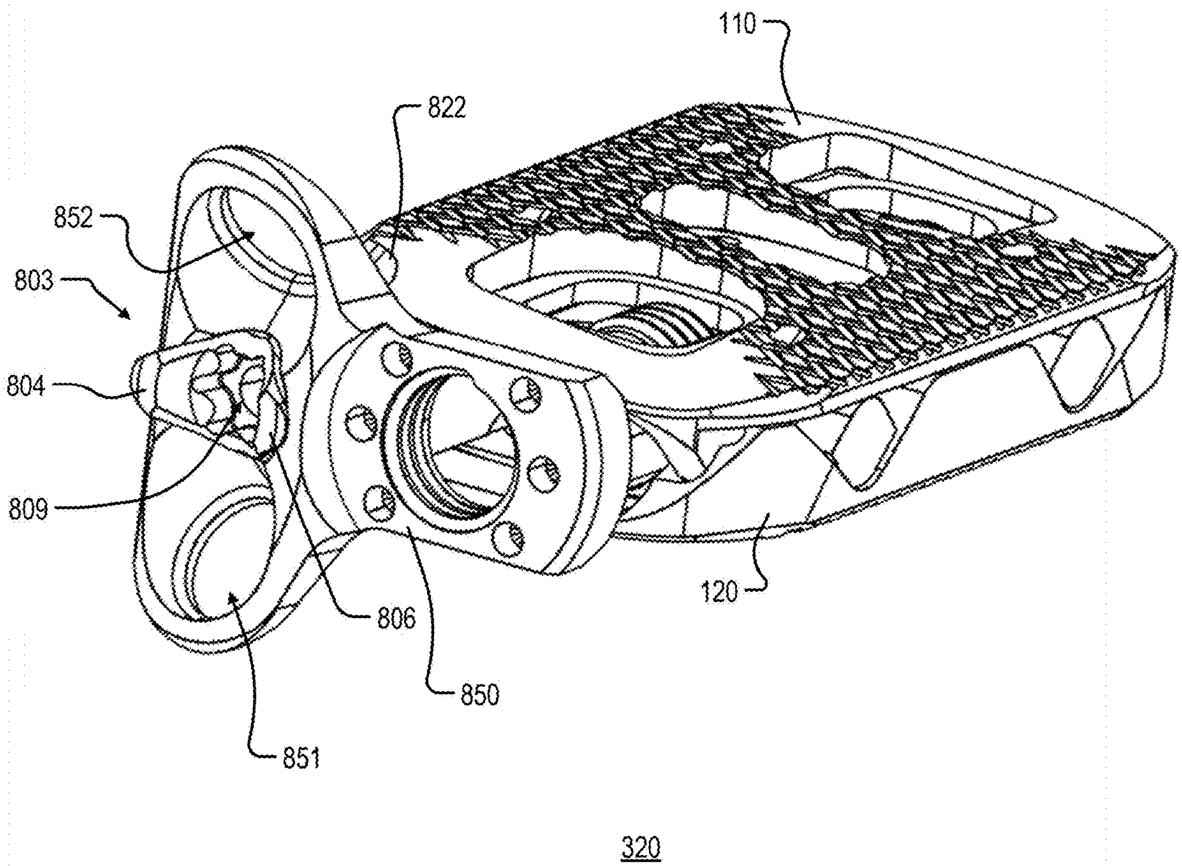


FIG. 83

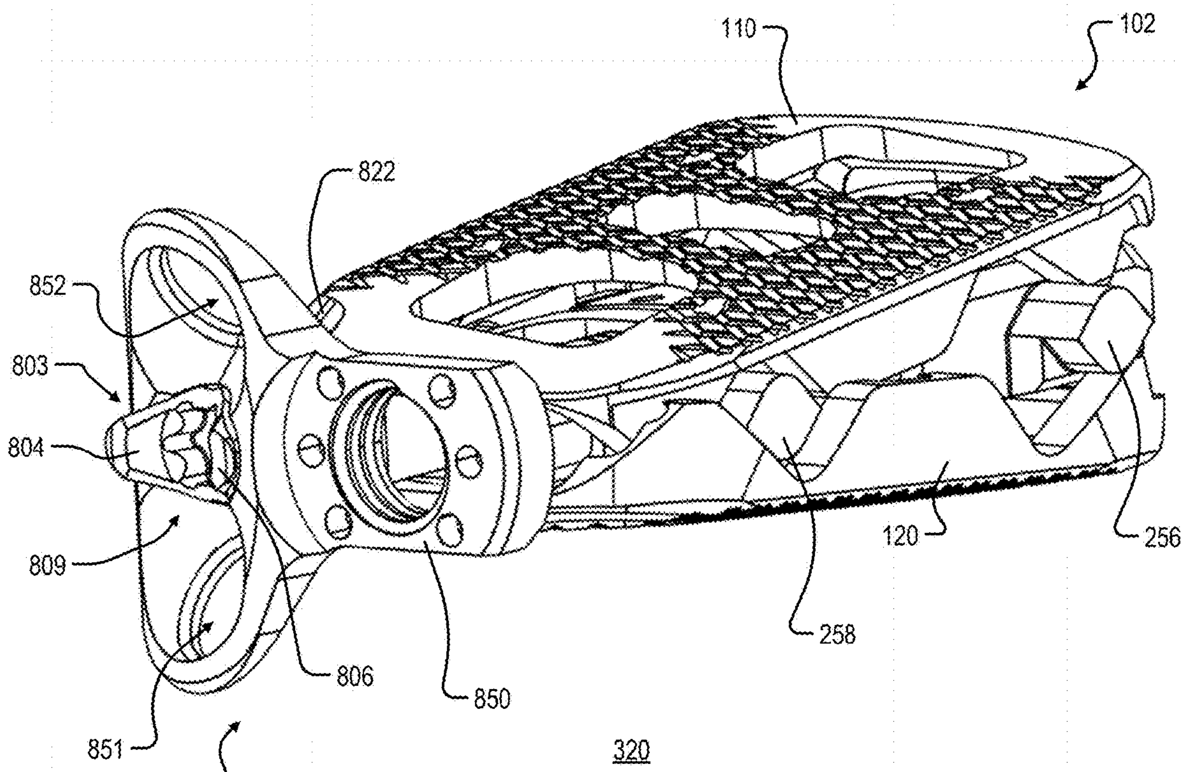


FIG. 84

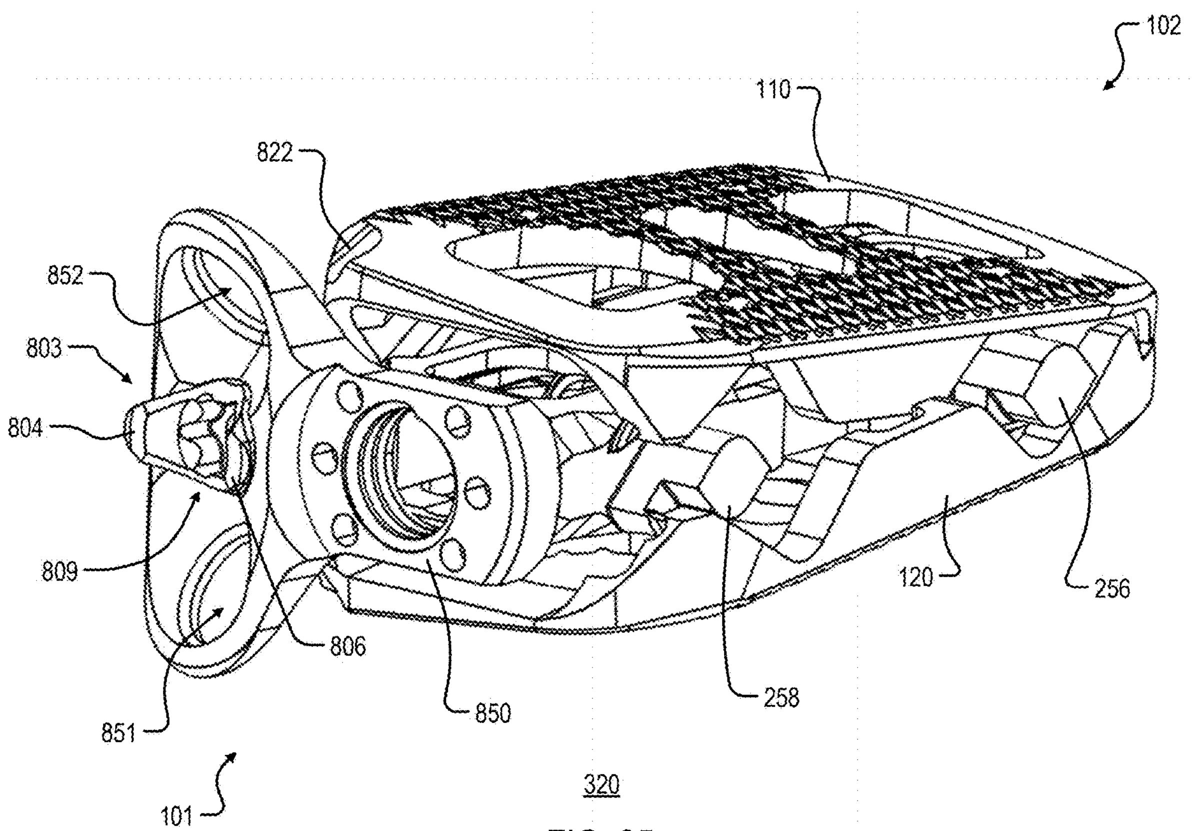
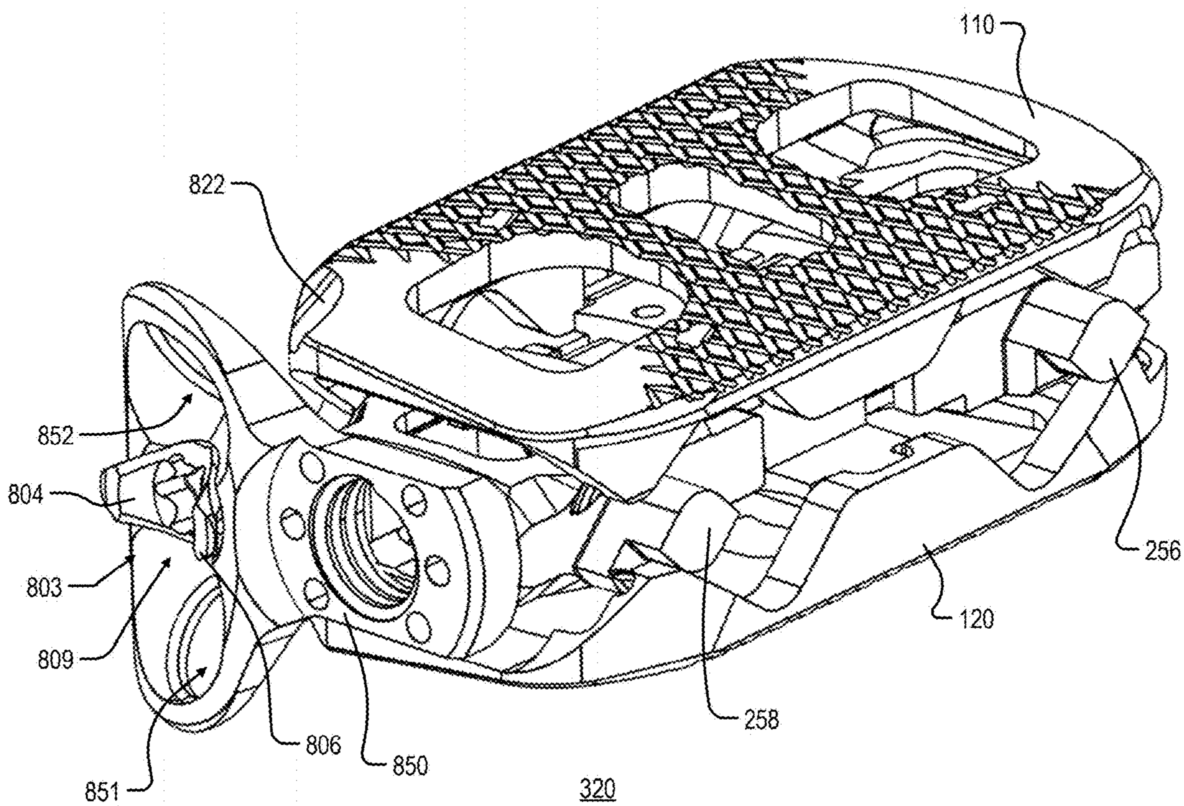
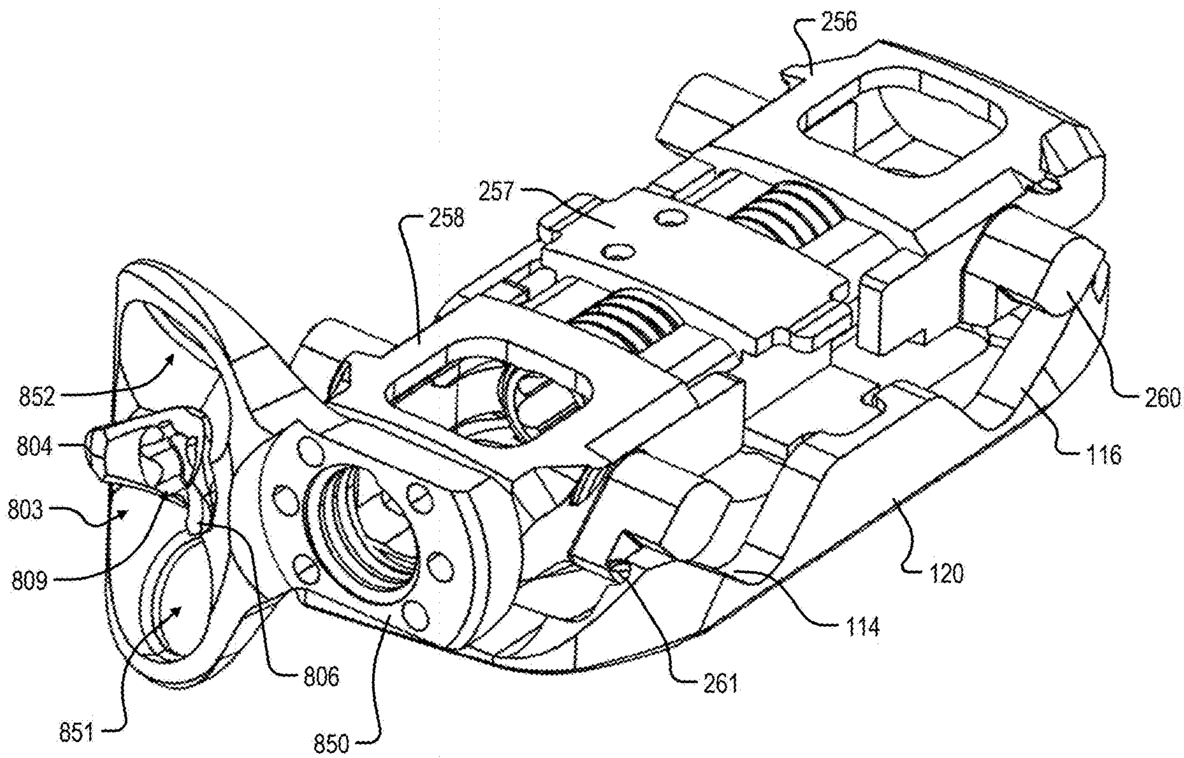


FIG. 85



320
FIG. 86



320
FIG. 87

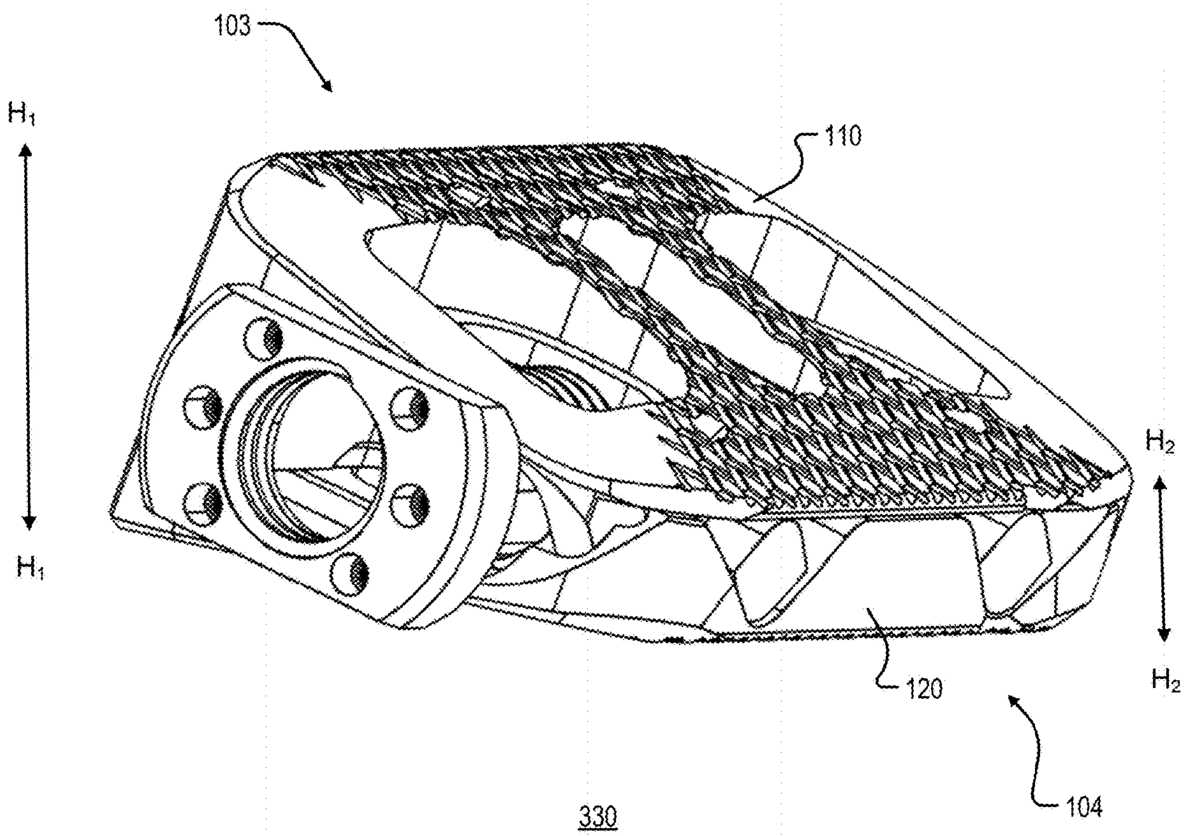
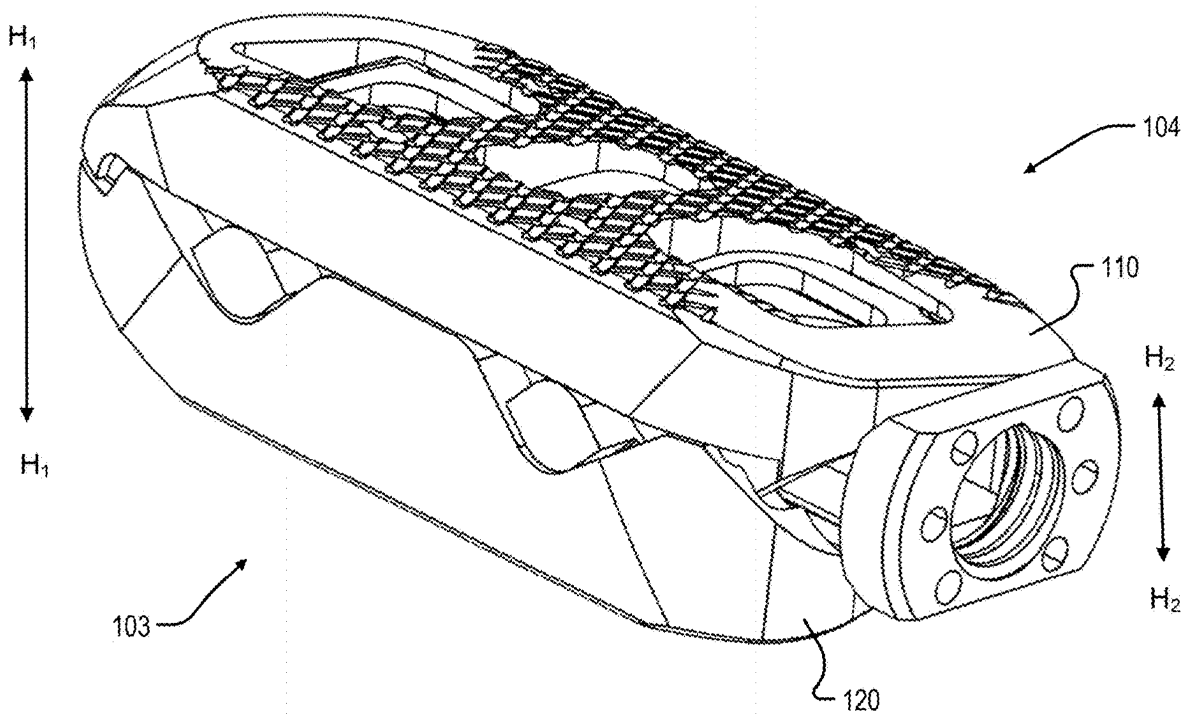


FIG. 88



330
FIG. 89

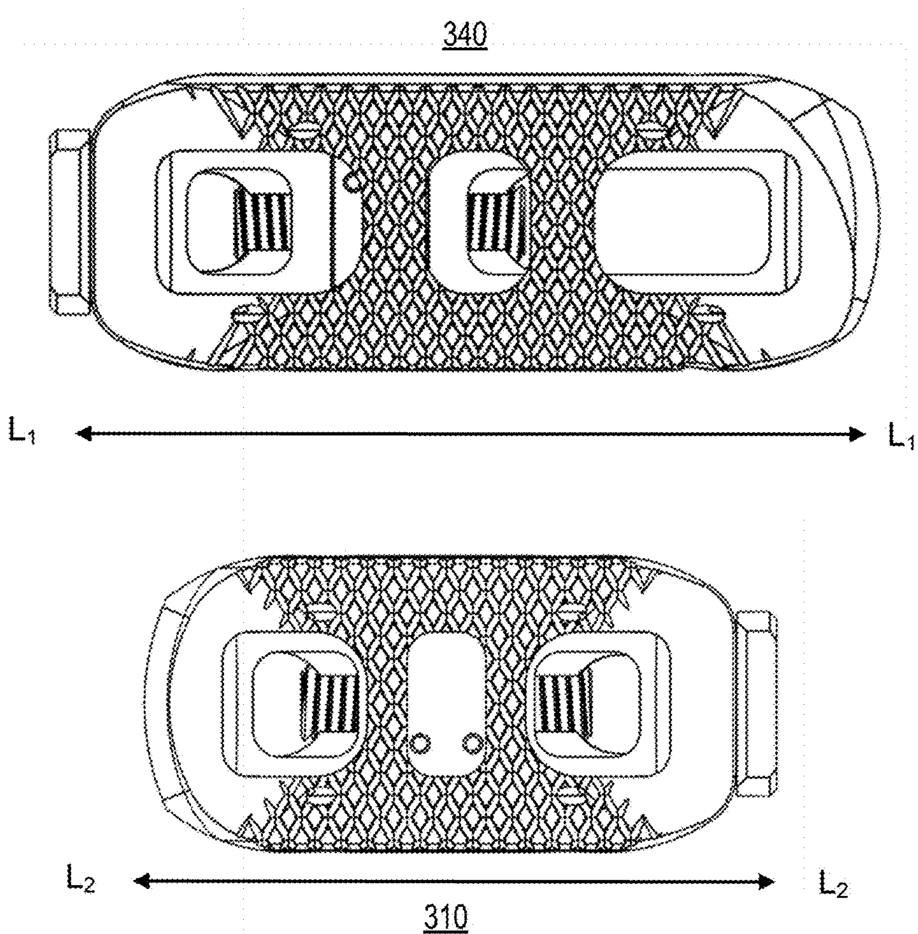


FIG. 90

DUAL EXPANDABLE INTER-BODY DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 17/887,957, titled Dual expandable inter-body device, filed Aug. 15, 2022, which is a continuation in part of U.S. patent application Ser. No. 17/391,403, titled Expandable inter-body device, expandable plate system, and associated methods, filed Aug. 2, 2021, now U.S. Pat. No. 11,833,059, which is a continuation in part of U.S. patent application Ser. No. 17/246,932, titled Expandable Inter-Body Device, System, and Method, filed May 3, 2021, now U.S. Pat. No. 11,963,881, which is a continuation in part of U.S. patent application Ser. No. 17/123,889, titled Expandable Inter-Body Device, System, and Method, filed Dec. 16, 2020, now U.S. Pat. No. 11,564,724, which claims priority to and incorporates by reference co-related patent applications, PCT/IB2020/000953, titled Expandable Inter-Body Device, System, and Method, filed Nov. 5, 2020; PCT/IB2020/000932, titled Screwdriver and Complimentary Screws, filed Nov. 5, 2020; and PCT/IB2020/000942, titled Expandable Inter-Body Device, System, and Method, filed Nov. 5, 2020. This application is also a continuation in part of U.S. patent application Ser. No. 17/123,897, titled Expandable inter-body device, system and method, filed Dec. 16, 2020, now U.S. Pat. No. 11,617,658. The contents of each are hereby incorporated in their entireties. This application also incorporates by reference: U.S. Pat. No. 11,285,014 titled Expandable inter-body device, system and method, filed May 4, 2021; U.S. Pat. No. 11,096,796, titled Interbody spinal implant having a roughened surface topography on one or more internal surfaces, and filed on Mar. 4, 2013; and U.S. Pat. No. 10,821,000, titled Titanium implant surfaces free from alpha case and with enhanced osteoinduction, and filed Jun. 29, 2017.

FIELD

[0002] The present disclosure generally relates to medical devices for the treatment of musculoskeletal disorders, and more particularly to a surgical device that includes an expandable spinal implant, systems for implanting and manipulating the expandable spinal implant, and a method for treating a spine.

BACKGROUND

[0003] Spinal disorders such as degenerative disc disease, disc herniation, osteoporosis, spondylolisthesis, stenosis, scoliosis and other curvature abnormalities, kyphosis, tumor, and fracture may result from factors including trauma, disease and degenerative conditions caused by injury and aging. Spinal disorders typically result in symptoms including pain, nerve damage, and partial or complete loss of mobility.

[0004] Non-surgical treatments, such as medication, rehabilitation and exercise can be effective, however, they may fail to relieve the symptoms associated with these disorders. Surgical treatment of these spinal disorders includes fusion, fixation, correction, discectomy, laminectomy and implantable prosthetics. As part of these surgical treatments, spinal constructs, such as, for example, bone fasteners, spinal rods and interbody devices can be used to provide stability to a treated region. For example, during surgical treatment, interbody devices may be introduced to a space between adjacent vertebral bodies (the interbody space) to properly space the vertebral bodies and provide a receptacle for bone growth promoting materials, e.g., grafting.

[0005] More recently, interbody devices have been introduced that provide additional capability beyond static spacing of the vertebral bodies. For example, some devices have expansion capability such that the implant may be introduced to the interbody space in a collapsed state and then expanded to produce additional spacing and, in some cases, introduce or restore curvature to the spine by expanding selectively. However, many existing expandable interbody designs have limited ranges of expansion.

[0006] An additional problem exists related to subsidence of spinal surfaces due to existing interbody devices having inadequately-sized load-bearing surfaces. In the case of expandable devices, the loads on the load-bearing surfaces, including loads generated during expansion of the implant, are often significant. An expandable implant with relatively large surface areas is needed to bear the loads, including the loads generated during implant expansion, in an attempt to avoid a need for follow-on surgery due to subsidence of spinal surfaces.

[0007] A further problem is instability of existing expandable interbody devices as they are expanded. Often, the load-bearing surfaces move relative to one another, as well as relative to an inserter, as the interbody device is expanded such that there is a risk of undesired shifts in the positioning of the interbody device within the interverterbral space. Additionally, and depending at least partly on the particular insertion technique employed, anatomical features such as the iliac crest and rib cage pose challenges to the adjustment of inter-body designs in situ.

[0008] The present disclosure seeks to address these and other shortcomings in the existing relevant arts.

SUMMARY

[0009] The techniques of this disclosure generally relate to highly adjustable interbody devices that are expandable to selectively increase/decrease a spacing distance between endplates of the interbody device and adjustable to selectively increase/decrease an angle of inclination between endplates of the interbody device. Additionally, at least in some embodiments, the techniques of this disclosure relate to a plate that may further be an expandable plate configured to be positioned external to and adjacent to a disc space that is securely connected to an adjustable interbody device configured to be positioned within the disc space. For example, an interbody device may be positioned between superior and inferior endplates and the expandable plate may be securely connected to the interbody device and be positioned outside of the disc space such that bone screws may selectively penetrate into the superior and inferior endplates.

[0010] The details of one or more aspects of the disclosure are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the techniques described in this disclosure will be apparent from the description and drawings, and from the claims.

[0011] In a first aspect, an expandable implant movable between a contracted position and an expanded position is disclosed. In various embodiments, the implant may include an expandable body having a length extending from a proximal end to a distal end in a proximal-to-distal direction, a width extending from a first lateral side to a second lateral

side in a widthwise direction, and a height extending from a superior end to an inferior end in a vertical direction, for example. In various embodiments, the length may be greater than the width. The expandable body may further include a superior endplate including a first outside surface and a first inside surface opposite the first outside surface, the first inside surface including first proximal ramps and first distal ramps disposed opposite the first proximal ramps, for example. The expandable body may further include an inferior endplate including a second outside surface and a second inside surface opposite the second outside surface, the second inside surface including second proximal ramps and second distal ramps disposed opposite the second proximal ramps, for example. The expandable body may further include a moving mechanism for expanding the superior endplate and the inferior endplate. In various embodiments, the moving mechanism may include a support block coupled to the superior endplate and the inferior endplate, the support block rotatably supporting a proximal set screw and a distal set screw along a rotation axis extending parallel to the proximal-to-distal direction, for example. In various embodiments, the moving mechanism may include a proximal trolley movably coupled to the proximal set screw, the proximal trolley including first superior ramped surfaces and first inferior ramped surfaces, for example. In various embodiments, the moving mechanism may include a distal trolley movably coupled to the distal set screw, the distal trolley including second superior ramped surfaces and second inferior ramped surfaces, for example. In at least some embodiments, in a contracted position the proximal trolley and the distal trolley may be disposed in a medial position within the expandable body, for example. In at least some embodiments, in a first expanded position, the proximal trolley may be disposed adjacent a proximal side of the expandable body and a spacing between the superior and inferior endplates at the proximal end is greater than a spacing between the superior and inferior endplates at the proximal end in the contracted position, for example. In at least some embodiments, in a second expanded position a spacing between the superior and inferior endplates at the distal end is greater than a spacing between the superior and inferior endplates at the distal end in the contracted position.

[0012] In another aspect, a laterally insertable spinal implant is disclosed. The implant may include an expandable body having a length extending from a proximal end to a distal end in a proximal-to-distal direction, a width extending from a first lateral side to a second lateral side in a widthwise direction, and a height extending from a superior end to an inferior end in a vertical direction, for example. In various embodiments, the length may be greater than the width, for example. The implant may further include a superior endplate including a first outside surface and a first inside surface opposite the first outside surface, the first inside surface including first proximal ramps and first distal ramps disposed opposite the first proximal ramps, for example. The implant may further include an inferior endplate including a second outside surface and a second inside surface opposite the second outside surface, the second inside surface including second proximal ramps and second distal ramps disposed opposite the second proximal ramps, for example. The implant may further include a support block coupled to the superior endplate and the inferior endplate, the support block having a proximal screw guide and a distal screw guide opposite the proximal screw guide, for example. In various embodiments, the proximal screw guide may define a first rotation axis and the distal screw guide may define a second rotation axis, and the first and second rotation axes may extend in the proximal-to-distal direction, for example. The implant may further include a proximal set screw rotatably supported by the proximal screw guide and a distal set screw rotatably supported by the distal screw guide, for example. The implant may further include a proximal trolley coupled to the proximal set screw and including first superior ramped surfaces and first inferior ramped surfaces, for example. The implant may further include a distal trolley coupled to the distal set screw and including second superior ramped surfaces and second inferior ramped surfaces, for example. In at least some embodiments, the proximal trolley is coupled to the proximal set screw and movable toward and away from the proximal end of the expandable body in the proximal-to-distal direction by rotation of the proximal set screw along the first rotation axis, the distal trolley is coupled to the distal set screw and movable toward and away from the distal end of the expandable body in the proximal-to-distal direction by rotation of the distal set screw along the second rotation axis, for example. In various embodiments, the proximal trolley and the distal trolley are configured to simultaneously distract the superior and inferior endplates in a parallel manner upon simultaneous rotation of both the proximal set screw and distal set screw in a first direction and simultaneously contract the superior and inferior endplates in a parallel manner upon simultaneous rotation of both the proximal set screw and distal set screw in a second direction opposite the first direction, for example. In various embodiments, the proximal set screw is configured to urge the proximal trolley towards the proximal end of the expandable body in the proximal-to-distal direction upon independent rotation of the proximal set screw in the first direction, thereby distracting the superior and inferior endplates at the proximal end of the expandable body, for example. In various embodiments, the distal set screw is configured to urge the distal trolley towards the distal end of the expandable body in the proximal-to-distal direction upon independent rotation of the distal set screw in the first direction, thereby distracting the superior and inferior endplates at the distal end of the expandable body, for example.

[0013] In another aspect, a spinal implant configured for lateral insertion surgical techniques is disclosed. The implant may include a superior endplate and an inferior endplate extending in a proximal to distal direction, for example. In various embodiments, the superior endplate may include a first outside surface and a first inside surface opposite the first outside surface, the first outside surface including at least one bone screw relief and the first inside surface including a first plurality of guide walls, for example. In various embodiments the superior endplate may further include a first proximal end and a first distal end opposite the first proximal end, first proximal ramps and first distal ramps disposed opposite the first proximal ramps, and a first lateral surface and a second lateral surface opposite the first lateral surface, the first and second lateral surfaces extending between the first proximal end and the first distal end, for example. The implant may further include an inferior endplate having a second outside surface and a second inside surface opposite the second outside surface, the second outside surface including at least one bone screw relief and the second inside surface including a second plurality of guide walls, for example. In various embodiments, the inferior endplate may further include a second proximal end and a second distal end opposite the second proximal end, second proximal ramps and second distal ramps disposed opposite the second proximal ramps, and a third lateral surface and a fourth lateral surface opposite the third lateral surface, the third and fourth lateral surfaces extending between the second proximal end and the second distal end, for example. The implant may further include a proximal plate including a plurality of bone screw apertures and a central aperture, for example. The implant may further include a moving mechanism operably coupled to the proximal plate, superior endplate and the inferior endplate, for example. The moving mechanism may further include a support block and a first trolley, and a second trolley disposed on opposite sides of the support block, a rotatable first set screw and a rotatable second set screw opposite the first set screw, for example. In various embodiments, the first set screw and second set screw may be configured to rotate in a first rotation direction and a second rotation direction about a rotation axis projecting in a direction substantially parallel to the length of the expandable body, and the proximal plate may be directly connected to the support block, for example. In at least some embodiments, the first trolley may be operably coupled to the first set screw and movable toward and away the support block in the proximal to distal direction by rotation of the first set screw along the rotation axis, the second trolley may be operably coupled to the second set screw and movable toward and away the support block in the proximal to distal direction by rotation of the second set screw along the rotation axis, for example. In at least some embodiments, the first trolley may include a first side surface and a second side surface opposite the first side surface and has a first plurality of projections projecting from the first and second side surfaces, for example. In at least some embodiments, the second trolley may include a third side surface and a fourth side surface opposite the third side surface and have a second plurality of projections projecting from the third and fourth side surfaces, for example. In at least some embodiments, the first and second plurality of projections correspond to a cross sectional shape of the first and second plurality of guide walls and are operably coupled thereto, respectively, such that the first and second plurality of projections move along the first and second plurality of guide walls, respectively, for example. In various embodiments, the moving mechanism may be configured to operably adjust a spacing between the superior and inferior endplates upon simultaneous rotation of the first and second set screws along the rotation axis. In various embodiments, the moving mechanism may be configured to operably adjust an angle of inclination between the superior and inferior endplates upon rotating either one of the first set screw and second set screw along the rotation axis, for example.

BRIEF DESCRIPTION OF DRAWINGS

[0014] FIG. **1**A is a perspective view of one embodiment of an expandable spinal implant in a fully contracted position in accordance with the principles of the present disclosure;

[0015] FIG. **1**B is an exploded parts view of the embodiment of FIG. **1**A in accordance with the principles of the present disclosure;

[0016] FIG. **1**C is a perspective view of one embodiment of an expandable spinal implant in a contracted or closed configuration in accordance with the principles of the present disclosure;

[0017] FIG. **1**D is a perspective view of one embodiment of an expandable spinal implant in an expanded or opened configuration in accordance with the principles of the present disclosure;

[0018] FIGS. **2**A and **2**B are a top down views of the embodiment of FIGS. **1**A and **1**B in accordance with the principles of the present disclosure;

[0019] FIGS. **2**C and **2**D are side views of the embodiment of FIGS. **1**A and **1**B in a contracted position in accordance with the principles of the present disclosure;

[0020] FIGS. **2**E and **2**F are side views of the embodiment of FIGS. **1**A and **1**B in an expanded position in accordance with the principles of the present disclosure;

[0021] FIG. **3**A is a perspective view of one embodiment of an expandable spinal implant in a closed configuration in accordance with the principles of the present disclosure;

[0022] FIG. **3**B is a perspective view of one embodiment of an expandable spinal implant in an expanded configuration in accordance with the principles of the present disclosure;

[0023] FIG. **4**A is a top down view of the embodiment of FIGS. **2**A-**2**C in accordance with the principles of the present disclosure;

[0024] FIG. **4**B is a side view of the embodiment of FIGS. **2**A-**2**C in a contracted position in accordance with the principles of the present disclosure;

[0025] FIG. **4**C is a side view of the embodiment of FIGS. **2**A-**2**C in a partially expanded and inclined position in accordance with the principles of the present disclosure;

[0026] FIG. **4**D is a side view of the embodiment of FIGS. **2**A-**2**C in a fully expanded position in accordance with the principles of the present disclosure;

[0027] FIG. **5**A is a top down view of one embodiment in accordance with the principles of the present disclosure;

[0028] FIG. **5**B is a front side view of the embodiment of FIG. **5**A in accordance with the principles of the present disclosure;

[0029] FIG. **5**C is an alternate side view of the embodiment of FIG. **5**A in accordance with the principles of the present disclosure;

[0030] FIGS. **6**A-**6**C are top down views of three exemplary footprint sizes of a top endplate in accordance with the principles of the present disclosure;

[0031] FIGS. **7**A-**7**C are top down views of three exemplary footprint sizes of a bottom endplate in accordance with the principles of the present disclosure;

[0032] FIG. **8** is perspective view of one embodiment of an expandable spinal implant system in accordance with the principles of the present disclosure;

[0033] FIG. **9**A is a cutout perspective showing a surgical tool in a first adjustment position where an exemplary spinal implant is in a contracted position;

[0034] FIG. **9**B is a cutout perspective showing the surgical tool in the first adjustment position after adjusting the exemplary spinal implant from the contracted position to a first expanded position;

[0035] FIG. **10**A is a cutout perspective showing the surgical tool in a second adjustment position where the exemplary spinal implant is in the first expanded position of FIG. **9**B;

[0036] FIG. **10**B is a cutout perspective showing the surgical tool in the second position after adjusting the exemplary spinal implant from the first expanded position to an expanded and angled position;

[0037] FIGS. **11**A and **11**B are perspective views of a moving mechanism in a contracted position and an expanded position, respectively, in accordance with the principles of the present disclosure;

[0038] FIGS. **12**A and **12**B are perspective views of the moving mechanism of FIGS. **11**A and **11**B in the contracted position and the expanded position, respectively, with a bottom endplate in accordance with the principles of the present disclosure;

[0039] FIGS. **13**A and **13**B are perspective views of the moving mechanism of FIGS. **12**A and **12**B in the contracted position and the expanded position, respectively, with a top endplate and the bottom endplate in accordance with the principles of the present disclosure;

[0040] FIGS. **14**A and **14**B are cut-out views of a moving mechanism in accordance with the principles of the present disclosure;

[0041] FIG. **15** is a cross section of the moving mechanism of FIGS. **14**A and **14**B along a longitudinal axis thereof in accordance with the principles of the present disclosure;

[0042] FIG. **16** is a perspective view of a top endplate and bottom endplate of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0043] FIG. **17** is an exploded view of the top endplate and bottom endplate of FIG. **16** in accordance with the principles of the present disclosure;

[0044] FIGS. **18**A-**18**B are perspective views of a first surgical tool of an expandable spinal implant system in accordance with the principles of the present disclosure;

[0045] FIGS. **19**A-**19**C are side views of first surgical tool and adjustment rod of an expandable spinal implant system, respectively, in accordance with the principles of the present disclosure;

[0046] FIG. **20** illustrates a perspective view of one embodiment of an expandable spinal implant system having anchoring screws in accordance with the principles of the present disclosure;

[0047] FIGS. **21**A-**21**B illustrate a lateral side view and front side view, respectively, of one embodiment of an expandable spinal implant system having anchoring screws in accordance with the principles of the present disclosure;

[0048] FIG. **22**A is a side view of a second surgical device suitable for use with the embodiment of FIG. **20** in accordance with the principles of the present disclosure;

[0049] FIG. **22**B is a side view of an enlarged region of FIG. **22**A in accordance with the principles of the present disclosure;

[0050] FIGS. **23**A-**23**C are various perspective views of exemplary anchoring screws suitable for use with the embodiment of FIG. **20** in conjunction with the second surgical tool of FIGS. **22**A-**22**B in accordance with the principles of the present disclosure;

[0051] FIGS. **24**A-**24**D are various side views and top down views of exemplary bone grafts in accordance with the principles of the present disclosure;

[0052] FIG. **25**A and FIG. **25**B illustrate a first bent position and a second bent position, respectively, of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0053] FIGS. **26**-**28** illustrate a left side view, right side view, and front side view, respectively, of an installed expandable spinal implant positioned between adjacent vertebral bodies in accordance with the principles of the present disclosure;

[0054] FIG. **29**A is a perspective view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0055] FIG. **29**B is an exploded view of the embodiment of FIG. **29**A in accordance with the principles of the present disclosure;

[0056] FIG. **30**A is a top down view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0057] FIG. **30**B is perspective view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0058] FIG. **30**C is a perspective view of one embodiment of an expandable spinal implant with a top endplate removed in accordance with the principles of the present disclosure;

[0059] FIG. **30**D is an alternate perspective view of one embodiment of an expandable spinal implant with a top endplate removed in accordance with the principles of the present disclosure;

[0060] FIG. **30**E is a top down view of one embodiment of a top endplate in accordance with the principles of the present disclosure;

[0061] FIG. **30**F is a top down view of one embodiment of a bottom endplate in accordance with the principles of the present disclosure;

[0062] FIG. **31** is a perspective view of one embodiment of an expandable spinal implant system illustrating three alternate angular positions of an insertion tool in accordance with the principles of the present disclosure;

[0063] FIG. **32**A is a top down view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0064] FIG. **32**B is a perspective view of the embodiment of FIG. **32**A in accordance with the principles of the present disclosure;

[0065] FIG. **33**A is a perspective view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0066] FIG. **33**B is a perspective view of the embodiment of FIG. **33**A in an expanded position in accordance with the principles of the present disclosure;

[0067] FIG. **33**C is a perspective view of the embodiment of FIG. **33**A in a first tilted position in accordance with the principles of the present disclosure;

[0068] FIG. **33**D is a perspective view of the embodiment of FIG. **33**A in a second tilted position in accordance with the principles of the present disclosure;

[0069] FIG. **34** is a perspective view of one embodiment of an expandable spinal implant system in accordance with the principles of the present disclosure;

[0070] FIG. **35** is a perspective view of one embodiment of an expandable spinal implant system illustrating three alternate angular positions of an insertion tool in accordance with the principles of the present disclosure;

[0071] FIG. **36** is a perspective view of one embodiment of an expandable spinal implant including a screw guide endplate having at least one aperture configured to receive a anchoring screw therein;

[0072] FIG. **37** is a front view of the embodiment of FIG. **36**;

[0073] FIGS. **38**A and **38**B are various perspective views of a screw guide endplate having at least one aperture configured to receive a anchoring screw therein;

[0074] FIGS. **39**A and **39**B are top down view of a top endplate and a bottom endplate including at least one slotted aperture configured to receive a anchoring screw therein;

[0075] FIG. **40** is a perspective view of one embodiment of an expandable spinal implant including a screw guide endplate having at least one aperture configured to receive a anchoring screw therein;

[0076] FIG. **41** is a front view of the embodiment of FIG. **40**;

[0077] FIG. **42**A is a front views of a screw guide endplate having at least one aperture configured to receive a anchoring screw therein;

[0078] FIG. **42**B is a front view of the screw guide endplate of FIG. **42**A including anchoring screws installed in each of the corresponding apertures;

[0079] FIG. **43**A and FIG. **43**B are various perspective views of a screw guide endplate having at least one aperture configured to receive a anchoring screw therein;

[0080] FIGS. **44**A and **44**B are top down views of a top endplate and a bottom endplate including at least one recessed portion configured to accommodate a anchoring screw;

[0081] FIG. **45** is a perspective view of an additional embodiment of an expandable spinal implant including an anterior endplate in accordance with the principles of the present disclosure;

[0082] FIG. **46** is an alternate perspective view of the embodiment of FIG. **45** in accordance with the principles of the present disclosure;

[0083] FIG. **47** is an exploded parts view diagram of the embodiment of FIG. **45** in accordance with the principles of the present disclosure;

[0084] FIG. **48**A is a first view of a bottom endplate of the embodiment of FIG. **45** in accordance with the principles of the present disclosure;

[0085] FIG. **48**B is a second view of a bottom endplate of the embodiment of FIG. **45** in accordance with the principles of the present disclosure;

[0086] FIG. **48**C is a perspective view of the embodiment of FIG. **45** in the expanded position in accordance with the principles of the present disclosure;

[0087] FIG. **49** is a perspective view of the embodiment of FIG. **45** including a plurality of bone screws in accordance with the principles of the present disclosure;

[0088] FIG. **50** is an alternate perspective view of the embodiment of FIG. **45** including a plurality of bone screws in accordance with the principles of the present disclosure;

[0089] FIG. **51** is a rear perspective view of the embodiment of FIG. **45** including a plurality of bone screws in accordance with the principles of the present disclosure;

[0090] FIG. **52** is a side view of an example bone screw;

[0091] FIG. **53** is a reference diagram illustrating various cardinal directions and planes with respect to a patient that the exemplary embodiments of FIGS. **1**-**44**B may operate, adjust, and/or move along in accordance with the principles of the present disclosure;

[0092] FIG. **54** is a perspective view of a first expandable plate embodiment for coupling to disclosed spinal implants;

[0093] FIG. **55** is an alternate perspective view of a first expandable plate embodiment for coupling to disclosed spinal implants;

[0094] FIG. **56** is a front view of a first expandable plate embodiment for coupling to disclosed spinal implants;

[0095] FIG. **57** is a perspective exploded parts view of a first expandable plate embodiment for coupling to disclosed spinal implants;

[0096] FIG. **58** is an alternate perspective exploded parts view of a first expandable plate embodiment for coupling to disclosed spinal implants;

[0097] FIG. **59** is an alternate perspective exploded parts view of a first expandable plate embodiment for coupling to disclosed spinal implants;

[0098] FIG. **60** is a front view of a first expandable plate embodiment coupled to a spinal implant;

[0099] FIG. **61** is a cross section view of FIG. **60**;

[0100] FIG. **62** is a perspective view of a second expandable plate embodiment for coupling to disclosed spinal implants;

[0101] FIG. **63** is an alternate perspective view of a second expandable plate embodiment for coupling to disclosed spinal implants;

[0102] FIG. **64** is a front view of a second expandable plate embodiment for coupling to disclosed spinal implants;

[0103] FIG. **65** is a perspective exploded parts view of a second expandable plate embodiment for coupling to disclosed spinal implants;

[0104] FIG. **66** is a perspective view of a second expandable plate embodiment in an expanded position;

[0105] FIG. **67** is an alternate perspective view of a second expandable plate embodiment in an expanded position;

[0106] FIG. **68** is a perspective view of a third expandable plate embodiment for coupling to disclosed spinal implants;

[0107] FIG. **69** is an alternate perspective view of a third expandable plate embodiment for coupling to disclosed spinal implants;

[0108] FIG. **70** is a front view of a third expandable plate embodiment for coupling to disclosed spinal implants;

[0109] FIG. **71** is a perspective exploded parts view of a third expandable plate embodiment for coupling to disclosed spinal implants;

[0110] FIG. **72** is a perspective view of a third expandable plate embodiment in an expanded position;

[0111] FIG. **73** is a perspective view of a third expandable plate embodiment in an expanded position;

[0112] FIG. **74** is a flow chart of a method of operation of various expandable plates;

[0113] FIG. **75** is a front perspective view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0114] FIG. **76** is a rear perspective view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0115] FIG. **77** is a first exploded parts view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0116] FIG. **78** is a first exploded parts view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0117] FIG. **79** is a top view showing various section lines of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0118] FIG. **80** is a perspective cross section drawing through section A_3 of FIG. **79**;

[0119] FIG. **81** is a perspective cross section drawing through section A_1 of FIG. **79**;

[0120] FIG. **82** is a perspective cross section drawing through section A_4 of FIG. **79**;

[0121] FIG. **83** is a front perspective view of one embodiment of an expandable spinal implant in accordance with the principles of the present disclosure;

[0122] FIG. **84** is a front perspective view of the embodiment of FIG. **83** in a partially expanded first position in accordance with the principles of the present disclosure;

[0123] FIG. **85** is a front perspective view of the embodiment of FIG. **83** in a partially expanded second position in accordance with the principles of the present disclosure;

[0124] FIG. **86** is a front perspective view of the embodiment of FIGS. **83-85** in a fully expanded position in accordance with the principles of the present disclosure;

[0125] FIG. **87** is a partial parts view of the embodiment of FIG. **86** with the superior endplate removed for ease of understanding in accordance with the principles of the present disclosure;

[0126] FIG. **88** is a front perspective view of one embodiment in accordance with the principles of the present disclosure;

[0127] FIG. **89** is a front perspective view of one embodiment in accordance with the principles of the present disclosure; and

[0128] FIG. **90** is a top-down view of one embodiment in accordance with the principles of the present disclosure.

DETAILED DESCRIPTION

[0129] The exemplary embodiments of, for example, an anterior expandable inter-body device, lateral expandable inter-body device, inter-body device systems, and inter-body device methods of use are discussed in terms of medical devices for the treatment of musculoskeletal disorders and more particularly, in terms of various inter-body devices suitable as spinal implants for anterior surgical techniques, oblique surgical techniques, and lateral surgical techniques. Exemplary embodiments are also discussed with related emphasis on specialized adjustment instruments such as, for example, an instrument capable of adjusting a spacing of the aforementioned various interbody devices between adjacent vertebrates of a spine by expansion and contraction as well as adjusting an angle of inclination with respect to the coronal plane and/or sagittal plane of a patient. Disclosed devices and systems may be capable of adjusting the curvature of a patient's spine for lordosis correction and a kyphosis correction. Likewise, an instrument capable of installing various anchoring screws is described in conjunction with disclosed inter-body devices.

[0130] As used herein, standard anatomical terms of location have their ordinary meaning as they would be understood by a person of ordinary skill in the art unless clearly defined or explained otherwise. It should be understood that various aspects disclosed herein may be combined in different combinations than the combinations specifically presented in the description and accompanying drawings. For example, characteristics of one embodiment may be combined or substituted with characteristics of another different embodiment unless those characteristics are clearly explained as being mutually exclusive. It should also be understood that, depending on the example, certain acts or events of any of the processes or methods described herein may be performed in a different sequence, may be added, merged, or left out altogether (e.g., all described acts or events may not be necessary to carry out the disclosed techniques and methods). In addition, while certain aspects of this disclosure are described as being performed by a single module or unit for purposes of clarity, it should be understood that the techniques of this disclosure may be performed by a combination of units or modules associated with, for example, a medical device.

[0131] In some embodiments, the present system includes an expandable spinal implant suitable for insertion for oblique techniques, postero-lateral procedures and/or transforaminal lumbar interbody fusions (sometimes referred to as TLIF procedures), direct posterior (sometimes referred to as PLIF procedures), direct lateral (sometimes referred to as DLIF procedures), anterior lumbar interbody fusions (sometimes refered to as ALIF procedures), or variations of these procedures, in which the present implant is inserted into an interverterbral space and then expanded in order to impart and/or augment a lordotic and/or kyphotic curve of the spine.

[0132] In some embodiments, the spinal implant system may also be employed to restore and/or impart sagittal balance to a patient by increasing and/or restoring an appropriate lordotic and/or kyphotic angle between vertebral bodies at a selected level where the spinal implant is implanted and expanded. Additionally, some embodiments may also be employed to restore and/or impart coronal balance for correction of, for example, scoliosis. In the various embodiments described, the spinal implant system may be useful in a variety of complex spinal procedures for treating spinal conditions beyond one-level fusions. Furthermore, the spinal implant system described in the enclosed embodiments may also be used as a fusion device with an expandable height for tailoring the implant to a particular interbody disc space to restore the spacing between adjacent vertebral bodies and facilitate spinal fusion between the adjacent vertebral bodies.

[0133] In some embodiments, and as mentioned above, the present disclosure may be employed to treat spinal disorders such as, for example, degenerative disc disease, disc herniation, osteoporosis, spondylolisthesis, stenosis, scoliosis and other curvature abnormalities, kyphosis, tumor and fractures. In some embodiments, the present disclosure may be employed with other osteal and bone related applications, including those associated with diagnostics and therapeutics. In some embodiments, the disclosed spinal implant system may be alternatively employed in a surgical treatment with a patient in a prone or supine position, and/or employ various surgical approaches to the spine, including anterior, posterior, posterior mid-line, direct lateral, postero-lateral oblique, and/or antero lateral oblique approaches, and in other body regions. The present disclosure may also be alternatively employed with procedures for treating the lumbar, cervical, thoracic, sacral and pelvic regions of a spinal column. The spinal implant system of the present disclosure may also be used on animals, bone models and other non-living substrates, such as, for example, in training, testing and demonstration.

[0134] The present disclosure may be understood more readily by reference to the following detailed description of the embodiments taken in connection with the accompanying drawing figures, which form a part of this disclosure. It is to be understood that this application is not limited to the specific devices, methods, conditions or parameters described and/or shown herein, and that the terminology used herein is for the purpose of describing particular embodiments by way of example only and is not intended to be limiting. In some embodiments, as used in the specification and including the appended claims, the singular forms "a," "an," and "the" include the plural, and reference to a particular numerical value includes at least that particular value, unless the context clearly dictates otherwise. Ranges may be expressed herein as from "about" or "approximately" one particular value and/or to "about" or "approximately" another particular value. When such a range is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent "about," it will be understood that the particular value forms another embodiment. It is also understood that all spatial references, such as, for example, horizontal, vertical, top, upper, lower, bottom, left and right, are for illustrative purposes only and can be varied within the scope of the disclosure. For example, the references "upper" and "lower" are relative and used only in the context to the other, and are not necessarily "superior" and "inferior". Generally, similar spatial references of different aspects or components, e.g., a "proximal end" of an end plate and a "proximal end" of a wedge, indicate similar spatial orientation and/or positioning, i.e., that each "proximal end" is situated on or directed towards the same end of the device. Further, the use of various spatial terminology herein should not be interpreted to limit the various insertion techniques or orientations of the implant relative to the positions in the spine.

[0135] As used in the specification and including the appended claims, "treating" or "treatment" of a disease or condition refers to performing a procedure that may include administering one or more drugs, biologics, bone grafts (including allograft, autograft, xenograft, for example) or bone-growth promoting materials to a patient (human, normal or otherwise or other mammal), employing implantable devices, and/or employing instruments that treat the disease, such as, for example, micro-discectomy instruments used to remove portions bulging or herniated discs and/or bone spurs, in an effort to alleviate signs or symptoms of the disease or condition. Alleviation can occur prior to signs or symptoms of the disease or condition appearing, as well as after their appearance. Thus, treating or treatment includes preventing or prevention of disease or undesirable condition (e.g., preventing the disease from occurring in a patient, who may be predisposed to the disease but has not yet been diagnosed as having it). In addition, treating or treatment does not require complete alleviation of signs or symptoms, does not require a cure, and specifically includes procedures that have only a marginal effect on the patient. Treatment can include inhibiting the disease, e.g., arresting its development, or relieving the disease, e.g., causing regression of the disease. For example, treatment can include reducing acute or chronic inflammation; alleviating pain and mitigating and inducing re-growth of new ligament, bone and other tissues; as an adjunct in surgery; and/or any repair procedure. Also, as used in the specification and including the appended claims, the term "tissue" includes soft tissue, ligaments, tendons, cartilage and/or bone unless specifically referred to otherwise. The term "bone growth promoting material" as used herein may include, but is not limited to: bone graft (autograft, allograft, xenograft) in a variety of forms and compositions (including but not limited to morselized bone graft); osteoinductive material such as bone morphogenetic proteins (BMP) (including but not limited to INFUSE® available from Medtronic) and alternative small molecule osteoinductive substances; osteoconductive materials such as demineralized bone matrix (DBM) in a variety of forms and compositions (putty, chips, bagged (including but not limited to the GRAFTON® family of products available from Medtronic)); collagen sponge; bone putty; ceramic-based void fillers; ceramic powders; and/or other substances suitable for inducing, conducting or facilitating bone growth and/or bony fusion of existing bony structures. Such bone growth promoting materials may be provided in a variety of solids, putties, liquids, colloids, solutions, or other preparations suitable for being packed or placed into or around the various implants **100**, **200**, **300** and embodiments described herein.

[0136] Various embodiments and components may be coated with a ceramic, titanium, and/or other biocompatible material to provide surface texturing at (a) the macro scale, (b) the micro scale, and/or (c) the nano scale, for example. Similarly, components may undergo a subtractive manufacturing process providing for surface texturing configured to facilitate osseointegration and cellular attachment and osteoblast maturation. Example surface texturing of additive and subtractive manufacturing processes may comprise (a) macro-scale structural features having a maximum peak-to-valley height of about 40 microns to about 500 microns, (b) micro-scale structural features having a maximum peak-to-valley height of about 2 microns to about 40 microns, and/or (c) nano-scale structural features having a maximum peak-to-valley height of about 0.05 microns to about 5 microns. In various embodiments, the three types of structural features may be overlapping with one another, for example. Additionally, such surface texturing may be applied to any surface, e.g., both external exposed facing surfaces of components and internal non exposed surfaces of components. Further discussion regarding relevant surface texturing and coatings is described in, for example, U.S. Pat. No. 11,096,796, titled Interbody spinal implant having a roughened surface topography on one or more internal surfaces, and filed on Mar. 4, 2013—the entire disclosure of which is incorporated herein by reference in its entirety. Accordingly, it shall be understood that any of the described coating and texturing processes of U.S. Pat. No. 11,096,796, may be applied to any component of the various embodiments disclosed herein, e.g., the exposed surfaces and internal surfaces of endplates. Another example technique for manufacturing an orthopedic implant having surfaces with osteoinducting roughness features including micro-scale structures and nano-scale structures is disclosed in U.S. Pat. No. 10,821,000, the entire contents of which are incorporated herein by reference. Additionally, an example of a commercially available product may be the Adaptix™ Interbody System sold by Medtronic Spine and comprising a titanium cage made with Titan nanoLOCK™.

[0137] The components of the expandable spinal implant systems described herein can be fabricated from biologically acceptable materials suitable for medical applications, including metals, synthetic polymers, ceramics and bone material and/or their composites. For example, the components of expandable spinal implant system, individually or collectively, can be fabricated from materials such as stainless steel alloys, commercially pure titanium, titanium alloys, Grade 5 titanium, super-elastic titanium alloys, cobalt-chrome alloys, stainless steel alloys, superelastic metallic alloys (e.g., Nitinol, super elasto-plastic metals, such as GUM METAL®), ceramics and composites thereof such as calcium phosphate (e.g., SKELITE™), thermoplastics such as polyaryletherketone (PAEK) including polyetheretherketone (PEEK), polyetherketoneketone (PEKK) and polyetherketone (PEK), carbon-PEEK composites, PEEK-BaSO4 polymeric rubbers, polyethylene terephthalate (PET), fabric, silicone, polyurethane, silicone-polyurethane copolymers, polymeric rubbers, polyolefin rubbers, hydrogels, semi-rigid and rigid materials, elastomers, rubbers, thermoplastic elastomers, thermoset elastomers, elastomeric composites, rigid polymers including polyphenylene, polyamide, polyimide, polyetherimide, polyethylene, epoxy, bone material including autograft, allograft, xenograft or transgenic cortical and/or corticocancellous bone, and tissue growth or differentiation factors, partially resorbable materials, such as, for example, composites of metals and calcium-based ceramics, composites of PEEK and calcium based ceramics, composites of PEEK with resorbable polymers, totally resorbable materials, such as, for example, calcium based ceramics such as calcium phosphate, tri-calcium phosphate (TCP), hydroxyapatite (HA)-TCP, calcium sulfate, or other resorbable polymers such as polyaetide, polyglycolide, polytyrosine carbonate, polycaprolactone and their combinations.

[0138] Various components of spinal implant system may be formed or constructed of material composites, including but not limited to the above-described materials, to achieve various desired characteristics such as strength, rigidity, elasticity, compliance, biomechanical performance, durability and radiolucency or imaging preference. The components of expandable spinal implant system, individually or collectively, may also be fabricated from a heterogeneous material such as a combination of two or more of the above-described materials. The components of the expandable spinal implant systems may be monolithically formed, integrally connected or include fastening elements and/or instruments, as described herein. For example, in some embodiments the expandable spinal implant systems may comprise expandable spinal implants **100**, **200**, **300** comprising PEEK and/or titanium structures with radiolucent markers (such as tantalum pins and/or spikes) selectively placed in the implant to provide a medical practitioner with placement and/or sizing information when the expandable spinal implant **100**, **200**, **300** is placed in the spine. The components of the expandable spinal implant system may be formed using a variety of subtractive and additive manufacturing techniques, including, but not limited to machining, milling, extruding, molding, 3D-printing, sintering, coating, vapor deposition, and laser/beam melting. Furthermore, various components of the expandable spinal implant system may be coated or treated with a variety of additives or coatings to improve biocompatibility, bone growth promotion or other features. For example, the endplates **110**, **120**, may be selectively coated with bone growth promoting or bone ongrowth promoting surface treatments that may include, but are not limited to: titanium coatings (solid, porous or textured), hydroxyapatite coatings, or titanium plates (solid, porous or textured).

[0139] The expandable spinal implant system may be employed, for example, with a minimally invasive procedure, including percutaneous techniques, mini-open and open surgical techniques to deliver and introduce instrumentation and/or one or more spinal implants at a surgical site within a body of a patient, for example, a section of a spine. In some embodiments, the expandable spinal implant system may be employed with surgical procedures, as described herein, and/or, for example, corpectomy, discectomy, fusion and/or fixation treatments that employ spinal implants to restore the mechanical support function of vertebrae. In some embodiments, the expandable spinal implant system may be employed with surgical approaches, including but not limited to: anterior lumbar interbody fusions (ALIF), posterior lumbar interbody fusion (PLIF), oblique lumbar interbody fusion, transforaminal lumbar interbody fusion (TLIF), various types of anterior fusion procedures, and any fusion procedure in any portion of the spinal column (sacral, lumbar, thoracic, and cervical, for example).

[0140] Generally in FIGS. **1-44**B, five exemplary embodiments of an expandable spinal implants **100**, **200**, **300**, **600**, and **700** are shown (spinal implant **100** is highlighted in exemplary FIGS. **1-28**, implant **200** is highlighted in exemplary FIGS. **29-31**, implant **300** is highlighted in exemplary FIGS. **32-35**, implant **600** is highlighted in exemplary FIGS. **36-39**B, implant **700** is highlighted in FIGS. **40-44**B). Exemplary embodiments of surgical tools **400**, **450**, and **500** are highlighted in exemplary FIGS. **8**, **18-23**C and disclosed in conjunction with an inter-body spinal implant system. For example, surgical tools **400**, **450**, and **500** are discussed concurrently with exemplary spinal implant **100**. It shall be understood that the same or similar surgical tools highlighted in exemplary FIGS. **8**, **18-23**C may be employed with expandable spinal implants **200**, **300**, **600**, and **700**. Similar and/or identical numbering of corresponding elements may be used interchangeably between the various exemplary embodiments of an expandable spinal implants **100**, **200**, **300**, **600**, and **700** for ease of understanding and convenience in explanation. For example, moving mechanism **250** is predominately discussed concurrently with exemplary spinal implant **100** and is highlighted in exemplary FIGS. **9**A-**15** although the same or similar moving mechanism **250** may be employed with expandable spinal implants **200**, **300**, **600**, and **700**. FIG. **53** is provided solely as a reference illustration showing a patient **1** and various standard medical terms and orientations with respect to cardinal directions and planes of the body of patient **1** in which expandable spinal implants **100**, **200**, **300**, **600**, and **700** may act.

[0141] Referring generally to FIGS. **1-28** a first exemplary expandable spinal implant **100**, moving mechanism **250**, first surgical tool **400**, and second surgical tool **500** are illustrated. Spinal implant **100** may be configured to be inserted in an intervertebral disc space between adjacent vertebral bodies accordingly to a variety of surgical techniques, e.g., anterior techniques, oblique techniques, and lateral techniques.

[0142] FIG. **1**A shows the spinal implant **100** in a perspective view and FIG. **1**B shows the spinal implant **100** in an exploded parts view. Exemplary spinal implant **100** includes a top endplate **110** (first endplate) and a bottom endplate **120** (second endplate) and a moving mechanism **250**, which will be described in greater detail below. Spinal implant **100** includes a proximal end **101** and a distal end **102** opposite the proximal end **101**, and a first lateral end **103** and a second lateral end **104** opposite the first lateral end

103. The first and second lateral ends **103**, **104** extend between the proximal end **101** and the distal end **102**. The proximal end **101** includes an exposed screw guide endplate **105** defining a corresponding screw guide aperture **107**, which are disposed between endplates **110** and **120**. The screw guide endplate **105** and guide aperture **107** will be described in greater detail below.

[0143] Top endplate **110** may include a first outside surface **111** and a first inside surface **112** opposite the first outside surface **111**. Similarly, bottom endplate **120** may include a second outside surface **121** and a second inside surface **122**. The outside surfaces **111**, **121** may be configured to be positioned between and/or contact vertebral bodies in a patients spine and have various surface characteristics. For example, in some embodiments, outside surfaces **111** and **122** may have a substantially linear surface profiles extending across faces of textured surfaces thereof. In other embodiments, outside surfaces **111** and **122** may have curved surface profiles extending across faces of textured surfaces thereof. Further details of endplates **110**, **120** will be described in greater detail below. Inside surfaces **111**, **122**, may surround moving mechanism **250** and have various contours, guides, cavities, and other operable characteristics that facilitate movement and/or provide mechanical advantage to other operable and movable corresponding parts to facilitate contraction, angular adjustment, lateral bending, absorption of compression forces, shear forces, etc. as will be explained in greater detail below.

[0144] In the exemplary embodiment, top endplate **110** includes a pair of first proximal ramps **114** and a pair of first distal ramps **116** opposite the first proximal ramps **114**. Each ramp of the first proximal ramps **114** includes an inclined surface extending away from inside surface **112** and moving mechanism **250**. Similarly, each ramp of first distal ramps **116** includes an inclined surface extending away from inside surface **112** and moving mechanism **250**. Bottom endplate **120** includes a pair of second proximal ramps **124** and a pair of second distal ramps **126** opposite the second proximal ramps **124**. Each ramp of the second proximal ramps **124** includes an inclined surface extending away from inside surface **122** and moving mechanism **250**. Similarly, each ramp of second distal ramps **126** includes an inclined surface extending away from inside surface **112** and moving mechanism **250**. Furthermore, each ramp **114**, **116**, **124**, **126** includes a corresponding guide wall **130** extending along an inside surface thereof and extending in a direction substantially parallel to the inclined surface of the corresponding ramp.

[0145] Exemplary spinal implant **100** includes a moving mechanism **250** that is operably coupled to top endplate **110** and bottom endplate **120** as will be explained in greater detail below. Moving mechanism **250** includes a first set screw **252** and a corresponding first trolley **256** operably coupled thereto, and a second set screw **254** and a corresponding second trolley **258** operably coupled thereto. A first functional feature of moving mechanism **250** is that it is further configured to increase and decrease a spacing between the top and bottom endplates **110**, **120** upon simultaneous rotation of the first and second set screws **252**, **254** in a clockwise and counterclockwise direction, respectively. A second functional feature of moving mechanism **250** is that it is further configured to increase and decrease an angle of inclination between the top and bottom endplates **110**, **120** upon rotation of the first set screw **252** in a clockwise and counterclockwise direction, respectively. Additional functions and attributes of moving mechanism **250** will be described in greater detail below.

[0146] FIG. **1**C is a perspective view of spinal implant **100** in a contracted position and FIG. **1**D is a perspective view of spinal implant **100** in an expanded position. In the contracted position of FIG. **1**C, top endplate **110** and bottom endplate **120** are contracted to a fully closed position. In the expanded position of FIG. **1**B, top endplate **110** and bottom endplate **120** are expanded to a mid-way position, i.e., endplates **110** and **120** can additionally expand if desired. In some embodiments, top endplate **110** may be referred to as an anterior wedge or anterior endplate and bottom endplate **120** may be referred to as a posterior wedge or posterior endplate.

[0147] As explained above, spinal implant **100** includes a proximal end **101** and a distal end **102** opposite the proximal end **101**, and a first lateral end **103** and a second lateral end **104** opposite the first lateral end **103**. It shall be understood that reference to other parts of spinal implant **100** may be in terms of the above orientation with reference to spinal implant **100** generally, e.g., endplate **110** may also include a proximal end **101** and a distal end **102** opposite the proximal end **101**, and a first lateral end **103** and a second lateral end **104** opposite the first lateral end **103**.

[0148] FIGS. **2**A and **2**B illustrate a top down view of spinal implant **100**. Spinal implant **100** has a length L and a width W predominately defined by a footprint of endplates **110**, **120**. Spinal implant **100** has a first reference axis A_1 and a second reference axis A_2. First reference axis A_1 may be understood as a projection passing through a central portion of guide aperture **107** in a direction parallel to an end surface of first and second lateral ends **103**, **104**, e.g., first reference axis A_1 may pass through the center of spinal implant **100** in a width wise direction. Second reference axis A_2 may be understood as a projection intersecting first reference axis A_1 and passing through the center of spinal implant **100** in a length wise direction. Top endplate **110** may have a plurality of channels **111***c* spaced apart from one another and extending in a length wise direction thereof, e.g., in a direction parallel with reference axis A_2. Similarly, bottom endplate **120** may have a plurality of channels **122***c* spaced apart from one another and extending in a length wise direction thereof, e.g., in a direction parallel with reference axis A_2. In the exemplary embodiment, channels **111***c*, **122***c* may each have an inclined edge portion that assists with positioning the spinal implant **100** between vertebral bodies and provides a surface for promoting bone growth thereon.

[0149] FIGS. **2**C and **2**D illustrate spinal implant **100** in a side view in a contracted position and FIGS. **2**E and **2**F illustrate spinal implant **100** in a side view in an expanded position. It shall be understood that FIGS. **2**C-**2**F schematically illustrate spinal implant **100** with some internal parts being illustrated or simplified and others being omit for ease of explanation. For example, FIGS. **2**C-**2**F are illustrated schematically solely to assist in explaining various positions of first and second endplates **110**, **120** with respect to one another. In the contracted position, a first height H_{1A} of proximal end **101** may be about 10 mm and in the expanded position a second height H_{1B} of proximal end **101** may be about 22 mm. In the contracted position, a first height H_{2A} of distal end **102** may be about 7 mm and in the expanded position a second height H_{2B} of distal end **102** may be about 12 mm. Additionally, in the contracted position, a first angle of inclination θ_1 between endplates **110**, **120** may be about 7° and in the expanded position a second angle of inclination θ_2 between endplates **110**, **120** may be about 25°. Although specific ranges are provided herein with reference to exemplary spinal implant **100**, other embodiments may have alternate corresponding dimensions, i.e., height, from those provided above. Likewise, other embodiments may have alternate corresponding angles of inclination between endplates **110**, **120**.

[0150] FIGS. **3**A and **3**B are perspective view of an alternate embodiment of a second spinal implant **200**. Spinal implant **200** may have the same characteristics or similar characteristics as spinal implant **100**. As illustrated, spinal implant **200** includes a top patterned endplate **110***a* and a bottom patterned endplate **120***a*. Top patterned endplate **110***a* includes an outside surface **111** and an inside surface **112** opposite the outside surface **111**. Similarly, bottom patterned endplate **120***a* includes a first outside surface **121** and a first inside surface **122** opposite the outside surface **111**. As illustrated, the outside surface **111** includes a plurality of raised diamond shaped surfaces **111***d* (a diamond tread pattern) and a plurality of first openings **111***a* that may each have a diamond like shape, a circular shape, and/or a diamond like shape including chamfered or rounded corners. Although not visible in FIGS. **3**A and **3**B, it shall be understood that bottom patterned endplate **120***a* may also have a plurality of raised diamond shaped surfaces and a plurality of openings the same as or similar to the plurality of raised diamond shaped surfaces **111***d* and the plurality of first openings **111***a* of top patterned endplate **110***a*.

[0151] As illustrated, the plurality of first openings **111***a* are circular and disposed in a central region of top patterned endplate **110***a*, although they may have alternate shapes and/or be disposed in alternate locations in other embodiments. For example, first and second outside surfaces **111** and **122** may comprise various anti-migration, anti-expulsion, and/or osseointegration features including, but not limited to: ridges, teeth, pores, and coatings (including but not limited to porous titanium coatings such as those provided on Capstone PTC™ implants available from Medtronic). The endplates **110***a*, **120***a* may further comprise at least one second opening **115** defined therein, and configured to allow bone growth materials to be packed, placed, or loaded into spinal implant **200**. In the exemplary embodiment a pair of second openings **115** are shown with each having a D like shape.

[0152] FIG. **4**A illustrates spinal implant **200** in a top down view and each of FIGS. **4**B-**4**D illustrate spinal implant **200** in a side view in a different respective position. FIG. **4**B illustrates spinal implant **200** in a first position, FIG. **4**C illustrates spinal implant **200** in a second position and FIG. **4**D illustrates spinal implant **200** in a third position. In the first position, a first height H_{1A} of proximal end **101** may be about 10 mm, in the second position a second height H_{1B} of proximal end **101** may be about 18 mm, and in the third position a third height Hic of proximal end **101** may be about 18 mm. In the first position, a first height H_{2A} of distal end **102** may be about 6 mm, in the second position a second height H_{2B} of distal end **102** may be about 5 mm, and in the third position a third height Hic of distal end **102** may be about 11.8 mm (approximately 12 mm). Additionally, in the first position, a first angle of inclination θ_1 between endplates **110***a*, **120***a* may be about 9°, in the second position a second angle of inclination θ_2 between endplates **110***a*, **120***a* may be about 30°, and in the third position a third angle of inclination θ_3 between endplates **110***a*, **120***a* may be about 13°. In some embodiments, the first position may correspond to a fully contracted position, the second position may correspond to a maximum inclination angle, and the third position may correspond to a fully expanded position. Although specific ranges are provided herein with reference to exemplary spinal implant **100**, other embodiments may have alternate corresponding dimensions, i.e., height, from those provided above. Likewise, other embodiments may have alternate corresponding angles of inclination between endplates **110***a*, **120***a*.

[0153] FIG. **5**A is a top down view of a spinal implant **300**. Spinal implant **300** may have the same characteristics or similar characteristics as spinal implant **200** and spinal implant **100**. FIGS. **5**B and **5**C are alternate side views of the embodiment of FIG. **5**A. As illustrated spinal implant **300** includes a first reference axis A_1 and a second reference axis A_2. First reference axis A_1 passes through the center of spinal implant **300** in a width wise direction and second reference axis A_2 passes through the center of spinal implant **300** in a length wise direction. First and second reference axes A_1 and A_2 may be understood as linear projections that are perpendicular with respect to one another. Additionally, first reference axis A_1 may pass through the center of guide aperture **107** and other components operably disposed therein, e.g., moving mechanism **250** as will be discussed in greater detail below.

[0154] As illustrated, spinal implant **300** includes a top curved endplate **110***c* and a bottom curved endplate **120***c*. The top curved endplate **110***c* features a concave surface profile with respect to the first and second reference axes A_1 and A_2 projecting thereunder. The concave surface profile is emphasized by the curved line thereabove. The bottom curved endplate **120** features a convex surface profile with respect to the first and second reference axes A_1 and A_2 projecting thereabove. The convex surface profile is emphasized by the curved line therebelow.

[0155] FIGS. **6**A-**6**C are top down views of three exemplary footprint sizes of a first top endplate **110***x*, second top endplate **110***y*, and third top endplate **110***z*. It shall be understood that first, second, and third top endplates **110***x*, **110***y*, and **110***z* may be substituted for endplates **110**, **110***a*, and **110***c* in accordance with the principles of the present disclosure. FIGS. **7**A-**7**C are top down views of three exemplary footprint sizes of a first bottom endplate **120***x*, second bottom endplate **120***y*, and third bottom endplate **120***z*. It shall be understood that first, second, and third bottom endplates **120***x*, **120***y*, and **120***z* may be substituted for endplates **120**, **120***a*, and **120***c* in accordance with the principles of the present disclosure. First top endplate **110***x* and first bottom endplate **120***x* may have a length of about 32 mm and a width of about 25 mm. Second top endplate **110***y* and second bottom endplate **120***y* may have a length of about 37 mm and a width of about 29 mm. Third top endplate **110***z* and third bottom endplate **120***z* may have a length of about 42 mm and a width of about 32 mm. It shall be understood that first top endplate **110***x* and first bottom endplate **110***y* are suitable for patients with relatively small vertebrae, second top endplate **110***y* and second bottom endplate **110***y* are suitable for patients with relatively larger vertebrae than the previous example, and third top endplate **110***z* and third bottom endplate **110***z* are suitable for patients with relatively larger vertebrae than the previous two examples. In this way, spinal implants **100**, **200**, and **300** may be configured to have any of the exemplary footprint sizes explained above depending on a particular patient's vertebral anatomy. For example, as part of an initial assessment a surgeon may assess which of the available footprint sizes is best suited for a particular patient's vertebral anatomy. It shall be understood that the above exemplary footprint sizes are non-limiting exemplary embodiments and that other footprint sizes may be used with any of spinal implants **100**, **200**, **300** provided the chosen footprint size is suitable for a particular patient's anatomy. However, the three exemplary footprint sizes explained above are generally suitable for the majority of patients.

[0156] FIG. **8** is a perspective view of one embodiment of an expandable spinal implant system **1000** in accordance with the principles of the present disclosure. First surgical tool **400** includes a handle **402**, shaft **404**, tip **406**, locking mechanism **408**, and adjustment knob **452**. Tip **406** is configured to be inserted inside of guide aperture **107** and operably connected to spinal implant **100**. First surgical tool **400** is configured to perform a variety of functions for operably manipulating spinal implant **100**. For example, first surgical tool **400** is configured to operably engage with spinal implant **100** via a secured connection such that a spinal implant **100** may be inserted between vertebral bodies of a patient according to anterior surgical techniques, oblique surgical techniques, and lateral surgical techniques. Additionally, first surgical tool **400** is configured to operably engage with spinal implant **100** to adjust spinal implant **100** from a contracted position to an expanded position and vice-versa. Furthermore, first surgical tool **400** is configured to operably engage with spinal implant **100** to adjust an angle of inclination between endplates **110**, **120**. Further still, spinal implant **100** may be adjusted in situ between vertebral bodies after spinal implant **100** is inserted into a patient. Additional attributes of the surgical tool will be disclosed below with reference to FIGS. **18**A-**19**B

[0157] FIG. **9**A is a cutout perspective showing first surgical tool **400** in a first adjustment position where the spinal implant **100** is in a contracted position and FIG. **9**B is a cutout perspective showing first surgical tool **400** in the first adjustment position after adjusting the spinal implant **100** from the contracted position to a first expanded position. As illustrated, tip **406** is inserted through guide aperture **107** and into moving mechanism **250**. Moving mechanism **250** includes a first set screw **252** and a second set screw **254** having respective internal cavities configured to operably receive tip **406**. In some embodiments, first set screw **252** may be referred to as an anterior screw and second set screw **254** may be referred to as a posterior screw. The first and second set screws **252**, **254** have a helical thread pitch that corresponds to keyed projections of first and second trolleys **256**, **258**, respectively. In the exemplary embodiment, the second set screw **254** has a reverse thread pitch and a shorter length than first set screw **252**. In some embodiments, the thread pitch may be an M6 thread pitch, however other embodiments may have other thread pitches.

[0158] Each internal cavity of set screws **252**, **254** comprises an internal circumferential surface that is keyed to the outside circumferential surface **456** of tip **406** of first surgical tool **400**. For example, the outside circumferential surface **456** may resemble the geometry of the tip of a torx driver, hex driver, or the like and the internal circumferential surfaces of the first and second set screws **252**, **254** may resemble the geometry of the cavity of the head of a torx screw, hex screw, or the like. In some embodiments, the internal circumferential surfaces of the first and second set screws **252**, **254** may be configured for a Torx T20 driver or the like, however other embodiments may be differently sized. In other embodiments, the connection between the outer circumferential surface **456** and the inner circumferential surfaces of first and second set screws **252**, **254** may comprise a variety of drive interfaces including but not limited to: multi-lobular drives; hexalobular drives; cross or Phillips head drives; straight or "flat head" drives; square or other polygonal drives; and/or combinations thereof. It shall be understood that any suitable geometrical shape or surface profile may be used by the exemplary embodiments disclosed herein provided the outside circumferential surface **456** is operably keyed to engage with the internal circumferential surfaces of the first and second set screws **252**, **254**.

[0159] In the exemplary embodiment, outside circumferential surface **456** is engaged with both the first and second set screws **252**, **254** and when first surgical tool **400** is rotated in a first direction (clockwise direction) the outside circumferential surface **456** translates both set screws **252**, **254** thereby causing the first and second trolleys **256**, **258** to move away from one another in opposite directions. In turn, the first and second trolleys **256**, **258** cause the top and bottom endplates **110**, **120** to move apart from one another an equal amount in the expansion direction indicated by the arrows. The expansion direction may be a generally vertical direction projecting away from and perpendicular to the generally horizontal direction of a rotation axis of the moving mechanism. Likewise, when first surgical tool **400** is rotated in a second direction (counter-clockwise direction) the outside circumferential surface **456** translates both set screws **252**, **254** thereby causing the first and second trolleys **256**, **258** to move towards one another (not illustrated). In turn, the first and second trolleys **256**, **258** urge the top and bottom endplates **110**, **120** to move towards one another an equal amount in a contraction direction (not illustrated). The contraction direction may be a generally vertical direction projecting towards and perpendicular to the generally horizontal direction of the rotation axis of the moving mechanism. In summary, when positioning the first surgical tool **400** in the first position and rotating the first surgical tool **400** in either the first or second direction the moving mechanism **250** operably adjusts a spacing between the top and bottom endplates by simultaneous rotation of the first and second set screws **252**, **254** along the rotation axis.

[0160] FIG. **10**A is a cutout perspective showing first surgical tool **400** in a second adjustment position where the spinal implant **100** is in the first expanded position of FIG. **9**B. As illustrated, first surgical tool **400** is retracted from moving mechanism **250** such that the outside circumferential surface **456** is only engaged with the first set screw **252**, i.e., first surgical tool **400** is in the second position. When first surgical tool **400** is in the second position and rotated in a first direction (clockwise direction) the outside circumferential surface **456** translates only the first set screw **252** thereby causing only the first trolley **256** to move towards the proximal end **101** of spinal implant **100** and allowing the second trolley **258** to remain stationary in place. In turn, the first trolley **256** urges the proximal end **101** of top and bottom endplates **110**, **120** thereby causing top and bottom endplates **110**, **120** to move apart from one another at the proximal end **101** in the direction shown by the arrows thereby increasing an angle of inclination between the top and bottom endplates **110**, **120**. Likewise, when first surgical tool **400** is in the second position and is rotated in the second direction (counter-clockwise direction) the outside circumferential surface **456** translates only the first set screw **252** thereby causing the first trolley **256** to move towards the stationary second trolley **258**. In effect, the top and bottom endplates **110**, **120** move towards one another at the proximal end **101** (not illustrated) thereby decreasing an angle of inclination between the top and bottom endplates **110**, **120**. In summary, when positioning the first surgical tool **400** in the second position and rotating the first surgical tool **400** in either the first or second direction the moving mechanism **250** operably adjusts an angle of inclination between the top and bottom endplates **110**, **120** upon rotating the first set screw along the rotation axis.

[0161] FIGS. **11**A and **11**B are perspective views of a moving mechanism **250** in a contracted position and an expanded position, respectively. Moving mechanism **250** is suitable for use in any exemplary embodiments disclosed herein. As illustrated moving mechanism **250** includes a screw guide housing **105***a* coupled to screw guide endplate **105** (not illustrated) and a central buttress block **257**. Screw guide housing **105***a* may operably retain first and second screws **252**, **254** therein and thereby define a rotation axis of moving mechanism **250** projecting in a longitudinal direction thereof. First and second trolleys **256**, **258** are operably coupled to first and second set screws **252**, **254** and are further configured to move along outside surfaces of screw guide housing **105***a* upon rotation of first and second set screws **252**, **254**.

[0162] First trolley **256** includes a first beveled edge **256***a* and a second beveled edge **256***b* opposite the first beveled edge **256***a*, the first and second beveled edges **256***a*, **256***b* are disposed on opposite sides of the rotation axis of the moving mechanism **250**. Second trolley **258** includes a third beveled edge **258***a* and a fourth beveled edge **258***b* (not illustrated) opposite the third beveled edge **258***a*, the third and fourth beveled edges **258***a*, **258***b* are disposed on opposite sides of the rotation axis of the moving mechanism **250**. Additionally, first trolley **256** has a first side surface and a second side surface opposite the first side surface, the first and second side surfaces being on opposite sides of the rotation axis of the moving mechanism **250**. Likewise, second trolley **256** has a third side surface and a fourth side surface opposite the third side surface, the third and fourth side surfaces being on opposite sides of the rotation axis of the moving mechanism **250**. Furthermore, buttress block **257** has a seventh and eighth side surface opposite the seventh side surface, the seventh and eighth side surfaces being on opposite sides of the rotation axis of the moving mechanism **250**.

[0163] First trolley **256** includes a first plurality of projections **256***c*, the second trolley **258** includes a second plurality of projections **258***c*, and the buttress block **257** includes a third plurality of projections **257***c*. In the exemplary embodiment, first trolley **256** has two projections **256***c* projecting perpendicularly out from first side surface and two projections **256***c* projecting perpendicularly out from second side surface. Likewise, second trolley **258** has two projections **258***c* projecting perpendicularly out from third side surface and two projections **258***c* projecting perpendicularly out from fourth side. Furthermore, buttress block **257** has two projections **257***c* projecting perpendicularly out from seventh side surface and two projections **258***c* projecting perpendicularly out from eighth side surface. The first and second plurality of projections **256***c*, **258***c* may be conically shaped projections having a dome like shape or a hemispherical shape, for example. In the non-limiting exemplary embodiment, each projection of the first and second plurality of projections **256***c*, **258***c* comprises a hemispherical projection having a flat surface that coincides with a corresponding surface of one of the first through fourth beveled edges **256***a*, **256***b*, **258***a*, **258***b*. However, other embodiments may have other shapes and/or surface profiles as may be consistent with the disclosure herein.

[0164] First trolley **256** includes a first plurality of wedges **256***d* and second trolley **258** includes a second plurality of wedges **258***d*. For example, first trolley **256** includes a first wedge **256***d* projecting away from the first side surface in a transverse direction of the moving mechanism **250** and a second wedge **256***d* projecting away from the second side surface in the transverse direction of the moving mechanism. Likewise, second trolley **258** includes a third wedge **258***d* projecting away from the third side surface in a transverse direction of the moving mechanism **250** and a fourth wedge **258***d* projecting away from the fourth side surface in the transverse direction of the moving mechanism. In the exemplary embodiment, each wedge of the first plurality of wedges **256***d* includes a corresponding upper contact surface **256***e* and a corresponding lower contact surface **256***f* and each respective upper contact surface **256***e* meets a corresponding lower contact surface **256***f* at an apex point (not labeled). Likewise each wedge of the second plurality of wedges **258***d* includes a corresponding upper contact surface **258***e* and a corresponding lower contact surface **258***f* and each respective upper contact surface **258***e* meets a corresponding lower contact surface **258***f* at an apex point (not labeled). In the exemplary embodiment, each upper contact surface **256***e*, **258***e* and each lower contact surface **256***f*, **258***f* has a curved surface profile. For example, each upper contact surface **256***e*, **258***e* is concave with respect to a corresponding apex point and each lower contact surface **256***f*, **258***f* is convex with respect to a corresponding apex point.

[0165] FIGS. **12**A and **12**B are perspective views of moving mechanism **250** of FIGS. **11**A and **11**B in the contracted position and the expanded position, respectively, shown with an exemplary bottom endplate **120**. FIGS. **13**A and **13**B are perspective views of the moving mechanism **250** of FIGS. **12**A and **12**B in the contracted position and the expanded position, respectively, with a top endplate **110** and a bottom endplate **120**. It shall be understood that FIGS. **12**A-**13**B schematically moving mechanism **250** with some internal parts being illustrated or simplified and others being omit for ease of explanation. For example, FIGS. **12**A-**13**B are illustrated schematically solely to assist in explaining operable characteristics of moving mechanism **250**. FIGS. **12**A and **12**B show bottom endplate **120** having a pair of second proximal ramps **124** and a pair of second distal ramps **126** disposed opposite the pair of second proximal ramps **124**. Each ramp of second proximal ramps **124** may include a first inclined contact surface **124***a* extending away from buttress block **257** and inclined with respect to an inside surface **122** of endplate **120**. Similarly, each ramp of second distal ramps **126** may include a second inclined contact surface **126***a* extending away from buttress block **257** and inclined with respect to an inside surface **122** of endplate **120**. In the exemplary embodiment, the first inclined contact surfaces extend a first length (first distance) and the second inclined contact surfaces extend a second length (second distance) and the first length is greater than the second length.

[0166] FIGS. **13**A and **13**B show top endplate **110** having a pair of first proximal ramps **114** and a pair of first distal ramps **116** disposed opposite the pair of first proximal ramps **114**. Each ramp of first proximal ramps **114** may include a third inclined contact surface **114***a* extending away from buttress block **257** and inclined with respect to an inside surface **112** of endplate **110**. Similarly, each ramp of first distal ramps **116** may include a fourth inclined contact surface **116***a* extending away from buttress block **257** and inclined with respect to an inside surface **112** of endplate **110**. In the exemplary embodiment, the third inclined contact surfaces extend a third length (third distance) and the fourth inclined contact surfaces extend a fourth length (fourth distance) and the third length is greater than the fourth length.

[0167] Each ramp of ramps **114**, **116**, **124**, **126** may have an inside surface disposed adjacent to and facing the rotation axis of moving mechanism **250** and an outside surface opposite the inside surface and facing away from the rotation axis of moving mechanism **250**. Additionally, each ramp of ramps **114**, **116**, **124**, **126** may include a corresponding guide wall **130**, which is best illustrated in FIGS. **12**A and **17**. Each guide wall **130** may extend along the inside surface of a corresponding ramp in a parallel direction to the corresponding contact surface. For example, with reference to FIGS. **12**A-**13**B, guide wall **130** extends along the inside surface of proximal ramp **124** in a direction that is substantially parallel to first inclined contact surface **124***a*. As best understood with reference to FIGS. **12**A-**12**B, each bottom most projection **256***c* of the first trolley **256** is disposed inside of a corresponding guide wall **130** of the second proximal ramps **124**. Likewise, each bottom most projection **258***c* of the second trolley **258** is disposed inside of a corresponding guide wall **130** of the second distal ramps **126**. Similarly, although not directly visible, in FIGS. **13**A-**13**B each top most projection **256***c* of the first trolley **256** is disposed inside of a corresponding guide wall **130** of first proximal ramps **114**. Likewise, each top most projection **258***c* of second trolley **258** is disposed inside of a corresponding guide wall **130** of first distal ramps **116**.

[0168] With reference to FIGS. **13**A and **13**B, when first surgical tool **400** is in the first position and translates first and second screws **252**, **254** in the first direction the first and second trolleys **256**, **258** move away from one another in opposite directions and the top endplate **110** and bottom endplate **120** move away from one another as the spinal implant **100** expands. For example, in some embodiments, beveled edges **256***a*, **256***b* of the first trolley **256** act against endplates **110**, **120** at a proximal end **101** thereof and the first plurality of wedges **256***d* contact and slide along a corresponding ramp of the first and second first proximal ramps **114**, **124**. However, in other embodiments, **256***e* and **256***f* may act against inclined contact surface **124***a* in lieu of providing beveled edges **256***a*, **256***b*. In some embodiments, beveled edges **258***a*, **258***b* of the second trolley **258** act against endplates **110**, **120** at a distal end **102** thereof and the second plurality of wedges **258***d* contact and slide along a corresponding ramp of the first and second first distal ramps **116**, **126**. However, in other embodiments, **258***e* and **258***f* may push against inclined contact surface **126***a* in lieu of providing beveled edges **256***a*, **256***b*. Additionally, each projection **256***c* of the first trolley **256** slides along a corresponding guide wall **130** of the first and second first proximal ramps **114**, **124** and each projection **258***c* of the second trolley **258** slides along a corresponding guide wall **130** of the first and second distal ramps **116**, **126**. Furthermore, during the expansion of spinal implant **100** each projection **257***c* of buttress block **257** may slide vertically in a corresponding vertical guide wall **130***a* (see FIG. **17**) of the top and bottom endplates **110**, **120**. In this way, the spinal implant **100** moves from a contracted position to an expanded position. It shall be understood that movement of spinal implant from the expanded position to the contracted position occurs in substantially the same way.

[0169] When first surgical tool **400** is in the second position and translates only the first screw **252** in the first direction the first trolley **256** moves away from buttress block **257** and stationary second trolley **258** and an angle of inclination between the top endplate **110** and bottom endplate **120** increases. For example, beveled edges **256***c* of first trolley **256** may push against endplates **110**, **120** at a proximal end **101** thereof and/or the first plurality of wedges **256***d* may contact and slide along a corresponding ramp of the first and second first proximal ramps **114**, **124** as explained above. Additionally, each projection **256***c* of the first trolley **256** slides along a corresponding guide wall **130** of the first and second first proximal ramps **114**, **124** as explained above. The second trolley **258** remains stationary with beveled edges **258***a*, **258***b* remaining in contact with endplates **110**, **120** at a distal end **102** thereof and the second plurality of wedges **258***d* remaining in contact with a corresponding ramp of the first and second distal ramps **116**, **126**. Due to first trolley **256** acting against endplates **110**, **120** by moving away from buttress block **127** and second trolley **258** remaining stationary the second plurality of wedges **258***d* pivot along a corresponding ramp of the first and second distal ramps **116**, **126** and each projection **258***c* of the second trolley **258** pivots and/or incrementally slides along a corresponding guide wall **130** of the first and second first distal ramps **116**, **126**. Furthermore, during the expansion of spinal implant **100** each projection **257***c* of buttress block **257** may slide vertically up and down in a corresponding vertical guide wall **130***a* (see FIG. **17**) of the top and bottom endplates **110**, **120** as necessary. In this way, a distance between endplates **110**, **120** at the proximal end **101** is increased and a distance between endplates **110**, **120** at the distal end **102** is minutely decreased thereby adjusting an angle of inclination between top endplate **110** and bottom endplate **120**. Those with skill in the art, will appreciate that in disclosed exemplary embodiments first set screw **252** is longer than second set screw **254** thereby providing more room for travel of the first trolley **256** such that the first trolley **256** may enable a greater distance of travel between endplates **110**, **120** at the proximal end **101** than second trolley **258** enables at the distal end **102**.

[0170] FIGS. **14**A and **14**B are cut-out views of a moving mechanism **250** in relation to a top endplate **110**. As shown, moving mechanism **250** includes a rotation axis R_1 projecting in a longitudinal direction thereof and extending in a transverse direction of endplate **110** (from proximal side **101** to distal side **102**). Rotation axis R_1 projects through the center of set screws **252**, **254**. Moving mechanism **250** includes a transverse axis T_1 intersecting a center of rotation axis and projecting perpendicular to rotation axis R_1 through buttress block **257**.

[0171] FIG. **15** illustrates a cross section of moving mechanism **250** taken along rotation axis R_1. As shown, first set screw **252** is operably coupled with first trolley **256** by a plurality of keyed projections **256***k* (thread pattern) that correspond to the pitch pattern of first set screw **252**. Second set screw **254** is operably coupled with second trolley **258** by a plurality of keyed projections **258***k* (thread pattern). First set screw **252** includes a first internal circumferential surface **252***a* and second set screw **254** includes a second internal circumferential surface. The buttress block **257** includes an interior retention cavity **257***b* where a first retaining portion **252***r* of first set screw **252** and a second retaining portion **254***r* of second set screw **254** are retained. Interior retention cavity **257***b* may be an internal cavity spanning the inside circumference of buttress block **257** and configured to enable first set screw **252** and second set screw **254** to freely rotate along the rotation axis R_1 while preventing first set screw **252** and second set screw **254** from traveling in the longitudinal direction of moving mechanism **250**.

[0172] FIG. **16** is a perspective view of a top endplate **110** and bottom endplate **120** of spinal implant **100** and FIG. **17** is an exploded view of the top endplate **110** and bottom endplate **120** of FIG. **16**. In the exemplary embodiment, when spinal implant **100** is in the closed position, inside surface **112** of top endplate **110** and inside surface **124** of bottom endplate **120** are nested or partially nested with respect to one another. For example, FIG. **16** shows first proximal ramps **114** of top endplate **110** inset from second proximal ramps **124** of bottom endplate **120**. Additionally, top endplate **110** includes a first plurality of recesses **110***n* that allow corresponding components of bottom endplate **120***a* to nest inside of when spinal implant **100** is in the contracted position. For example, FIG. **16** shows second proximal ramps **124** nested inside of recess **110***n*. In some embodiments, recesses **110***n* may be referred to as nested recesses for convenience in explanation.

[0173] Top endplate **110** and/or bottom endplate **120** may optionally include at least one anchoring aperture **129**. In the exemplary embodiment, top endplate **110** includes a pair of top anchoring apertures **129***a*, **129***b*, that pass through top endplate **110** at an inclined angle with respect to outside surface **111** of top endplate **110**. Similarly, bottom endplate **120** includes a pair of bottom anchoring apertures **129***c*, **129***d* that pass through bottom endplate **120** at an inclined angle with respect to outside surface **121** of endplate **120**. Each anchoring aperture **129** of the plurality of anchoring apertures **129***a*-**129***d* is disposed adjacent an outside surface of a corresponding ramp **114**, **116** however exemplary embodiments are not limited to the specific location shown in FIG. **17**.

[0174] FIGS. **18**A-**18**B are perspective views of a first surgical tool **400** of an adjustable spinal implant system in accordance with the principles of the present disclosure. FIGS. **19**A-**19**B are side views of the first surgical tool **400** and a corresponding adjustment rod **450** configured for insertion inside of first surgical tool **400**. Tip **406** is configured to connect to spinal implant **100** such that spinal implant **100** is securely attached to first surgical tool **400** by engaging locking mechanism **408**. Similarly, tip **406** is configured to disconnect from spinal implant **100** such that spinal implant **100** is no longer securely attached to first surgical tool **400** by disengaging locking mechanism **408**. For example, FIG. **19**A shows tip **406** in a first locking position with tip grips **406***a* being expanded for gripping onto spinal implant **100** and FIG. **19**B shows tip **406** in a second locking position with tip grips **406***a* being retracted. Locking mechanism **408** is configured to toggle between the first locking position and second locking position. In some embodiments, when locking mechanism **408** is engaged in the first locking position spinal implant **100** is fixedly coupled to first surgical tool **400** such that it will not rotate. This may be advantageous for initial positioning of spinal implant **100** between vertebral bodies during surgery. Additionally, first surgical tool **400** includes a positioning mechanism **410** configured to position adjustment rod **450** in a first position and a second position (see FIG. **19**A). First surgical tool **400** may also include a push button **420** to toggle between positioning adjustment rod **450** in a first position to engage both first and second set screws **252**, **254** and a second position to engage only the first set screw **252** (see FIG. **18**B). Furthermore, in some embodiments first surgical tool **400** may include a window **421** to identify whether both first and second set screws **252 254** are engaged for parallel expansion/contraction of spinal implant **100** or whether only the first set screw **252** is engaged for adjusting an angle of inclination of spinal implant **100**.

[0175] In the exemplary embodiment, first surgical tool **400** includes a central shaft aperture **409** extending through handle **402**, shaft **404**, and tip **406**. Central shaft aperture **409** is configured to receive adjustment rod **450** therein such that adjustment knob **452** is rotatable therein and protrudes, at least partly, from both ends. Adjustment rod **450** includes an adjustment knob **452**, first and second positioning surfaces **453**, **454** and keyed circumferential surface **456**. When adjustment rod **450** is positioned within central shaft aperture **409**, adjustment knob **452** protrudes from one end and keyed circumferential surface **456** protrudes from the other end (see FIG. **14**). With adjustment rod **450** inserted within central shaft aperture **409** positioning mechanism **410** can extend and retract adjustment rod **450** in the longitudinal direction of shaft **409**. As explained above with respect to FIGS. **13**A and **13**B, when first surgical tool **400** is in the first position, keyed circumferential surface **456** may rotate first and second set screws **252**, **254** along the rotation axis and when first surgical tool **400** is in the second position, keyed circumferential surface **456** may rotate only the first set screw **252** along the rotation axis. In some embodiments, positioning mechanism **410** is configured to be toggled between a first position and a second position where it can act against positioning surfaces **453**, **454** to extend and retract adjustment rod **450** in the longitudinal direction of shaft **409**. For example, in the first position positioning mechanism **410** may extend adjustment rod **450** from tip **406** to an extended position where circumferential surface **456** may engage with internal circumferential surfaces of the first and second set screws **252**, **254**. In the second position, positioning mechanism **410** may retract adjustment rod **450** through tip **406** to a partially retracted position where circumferential surface **456** may only engage with internal circumferential surface of the first set screw **252**. An internal gearing of positioning mechanism **410** may include internal locking pins and surfaces that act against positioning surfaces **453**, **454** such that when an exposed turn dial knob of positioning mechanism **410** is turned to a particular position, the internal locking pins and surfaces act against the inclined and recessed surfaces of positioning surfaces **453**, **454**.

[0176] Additionally, in some embodiments, first surgical tool **400** may be configured to receive adjustment rods **450**

of varying lengths having varying outside circumferential surfaces **456** and positioning surfaces **453**, **454**. For example, first surgical tool **400** may be configured to receive a first relatively shorter adjustment rod **450** optimized for use for a spinal implant **100** using corresponding relatively smaller endplates **110**, **120** of FIGS. **6**A-7C and a corresponding smaller moving mechanism **250** having a relatively shorter longitudinal axis optimized for such relatively shorter endplates **110***x*, **120***x*. For example still, first surgical tool **400** may be configured to receive a second relatively longer adjustment rod **450** optimized for use for a spinal implant **100** using corresponding relatively larger endplates **110***z*, **120***z* of FIGS. **6**A-7C and a corresponding larger moving mechanism **250** having a relatively longer longitudinal axis optimized for such relatively longer endplates **110***z*, **120***z*.

[0177] Additionally, in some embodiments, first surgical tool **400** may be configured to receive multiple types of adjustment rods **450**. In at least one embodiment, first surgical tool **400** may receive a first adjustment rod **450** with an outside circumferential surface **456** that is configured to engage (1) both the first and second set screws **252**, **254** at the same time and (2) the first set screw **252**. For example, the first adjustment rod **450** may be toggled between (1) a first position where outside circumferential surface **456** is fully extended and configured to engage both the first and second set screws **252**, **254**, and (2) a second position where outside circumferential surface **456** is partially extended (and/or partially retracted) to engage only the first set screw **252**. In an alternate embodiment, first surgical tool **400** may receive a second adjustment rod **450** with an outside circumferential surface **456** that is configured to engage only one set screw **252**, **254** at a time. For example, the outside circumferential surface **456** may have an engagement surface with a longitudinal length that corresponds to a single set screw **252**, **254** such that it only engages with a single set screw **252**, **254** at a time. For example, the second adjustment rod **450** may be toggled between (1) a first position where outside circumferential surface **456** is fully extended and configured to engage the second set screw **254** independently of the first set screw **252** and (2) a second position where outside circumferential surface **456** is partially extended (and/or partially retracted) to engage only the first set screw **252**. At least one advantage of having first surgical tool **400** being configured to receive multiple types of adjustment rods **450** of varying lengths and having outside circumferential surfaces of different lengths is that a surgeon can quickly and easily select the appropriate adjustment rod **450**. For example, a surgeon may select first adjustment rod **450** to expand/contract a spacing between endplates **110**, **120** by the same or substantially the same amount while maintaining the angle of inclination between endplates **110**, **120**, i.e., by engaging both first and second set screws **252**, **254**. Additionally, a surgeon may select second adjustment rod **450** to selectively increase/decrease an angle of inclination between endplates of spinal implant **100** at the proximate side **101** and the distal side **102** independently, i.e., by only engaging one of first and second set screws **252**, **254** at a time. For example still, the second adjustment rod **450** may be configured to adjust spinal implant **100** to enable anterior expansion separately from enabling posterior expansion which may enable spinal implant **100** to be placed in kyphosis as is consistent with above explained embodiments.

[0178] Furthermore, in some embodiments, first surgical tool **400** is configured to operate in three modes. In the first mode, tip grips **406***a* are securely connected to spinal implant **100**. In the second mode, adjustment rod **450** may be positioned in a first position such that upon selective rotation of adjustment knob **452** a spacing between endplates **110**, **120** selectively increase/decrease in minute increments. For example, by rotating each of first set screw **252** and second set screw **254**. In the third mode, adjustment rod **450** may be positioned in a second position such that upon selective rotation of adjustment knob **452** an angle of inclination between endplates **110**, **120** may selectively increase/decrease in minute increments. For example, by only rotating first set screw **252** an angle of inclination between endplates **110**, **120** may increase/decrease by moving one side of the endplates **110**,**120** towards/away from each other and moving the opposite side of the endplates **110**,**120** in an opposite direction. In some embodiments, this may also happen by only rotating second set screw **254**. For example, first surgical tool **400** may have a relatively short circumferential engagement surface **456** that will only engage a single one of the internal circumferential surfaces of first or second set **252**, **254** at a time.

[0179] FIG. **20** illustrates a perspective view of one embodiment of an expandable spinal implant **100** including a plurality of anchoring screws **510**. In some embodiments, anchoring screws **510** may be referred to as bone screws. In the exemplary spinal implant **100**, top endplate **110** includes a first anchoring screw **510***a*, and a second anchoring screw **510***b* opposite the first anchoring screw **510***a* that each extend through a corresponding aperture. For example, first and second anchoring screws **510***a*, **510***b* pass through a corresponding aperture of top endplate **110** configured to orient them at an inclined angle with respect to outside surface **111** of top endplate **110**. Similarly, bottom endplate **120** includes a third anchoring screw **510***c*, and a fourth anchoring screw **510***d* that each extend through a corresponding aperture. Anchoring screws **510***c*, **510***d* project from a proximal end **101** of spinal implant **100** at an inclined angle towards distal end **102**. For example, third and fourth anchoring screws **510***c*, **510***d* pass through a corresponding aperture of bottom endplate **120** configured to orient them at an inclined angle with respect to outside surface **121** of bottom endplate **120**. However, it shall be understood that in other embodiments at least one aperture may orient a corresponding anchoring screw **510***a*, **510***b*, **510***c*, **510***d* at any angle with respect to the corresponding endplate **110**, **120** consistent with the disclosure herein. Anchoring screws **510***a*-**510***d* are configured to anchor into corresponding adjacent vertebral bodies.

[0180] FIGS. **21**A-**21**B illustrate a lateral side view and front side view, respectively, of one embodiment of an expandable spinal implant system in which anchoring screws **510***a*-**510***d* are anchored into adjacent vertebral bodies. As illustrated, anchoring screws **510***a*, **510***b* project out from top endplate **110** of spinal implant **100** from a proximal end **101** at an inclined angle towards distal end **102** thereby anchoring into a top vertebral body V_1. Similarly, anchoring screws **510***a*, **510***b* project out from bottom endplate **120** of spinal implant **100** from a proximal end **101** at an inclined angle towards distal end **102** thereby anchoring into a bottom vertebral body V_2. As used herein, a pair of vertebral bodies, adjacent vertebral bodies, and/or first and second vertebral bodies may refer to, e.g., top vertebral body V_1 and bottom vertebral body V_2.

[0181] FIG. **22**A is a side view of a second surgical tool **500** suitable for use with disclosed embodiments and systems herein, e.g., to drive anchoring screws **510***a*-**510***d*. FIG. **22**B is a side view of an enlarged region of FIG. **22**A. Exemplary, second surgical tool **500** includes a ratcheting drive shaft **555**, a positioning handle **520**, a tip portion **530**, a drive shaft housing **540**, and a trigger **550**. Ratcheting drive shaft **555** may be configured to connect and disconnect with a ratcheting handle (not shown) and rotate within ratcheting drive shaft housing **540**. For example, the drivable connection may comprise a variety of drive interfaces including but not limited to: multi-lobular drives; hexalobular drives; cross or Phillips head drives; straight or "flat head" drives; square or other polygonal drives; and/or combinations thereof. Positioning handle **520** may be configured to assist with maintaining and controlling the second surgical tool **500**, e.g., in view of torque transmitted through ratcheting drive shaft **555**. Tip portion **530** is angled at a degree p with respect to a longitudinal direction of drive shaft housing **540**. In some embodiments, tip portion **530** is angled such that the degree p corresponds to the inclination of anchoring screws **510***a*-**510***d* and the inclination of anchoring aperture **129**. For example, anchoring apertures **129** may be inclined about 30°-50°, and more particularly about 40°, with respect to an outside surface **111**, **121** of endplates **110**, **120**. This arrangement may be advantageous for driving anchoring screws **510***a*-**510***d* while spinal implant **100** is positioned between adjacent vertebral bodies. Tip portion **530** may secure anchoring screw **510** in an internal cavity therein such that anchoring screw **510** may not disconnect during initial positioning of anchoring screw **510**. For example, tip portion **530** may have a flexible elastic member configured to securely retain a head portion of anchoring screw **510**. Tip portion **530** may, however, release anchoring screw **510** when anchoring screw is sufficiently anchored into an anatomical feature, such as a vertebrae for example. This feature may be particularly advantageous during surgery for maintaining the anchoring screw **510** in tip portion **530** such that anchoring screw **510** does not uncouple from tip portion **530** when initially positioning anchoring screw **510** in an anchoring aperture, for example anchoring aperture **129**. Additionally, in some embodiments tip portion **530** is operably coupled with trigger **550** such that trigger **550** may disconnect anchoring screw **510** when anchoring screw **510** is installed. In some embodiments, trigger **550** may not be necessary because tip portion **530** may self-release anchoring screw **510** after installation.

[0182] FIGS. **23**A-**23**C are various perspective views of exemplary anchoring screws suitable for use with disclosed embodiments herein in conjunction with the second surgical tool **500**. FIG. **23**A shows a trocar tip anchoring screw **510***e*, FIG. **23**B shows a flutes or fluted tip anchoring screw **510***f*, and FIG. **23**C shows a speed anchoring screw **510***g*. Each anchoring screw **510***e*-**510***g* may have a thread pitch and sizing that corresponds to a size of anchoring aperture **129**. Trocar tip anchoring screw **510***e* includes an angled tip portion **510***e*-**1** and a thread pattern including threads **510***e*-**2**. Threads **510***e*-**2** may be spaced back from angled tip portion **510***e*-**1** which may facilitate with aligning anchoring screw **510***e* with anchoring aperture **129**. For example, in some embodiments, threads **510***e*-**2** are spaced back about 3 mm from angled tip portion **510***e*-**1**. Fluted tip anchoring screw **510***f* includes a cutting tip **510***f*-**1** and a thread pattern included threads **510***f*-**2**. Cutting tip **510***f*-**1** may extend a relatively long distance from the beginning of threads **510***f*-**2** such that the cutting tip **510***f*-**1** may pre-drill into an adjacent vertebral body before the threads **510***f*-**2** engage with anchoring aperture **129**. For example, in some embodiments, threads **510***f*-**2** are spaced back about 8 mm from cutting tip **510***f*-**1**. Speed anchoring screw **510***g* includes a conical tip **510***g*-**1** and a thread pattern including threads **510***g*-**2**. Different from trocar tip anchoring screw **510***e* and fluted tip anchoring screw **510***f*, threads **510***g*-**2** of speed anchoring screw **510***g* may begin immediately adjacent conical tip **510***g*-**1**.

[0183] FIGS. **24**A-**24**D are various side views and top down views of exemplary bone graft areas in accordance with the principles of the present disclosure. In the side view of FIG. **24**A, first and second regions R_1, and R_2 are shown where bone growth material may be grafted and/or bone growth promoting materials may be used. In the top down view of FIG. **24**B, third and fourth regions R_3, R_4 are shown where bone growth material may be grafted and/or bone growth promoting materials may be used. In some embodiments, third and fourth regions R_3, R_4 overlap vertically with first and second regions R_1, and R_2. In FIGS. **24**C and **24**D an exemplary grafting section GS is shown. Grafting section GS may be grafted to an endplate **110**, **120**. In some embodiments, grafting section GS may be filled with a bone growth material having a resultant surface area ranging from about 140 mm^2 to about 180 mm, and more particularly about 160 mm^2. For example, the bone growth material may extend through the grafting section GS three dimensionally and have a corresponding surface area ranging from about 140 mm^2 to about 180 mm^2, and more particularly about 160 mm^2. Consistent with disclosed embodiments herein, the open arrangement of spinal implant **100** and endplates **110**, **120** in particular is advantageous for direct segmental fusion techniques. For example, the superior and inferior vertebral endplates allow the creation of a fusion bone bridge to solidify a segment. Additionally, the expandable and contractible nature of spinal implant **100** lends to bone packing techniques after positioning and adjusting spinal implant **100** between vertebral bodies. For example, after spinal implant **100** is positioned between adjacent vertebral bodies, spinal implant **100** may be packed with bone material in situ. In some embodiments, the endplate **110** may be considered a direct superior vertebral endplate and endplate **120** may be considered an inferior vertebral endplate where such endplates are configured to allow for a fusion bone bridge there through to solidify a segment.

[0184] In some embodiments, the spinal implant system includes an agent, including but not limited to the bone growth promoting materials described herein, which may be disposed, packed, coated or layered within, on or about the components and/or surfaces of the spinal implant system. In some embodiments the bone growth promoting material may be pre-packed in the interior of spinal implant **100**, and/or may be packed during or after implantation of the implant via a tube, cannula, syringe or a combination of these or other access instruments. Additionally, bone growth promoting material may be further tamped into spinal implant **100** before, during or after implantation. In some embodiments, the bone growth promoting material and/or directly grafted material may enhance fixation of spinal implant **100** with adjacent bony structures. In some embodiments, the agent may include one or a plurality of therapeutic agents and/or pharmacological agents for release, including sustained release, to treat, for example, pain, inflammation and degeneration.

[0185] FIGS. **25**A and **25**B illustrate spin implant **100** in a first bent position and a second bent position, respectively. FIG. **25**A shows spinal implant **100** where top endplate **110** is bent in a first lateral direction with respect to bottom endplate **120**. FIG. **25**B shows spinal implant **100** where top endplate **110** is bent in a second lateral direction, opposite the first lateral direction, with respect to bottom endplate **120**. As explained in greater detail above, the various disclosed projections, guide walls, cavities, recesses, etc. are configured such that spinal implant **100** may allow for lateral bending to some predetermined degree. For example, projections **256***c*, **257***c*, **258***c* may pivot laterally in guide walls **130** to accommodate some degree of lateral bending. In this way, top endplate **110** and bottom endplate **120** may be configured to laterally bend with respect one another in a first direction and a second direction by a predetermined amount. However, in other embodiments it may be desirable for spinal implant **100** to be rigid in the lateral direction and for no lateral bending to be permissible.

[0186] FIGS. **26**-**28** illustrate a left side view, right side view, and front side view, respectively, of an installed expandable spinal implant **100** positioned between adjacent vertebral bodies according to various surgical techniques, e.g., anterior techniques, oblique techniques, lateral techniques. For example, FIGS. **26**-**28** show spinal implant **100** after being installed according to an anterior lumbar interbody fusion (ALIF) technique.

[0187] Spinal implant systems of the present disclosure can be employed with a surgical arthrodesis procedure, such as, for example, an interbody fusion for treatment of an applicable condition or injury of an affected section of a spinal column and adjacent areas within a body, such as, for example, intervertebral disc space between adjacent vertebrae, and with additional surgical procedures and methods. In some embodiments, spinal implant systems can include an intervertebral implant that can be inserted between adjacent vertebral bodies to space apart articular joint surfaces, provide support for and maximize stabilization of vertebrae. In some embodiments, spinal implant systems may be employed with one or a plurality of vertebra.

[0188] Consistent with the disclosed embodiments herein, a medical practitioner may obtain access to a surgical site including vertebrae such as through incision and retraction of tissues. Spinal implant systems of the present disclosure can be used in any existing surgical method or technique including open surgery, mini-open surgery, minimally invasive surgery and percutaneous surgical implantation, whereby vertebrae are accessed through a mini-incision, retractor, tube or sleeve that provides a protected passageway to the area, including, for example, an expandable retractor wherein the sleeve is formed from multiple portions that may be moved apart or together and may be inserted with the portions closed or together and then expanded to allow for insertion of implants of larger size than the closed cross section of the unexpanded retractor portions. In one embodiment, the components of the spinal implant system are delivered through a surgical pathway to the surgical site along a surgical approach into intervertebral disc space between vertebrae. Various surgical approaches and pathways may be used.

[0189] As will be appreciated by one of skill in the art, a preparation instrument (not shown) may be employed to remove disc tissue, fluids, adjacent tissues and/or bone, and scrape and/or remove tissue from endplate surfaces of a first vertebra and/or endplate surface of a second vertebra in preparation for or as part of the procedures utilizing a system of the present disclosure. In some embodiments, the footprint of spinal implant **100** is selected after trialing using trialing instruments (not shown) that may approximate the size and configuration of spinal implant **100**. In some embodiments, such trials may be fixed in size and/or be fitted with moving mechanisms **250** similar to embodiments described herein. In some embodiments, spinal implant **100** may be visualized by fluoroscopy and oriented before introduction into intervertebral disc space. Furthermore, first and second surgical tools **400**, **500**, and spinal implant **100** may be fitted with fiducial markers to enable image guided surgical navigation to be used prior to and/or during a procedure.

[0190] Components of a spinal implant systems of the present disclosure can be delivered or implanted as a preassembled device or can be assembled in situ. In one embodiment, spinal implant **100** is made of a single piece construction that may not be disassembled without destroying the device. In other embodiments, spinal implant **100** may comprise removable parts. Components of spinal implant system including implant **10**, **20**, **30** may be expanded, contracted, completely or partially revised, removed or replaced in situ. In some embodiments, spinal implant **100** can be delivered to the surgical site via mechanical manipulation and/or a free hand technique.

[0191] Additionally, components of spinal implant **100** can include radiolucent materials, e.g., polymers. Radiopaque markers may be included for identification under x-ray, fluoroscopy, CT or other imaging techniques. Furthermore, first and second surgical tools **400**, **500** may be radiolucent and may optionally include markers added at a tip portion thereof to permit them to be seen on fluoroscopy/x-ray while advancing into the patient. At least one advantage to having spinal implant **100** is that a medical practitioner can verify the positioning of spinal implant **100** relative to adjacent vertebral bodies and make further adjustments to the spacing between endplates **110**, **120**, angle of inclination between endplates **110**, **120**, and the overall positioning of the device within a patient's body. In this way, spinal implant **100** may correct alignment of a patient's spine in a sagittal plane.

[0192] FIG. **29**A is a perspective view of a second embodiment of an expandable spinal implant **200** in accordance with the principles of the present disclosure. Aspects of second spinal implant **100** may be the same as, substantially the same as, or similar to spinal implant **100**. Additionally, second spinal implant **200** may be used in previously disclosed systems and methods. Accordingly, duplicative description thereof will be omitted.

[0193] FIG. **29**B is an exploded view illustrating second spinal implant **200**. Second spinal implant **200** a top endplate **110** (first endplate) and a bottom endplate **120** (second endplate) and a moving mechanism **2500**, which will be described in greater detail below. The proximal end **101** includes a screw guide endplate **1050** disposed between endplates **110** and **120**. In some embodiments, screw guide endplate **1050** may be pivotable left-right and up-down to accommodate insertion of first surgical tool **400** from an off-angle position. For example, screw guide endplate **1050** may accommodate a surgical tool that is insert off angle (not axially aligned) in a range of about 1° to 20°, and more particularly about 1° to 15° in the horizontal and vertical directions. At least one advantage of this arrangement is that first surgical tool **400** may be inserted off angle with respect to guide aperture **107** of spinal implant **200**.

[0194] In the exemplary embodiment, moving mechanism **2500** is operably coupled to top endplate **110** and bottom endplate **120** similarly as explained above. Moving mechanism **2500** differs from moving mechanism **250** in that moving mechanism **2500** may be miss aligned, for example by about 5°, 10°, 15°, or **200** when compared to moving mechanism **250** of the first embodiment. In at least one embodiment, moving mechanism **2500** is misaligned about 150 to facilitate insertion and posterior adjustment by reconnection posteriorly. In the exemplary embodiment, moving mechanism **2500** operates by the same principles as moving mechanism **250** although the interior contours of top endplate **110** and bottom endplate **120** are shifted to allow moving mechanism **2500** to be miss aligned.

[0195] FIG. **30**A is a top down view of spinal implant **200** contrasting an embodiment where moving mechanism **2500** is miss aligned. As illustrated, spinal implant **200** has a first reference axis B_1 and a second reference axis B_2. First reference axis B_1 may be understood as a projection where moving mechanism **2500** is not miss aligned and where moving mechanism **2500** is in a centered position. Second reference axis B_2 may be understood as a projection passing through a central portion of guide aperture **107** through moving mechanism **2500** when moving mechanism **2500** is miss aligned inside of endplates **110**, **120** to an off-centered position.

[0196] Referring generally to FIGS. **30**B-**30**F, a modified embodiment of spinal implant **200** where moving mechanism **2500** is miss aligned is disclosed. In the disclosed embodiment, moving mechanism **2500** features the same parts as moving mechanism **250** and operates under the same principles as explained previously. In the disclosed embodiment, moving mechanism **2500** is miss aligned by about 150 when compared with moving mechanism **250** of spinal implant **100**. In other embodiments, moving mechanism **2500** may be miss aligned within any suitable range, e.g., from about 5° to 25°. FIG. **30**C is a perspective view of the embodiment of FIG. **30**B with a top endplate **110** removed for ease of understanding. As illustrated, moving mechanism **2500** is misaligned and the top and bottom endplates **110**, **120** have a different geometry to accommodate the miss aligned moving mechanism **2500**. Top and bottom endplates **110**, **120** may feature the same or substantially the same characteristics as previously disclosed. FIG. **30**D is an alternate perspective view of the embodiment of FIG. **30**B with a top endplate **110** removed for ease of understanding. FIG. **30**E is a top down view of an exemplary top endplate **110** for use with the embodiment of FIG. **30**B and FIG. **30**F is a top down view of an exemplary bottom endplate **120** for use with the embodiment of FIG. **30**B.

[0197] FIG. **31** is a perspective view of spinal implant **200** in an installed position between vertebral bodies and three alternate positions of first surgical tool **400**. FIG. **31** shows how first surgical tool **400** may be inserted into guide aperture **107** off angle with respect to first reference axis B_1. Reference ring RR represents the extent of viable offset positions that first surgical tool **400** may be operably inserted in guide aperture **107**. In some embodiments, first surgical tool **400** may be bent at a midsection area at 15° to enable a surgeon to adjust spinal implant **200** in such a way as to avoid anatomical features and organs, such as, for example the pelvic ring and iliac crest. Additionally, this advantage is further expanded upon when using a miss-aligned moving mechanism **2500** that is miss aligned by, for example, about 15°. Therefore, disclosed systems of spinal implant **200** are able to be manipulated by a surgeon via surgical tool **400** at the combined total angular extent the moving mechanism **2500** is offset and the angular extent the surgical tool is bent. In at least one embodiment, the total angular extent is about 30° on account of the moving mechanism **2500** being offset about 15° and the surgical tool **400** being bent about 15°.

[0198] FIG. **32**A is a top down view of a third embodiment of an expandable spinal implant **300** in accordance with the principles of the present disclosure. FIG. **32**B shows spinal implant **300** in a perspective view. Aspects of spinal implant **300** may be the same as, substantially the same as, or similar to spinal implant **100**. Additionally, spinal implant **300** may be used in previously disclosed systems and methods. Accordingly, duplicative description thereof will be omitted.

[0199] In some embodiments, the sizing and orientation of top and bottom endplates **110**, **120** and the sizing and orientation of moving mechanism **250*d*** is particularly advantageous for lateral insertion techniques. Spinal implant **300** includes a first reference axis C_1 and a second reference axis C_2. Different than previous embodiments, first reference axis C_1 may span a longitudinal length of spinal implant **300** and pass directly through a rotation axis of moving mechanism **250*d***. Second reference axis C_2 may bisect spinal implant **300** transversely across the center thereof. Additionally, second reference axis C_2 may intersect first reference axis C_1 and project through a center of buttress block **257**.

[0200] Spinal implant **300** may include a top endplate **110*d*** and a bottom endplate **120*d*** and a moving mechanism **250**, which may be the same as or substantially the same as described above. Spinal implant **300** includes a proximal end **101** and a distal end **102** opposite the proximal end **101**, and a first lateral end **103** and a second lateral end **104** opposite the first lateral end **103**. The first and second lateral ends **103**, **104** extend between the proximal end **101** and the distal end **102**. The proximal end **101** includes an exposed screw guide endplate **105** defining a corresponding screw guide aperture **107**, which are disposed between endplates **110*d*** and **120*d***. The screw guide endplate **105** and guide aperture **107** may be the same as or substantially the same as described above.

[0201] Top endplate **110** may include a first outside surface **111*d*** and a first inside surface **112*d*** opposite the first outside surface **111*d***. Similarly, bottom endplate **120*d*** may include a second outside surface **121*d*** and a second inside surface **122*d***. The outside surfaces **111*d***, **121*d*** may be configured to be positioned between and/or contact vertebral bodies in a patients spine and have various surface characteristics similar to those described above with reference to spinal implant **100**. In some embodiments, outside surfaces **111*d*** and **122*d*** may have a substantially linear surface profile across faces of textured surfaces thereof. In other embodiments, outside surfaces **111*d*** and **122*d*** may have curved surface profiles across faces of textured surfaces thereof. Further details of endplates **110***d*, **120***d* will be described in greater detail below.

[0202] Inside surfaces **111***d*, **122***d*, may surround moving mechanism **250** and have various contours, guides, cavities, and other operable characteristics that facilitate movement and/or provide mechanical advantage to other operable and movable corresponding parts to facilitate contraction, angular adjustment, lateral bending, absorption of compression forces, shear forces, etc. as will be explained in greater detail below.

[0203] In the exemplary embodiment, top endplate **110***d* includes a pair of first proximal ramps **114***d* and a pair of first distal ramps **116***d* opposite the first proximal ramps **114***d*. Each ramp of the first proximal ramps **114***d* includes an inclined surface extending away from inside surface **112***d* and moving mechanism **250***d*. Similarly, each ramp of first distal ramps **116***d* includes an inclined surface extending away from inside surface **112***d* and moving mechanism **250***d*. Bottom endplate **120***d* includes a pair of second proximal ramps **124***d* and a pair of second distal ramps **126***d* opposite the second proximal ramps **124***d*. Each ramp of the second proximal ramps **124***d* includes an inclined surface extending away from inside surface **122***d* and moving mechanism **250***d*. Similarly, each ramp of second distal ramps **126***d* includes an inclined surface extending away from inside surface **11***d***1** and moving mechanism **250***d*.

[0204] Exemplary spinal implant **300** includes a moving mechanism **250***d* that is operably coupled to top endplate **110***d* and bottom endplate **120***d*, similarly as explained above with reference to spinal implant **100**. Accordingly, duplicative description will not be repeated. A first functional feature of moving mechanism **250***d* is that it is further configured to increase and decrease a spacing between the top and bottom endplates **110***d*, **120***d* upon simultaneous rotation of first and second set screws **252**, **254** in a clockwise and counterclockwise direction, respectively. A second functional feature of moving mechanism **250***d* is that it is further configured to increase and decrease an angle of inclination between top and bottom endplates **110***d*, **120***d* upon rotation of the first set screw **252** in a clockwise and counterclockwise direction, respectively.

[0205] FIG. **33**A is a perspective view of spinal implant **300** in a contracted position and FIG. **33**B is a perspective view of spinal implant **300** in an expanded position. In the contracted position of FIG. **33**A, top endplate **110***d* and bottom endplate **120***d* are contracted to a fully closed position. In the expanded position of FIG. **33**B, top endplate **110***d* and bottom endplate **120***d* are expanded an equal amount. Similarly as explained above with reference to spinal implant **100** and FIGS. **9**A-**9**B when first surgical tool **400** is inserted in guide aperture **107** in a first position and rotated in a first direction (clockwise direction) the first and second trolleys **256**, **258** move away from one another an equal amount in opposite directions. In turn, the first and second trolleys **256**, **258** cause the top and bottom endplates **110***d*, **120***d* to move apart from one another an equal amount. Likewise, when first surgical tool **400** is rotated in a second direction (counter-clockwise direction) first and second trolleys **256**, **258** cause the top and bottom endplates **110***d*, **120***d* to move towards one another an equal amount in a contraction direction (not illustrated). In summary, when positioning the first surgical tool **400** in the first position and rotating the first surgical tool **400** in either the first or second direction the moving mechanism **250***d* operably adjusts a spacing between the top and bottom endplates **110***d*, **120***d*. FIG. **33**C is a perspective view of spinal implant **300** in a first angled position and FIG. **33**D is a perspective view of spinal implant **300** in a second angled position. Spinal implant **300** may have the same or similar features as explained above with respect to spinal implants **100**, **200**. Spinal implant **300** may be capable of (1) expanding/contracting the proximal end while the distal end remains stationary, (2) expanding/contracting the distal end while the proximal end remains stationary, and (3) expanding/contracting both the proximal end and distal end simultaneously. Similarly as explained above with reference to spinal implant **100** and FIGS. **10**A-**10**B when first surgical tool **400** is inserted in guide aperture **107** in a second position, and rotated in a first direction (clockwise direction) the first trolley **256** moves away from the proximal end **101** of spinal implant **100** and the second trolley **258** remains stationary in place. In effect, the top and bottom endplates **110***d*, **120***d* move towards one another at the distal end **102** (not shown) and move away from one another at the proximal end **101** thereby decreasing an angle of inclination between the top and bottom endplates **110**, **120**.

[0206] Likewise, when first surgical tool **400** is in the second position and is rotated in the second direction (counter-clockwise direction) the first trolley **256** moves towards the stationary second trolley **258**. In effect, the top and bottom endplates **110***d*, **120***d* move towards one another at the proximal end **101** (not shown) thereby decreasing an angle of inclination between the top and bottom endplates **110***d*, **120***d*. In summary, when positioning the first surgical tool **400** in the second position and rotating the first surgical tool **400** in either the first or second direction the moving mechanism **250** operably adjusts an angle of inclination between the top and bottom endplates **110**, **120** upon rotating the first set screw along the rotation axis.

[0207] In the contracted position of FIG. **33**A, a first height between top endplate **110***d* and bottom endplate **120***d* on the proximal side **101** and distal side **102** is about 9 mm. In the first expanded position of FIG. **33**B, a second height of spinal implant **300** between top endplate **110***d* and bottom endplate **120***d* on the proximal side **101** and distal side **102** is about 9 mm. Additionally, in the first expanded position of FIG. **33**B, top endplate **110***d* is parallel with respect to bottom endplate **110***d*. In the first angled position of FIG. **33**C, the top and bottom endplates **110***d*, **120***d* are contacting each other at the distal side **102** and are spaced apart from one another at the proximal side **101**. For example, at the distal side **102**, the height between top endplate **110***d* and bottom endplate **120***d* is about 9 mm. For example still, at the proximate side **101**, the height between top endplate **110***d* and bottom endplate **120***d* is about 16 mm. Accordingly, an angle of inclination between top endplate **110***d* and bottom endplate **120***d* at the distal side **101** is about 11°. In the second angled position of FIG. **33**D, the top and bottom endplates **110***d*, **120***d* are contacting each other at the proximal side **102** and are spaced apart from one another at the distal side **101**. For example, at the proximal side **102**, the height between top endplate **110***d* and bottom endplate **120***d* is about 9 mm. For example still, at the distal side **101**, the height between top endplate **110***d* and bottom endplate **120***d* is about 16 mm. Accordingly, an angle of inclination between top endplate **110***d* and bottom endplate **120***d* at the proximal side **101** is about 11°.

[0208] In some embodiments, spinal implant **300** may comprise a three position inner drive shaft (not illustrated) complimentary to or in place of components of moving mechanism **250**. The three position inner drive shaft may enable the first and second set screws **252**, **254** to be adjusted independently from one another as well as enabling the first and second set screws **252**, **254** to be adjusted concurrently or simultaneously. For example, first surgical tool **400** may have a relatively short circumferential surface **456** that will only engage one of the internal circumferential surfaces of first or second set screws **252**, **254** at a time. For example still, another first surgical tool **400** having a relatively longer circumferential surface **456** may engage both of the internal circumferential surfaces of the first and second set screws **252**, **254** at the same time. Consistent with disclosed embodiments, a surgeon can use a first surgical tool **400** having a relatively shorter circumferential surface **456** to perform angular adjustments of spinal implant **300** and then use a first surgical tool **400** having a relatively longer circumferential surface **456** to perform height adjustments of spinal implant **300**. In other embodiments, spinal implant **300** may include a screw guide aperture **107** on both sides of the spinal implant **300** thereby providing access to the first set screw **252** independently from second set screw **254**.

[0209] FIG. **34** is a perspective view of a spinal implant system utilizing spinal implant **300** and first surgical tool **400**. In the exemplary system, spinal implant **300** is positioned in an installed position between vertebral bodies by first surgical tool **400** according to lateral insertion techniques as explained in greater detail above. First surgical tool **400** may operably adjust spinal implant **300** in situ between vertebral bodies as explained in greater above. For example, first surgical tool **400** may operably expand spinal implant **300** at a proximal side **101** and/or a distal side **102** thereof. In this way, spinal implant **300** may correct alignment of a patient's spine in a coronal plane.

[0210] FIG. **35** is a perspective view of a spinal implant system utilizing spinal implant **300** highlighting how first surgical tool **400** may manipulate spinal implant **300** from various angles. For example, spinal implant **300** may include the same, substantially the same, or similar components to moving mechanism **2500** as explained above. In the exemplary embodiment, first surgical tool **400** may be inserted into guide aperture **107** off angle with respect to first reference axis B**1**. Reference ring RR represents the extent of viable offset positions that first surgical tool **400** may be operably inserted in guide aperture **107**. In some embodiments, first surgical tool **400** may be bent at a midsection area at 15° (not illustrated) to enable a surgeon to adjust spinal implant **300** in such a way as to avoid anatomical features and organs, such as, for example the pelvic ring and iliac crest.

[0211] Referring generally to FIGS. **36**-**39**B an additional expandable spinal implant **600** is disclosed. Expandable spinal implant **600** may have the same, substantially the same, and/or similar components and attributes as spinal implants **100**, **200**, and **300** including general applicability with other relevant systems and surgical tools disclosed hereinabove. Spinal implant **600** may include a screw guide endplate **6150** having at least one aperture **610** configured to receive an anchoring screw **510** therein. Screw guide endplate **6150** may be relatively longer in length than screw guide endplate **150** discussed above and screw guide endplate **6150** may be operably coupled with moving mechanism **250** similarly as explained above with respect to spinal implants **100**, **200**, and **300**.

[0212] In the illustrated embodiment, top endplate **110** and bottom endplate **120** may each have an accommodating portion **630** having a corresponding size and geometry to the end portions of screw guide endplate **6150** such that when spinal implant **600** is in the fully collapsed position the end portions of screw guide endplate **6150** will not increase a relative height of implant **600** in a fully collapsed position. For example, endplates **110**, **120** may fully close without being impacted by screw guide endplate **6150** and therefore maintain a relatively compact size.

[0213] FIGS. **38**A and **38**B illustrate a front perspective view and a rear perspective view of an exemplary screw guide endplate **6150** having at least one aperture **610** configured to receive an anchoring screw **510** therein. In the illustrated embodiment, two apertures **610** are shown although embodiments in accordance with the principles of this disclosure may have any number of apertures **610**. As illustrated, each aperture **610** may be configured to selectively receive a corresponding anchoring screw therein. The outside entrance to each aperture **610** may define two alternate guided paths. For example, a first guided path may be defined by the entrance to aperture **610** and a first exit aperture **610***a* and a second guided path may be defined by the entrance to aperture **610** and a second exit aperture **610***b*. In this way aperture **610** may be configured to orient one corresponding anchoring screw **510** at a time in either of a first orientation or a second orientation.

[0214] Corresponding exemplary first and second orientations are illustrated in FIG. **37** which shows a first anchoring screw **510** (right anchoring screw) oriented upward at an inclined angle with respect to top endplate **110** and a second anchoring screw **510** (left anchoring screw) oriented downward at an inclined angle with respect to bottom endplate **120**. Additionally, the first orientation may align a corresponding anchoring screw **510** such that it projects through a corresponding slotted aperture **640** of the first endplate **110** (see FIGS. **36** and **39**A). Similarly, the second orientation may align a corresponding anchoring screw **510** such that it projects through a corresponding slotted aperture **640** of the second endplate **120** (see FIGS. **36** and **39**B).

[0215] At least one advantage of the disclosed spinal implant **600** is that screw guide endplate **6150** and moving mechanism **250** may be configured such that the moving mechanism **250** can selectively adjust a spacing between the first and second endplates **110**, **120** and adjust an angle of inclination between the first and second endplates while the at least one corresponding anchoring screw **510** is anchored within a corresponding vertebrae. For example, a surgeon may initially position spinal implant **600** between adjacent vertebrae of a patient and install a corresponding first anchoring screw **510** in a first orientation projecting through slotted aperture **640** of first endplate **110** and a corresponding second anchoring screw **510** in a second orientation projecting through slotted aperture **640** of second endplate **120**. Next, the surgeon may continue to adjust the spacing and/or angle of inclination between endplates **110**, **120** until the endplates **110**, **120** are in the desired position. This is possible, at least partly, because the relative location of the screw guide endplate **6150** remains fixed due to the anchored anchoring screws **510** and the first and second endplates can freely expand/contract and/or incline/decline via moving mechanism **250** while anchoring screws **510** extend through slotted aperture **640** (which has a geometry such that the anchored anchoring screws **510** do not interfere with the movement of endplates **110**, **120**). For example, the endplates **110**, **120** may freely move while anchoring screws **510** remain anchored in place in the corresponding vertebrae while also changing a relative positioning with respect to the slotted aperture **640** due to movement of endplates **110**, **120**.

[0216] Referring generally to FIGS. **40-44**B an additional expandable spinal implant **700** is disclosed. Expandable spinal implant **700** may have the same, substantially the same, and/or similar components and attributes as spinal implants **100**, **200**, **300**, and **600** including general applicability with other relevant systems and surgical tools disclosed hereinabove. Spinal implant **700** may include a screw guide endplate **7150** having at least one aperture **710** configured to receive an anchoring screw **510** therein. Screw guide endplate **7150** may be relatively longer in length than screw guide endplate **150** discussed above and screw guide endplate **7150** may be operably coupled with moving mechanism **250** similarly as explained above with respect to spinal implants **100**, **200**, and **300**.

[0217] In the illustrated embodiment, top endplate **110** and bottom endplate **120** may each have an accommodating portion **730** having a corresponding size and geometry to the end portions of screw guide endplate **7150** such that when spinal implant **700** is in the fully collapsed position the end portions of screw guide endplate **7150** will not increase a relative height of implant **700** in a fully collapsed position. For example, endplates **110**, **120** may fully close without being impacted by screw guide endplate **7150** and therefore maintain a relatively compact size.

[0218] FIGS. **42**A and **42**B illustrate an exemplary screw guide endplate **7150** with and without corresponding anchoring screws **510**, respectively. FIGS. **43**A and **43**B illustrate a front perspective view and a rear perspective view of an exemplary screw guide endplate **7150** having at least one aperture **710** configured to receive an anchoring screw **510** therein. In the illustrated embodiment, four apertures **710** are shown, although embodiments in accordance with the principles of this disclosure may have any number of apertures **710**.

[0219] As illustrated, each aperture **710** may be configured to selectively receive a corresponding anchoring screw **510** therein. The outside entrance to each aperture **710** may define a guided path configured to orient a corresponding anchoring screw **510** in an inclined position extending away from a proximal side of a corresponding endplate **110** or **120**. For example, screw guide endplate **7150** may include a total of four apertures **710**, and the four apertures **710** may include two top most apertures **710** and two bottom most apertures **710**. In the disclosed embodiment, the two top most apertures **710** may be configured to incline a corresponding anchoring screw **510** with respect to top endplate **110** that extends away from a proximal side of implant **700** towards a distal side of implant **700**. Similarly, the two bottom most apertures **710** may be configured to incline a corresponding anchoring screw **510** with respect to bottom endplate **120** that extends from a proximal side of implant **700** towards a distal side of implant **700**. Corresponding orientations are illustrated in FIGS. **40**, **41**, and **42**B which show two top anchoring screws **510** oriented upward at an inclined angle with respect to top endplate **110** and two bottom anchoring screws **510** oriented downward at an inclined angle with respect to bottom endplate **120**. Alternatively, the screw holes in the plate may be arranged and numbered in various alternative designs including, instead of two holes on top and bottom, presenting a single hole in the center or on one side or the other on top and bottom, or two holes on one of the top or bottom and one hole on the opposite side, top or bottom. These screw holes may further include protrusions, threads or other features to control, guide, and/or retain the screws in place or include features such as retaining clips, springs, or covers to retain the screws in place once inserted. The screw holes may be of various shapes including cylindrical, conical, or designed to receive a bulbous or spherical screw head.

[0220] FIGS. **44**A and **44**B may illustrate a top endplate **110** and a bottom endplate **120**, respectively, with an anchoring screw **510** in one corresponding aperture **710** and without an anchoring screw **510** in the other corresponding aperture **710** for ease of explanation. As illustrated, the top endplate **110** may include at least one anchoring screw **510** such that it projects through or across a corresponding recess **740** of the first endplate **110**. Similarly, the bottom endplate **120** may include at least one anchoring screw **510** such that it projects through or across a corresponding recess **740** of the first endplate **110**.

[0221] At least one advantage of the disclosed spinal implant **700** is that screw guide endplate **7150** and moving mechanism **250** may be configured such that the moving mechanism **250** can selectively adjust a spacing between the first and second endplates **110**, **120** and adjust an angle of inclination between the first and second endplates while the at least one corresponding anchoring screw **510** is anchored within a corresponding vertebrae. For example, a surgeon may initially position spinal implant **700** between adjacent vertebrae of a patient and install at least one corresponding anchoring screw **510** in a first orientation projecting through or across a corresponding recess **740** of first endplate **110** and at least one corresponding anchoring screw **510** in a second orientation projecting through or across recess **740** of second endplate **120**. Next, the surgeon may continue to adjust the spacing and/or angle of inclination between endplates **110**, **120** until the endplates **110**, **120** are in the desired position. This is possible, at least partly, because the relative location of the screw guide endplate **7150** remains fixed due to the anchored anchoring screws **510** and the first and second endplates can freely expand/contract and/or incline/decline via moving mechanism **250** while anchoring screws **510** extend through or across recess **740** (which has a geometry such that anchored anchoring screws **510** do not interfere with the movement of endplates **110**, **120**). For example, the endplates **110**, **120** may freely move while anchoring screws **510** remain anchored in place in the corresponding vertebrae.

[0222] FIGS. **45** and **46** are perspective views of an additional embodiment of an expandable spinal implant **800** including an anterior endplate **810** in accordance with the principles of the present disclosure. In some embodiments, anterior endplate **810** may be referred to as a third endplate, or may be referred to as a medial, lateral, or posterior endplate depending upon orientation or approach employed and the specific configuration and shape of the implant and the location, side or end to which the third plate is affixed or located. FIG. **47** is an exploded parts view diagram of the embodiment of FIG. **45** in accordance with the principles of the present disclosure. Expandable spinal implant **800** may include the same, substantially the same, and/or similar features as the various above disclosed embodiments. For example, moving mechanism **250** may operate in the same, substantially the same, and/or similar manner as explained above. However, implant **800** may include an anterior endplate **810**, a top endplate **820** (superior endplate), and a bottom endplate **830** (inferior endplate) having different characteristics as will be explained in further detail below.

[0223] Implant **800** may include an anterior side **800***a*, a posterior side **800***p* and two opposing lateral sides **8001**, for example. Additionally, the outside contours of implant **800** may include a top endplate **820** (superior endplate), bottom endplate **830** (inferior endplate) and an anterior endplate **810** (front endplate), for example. In various embodiments, the top endplate **820** and bottom endplate **830** may collectively define the posterior side **800***p* (rear side) of implant **800**. Anterior endplate **810** may include a plurality of circular bone screw apertures **801**, for example. In the example embodiment, four circular bone screw apertures **801** are disclosed although in other embodiments the number of bone screw apertures **801** may be more or less. For example, in some embodiments there may be an additional 5^{th} and 6^{th} bone screw aperture in the medial location of anterior endplate **810**. In other embodiments, there may be a total of two bone screw apertures **801** including a left bone screw aperture **801** diagonally projecting over the top endplate **820** and a right bone screw aperture **801** diagonally projecting over the bottom endplate **820**.

[0224] In various embodiments, each bone screw aperture **801** may include at least one circular ring portion **801***a* that facilitates seating of a bone screw **511** (see FIG. **52**) and/or facilitates the alignment of a drill in a coaxial relationship, e.g., surgical tool **500** as disclosed above. For example, the ring portion **801***a* may define a bearing surface for seating an inclined surface **512** of an outdented rail **513** of a head portion of a bone screw **511**, for example. In various embodiments, the ring portion **801***a* may have a size and shape generally corresponding to a size and shape of the inclined surface **512** and define an interior diameter that is less than a cross sectional diameter of the outdented rail **513**. Additionally, in various embodiments, the ring portion **801***a* of bone screw apertures **801** may allow about +/−100 and in some embodiments about +/−5° of freedom to the corresponding bone screw **511** due to the inclined surface **512**, for example.

[0225] Anterior endplate **810** may include at least one bone screw lock **803** for preventing bone screws **511** from backing out. For example, bone screw lock **803** may be a rotatable lock that may rotate about 90° between an open position and a closed position to prevent bone screws **511** from backing out, for example. In various embodiments, anterior endplate **810** may include at least one attachment point **805** for connecting implant **800** with a surgical tool. In the disclosed embodiment, a plurality of attachment points **805** are distributed around screw guide aperture **807**. In the disclosed embodiment, six attachment points **805** are radially distributed around screw guide aperture **807** although other embodiments may have more or less, e.g. 2, 3, 4, 5, 7 or 8.

[0226] As understood best with reference to FIG. **47**, anterior endplate **810**, top endplate **820**, and bottom endplate **830** may be operably coupled to moving mechanism **250**. For example, moving mechanism **250** serves as a central attachment location for each of the endplates **810**, **820**, **830** and each of the endplates **810**, **820**, **830** may interact independently with moving mechanism **250**, for example. In the disclosed embodiment, anterior endplate **810** may be operably coupled to moving mechanism **250** by inserting posts **855** into a corresponding post retaining aperture **255** having a size and shape configured to securely couple the two together. In various embodiments, posts **855** may extend from an inside surface of anterior endplate **810** in a direction towards the posterior side **800***p* of implant **800** and towards moving mechanism **250**. In this way, anterior endplate **810** is independently secured to moving mechanism **250** from top endplate **820** and bottom endplate **830**, for example.

[0227] FIGS. **48**A and **48**B are top down views of an example bottom endplate **830** of spinal implant **800**. In various embodiments, bottom endplate **830** and top endplate **820** may include the same, substantially the same, and/or similar characteristics. In the example illustration, bottom endplate **830** may include a bone screw relief **832** for each corresponding bone screw aperture **801**. For example, bone screw relief **832** comprises an arcuate channel and/or conical channel defining a portion of the outside surface of endplate **830**. In some embodiments, the number of bone screw reliefs **832** may be more or less. For example, a single bone screw relief **832** or three bone screw reliefs **832**. In some embodiments, the top endplate **820** may include a first bone screw relief **822** and the bottom endplate **830** may include a second bone screw relief **832** that project oppositely from one another in a diametrically opposed direction. Additionally, in the top down views of FIGS. **48**A and **48**B it is shown that a gap **840** (void space) exists between anterior endplate **810** and bottom endplate **830**. The gap **840** between anterior endplate **810** and endplates **820**, **830** may be present in both the expanded and contracted position. For example, as shown in FIG. **48**C implant **800** is in an expanded position and a gap **840** is present between anterior endplate **810**, top endplate **820**, and bottom endplate **830**. For example still, gap **840** may define a continuous discontinuity between the posterior side of the anterior endplate **810** and the anterior side of the top endplate **820** and bottom endplate **830**.

[0228] FIG. **49** is a perspective view of spinal implant **800** in an expanded configuration including a plurality of bone screws **511** extending over corresponding bone screw apertures **801**. In the example embodiment, when implant **800** is in the fully expanded position a trajectory of the bone screws **511** is unaffected by the top endplate **820** and/or bottom endplate **830**. For example, the bone screw reliefs **822**, **832** allow the implant **800** to fully expand without interfering with bone screws **511**. For example still, bone screws **511** may be secured to a boney surface and only anchor implant **800** via bone screw apertures **801** of anterior endplate **810**.

[0229] FIG. **50** is an alternate perspective view of the embodiment of FIG. **45** including a plurality of bone screws **511** that are prevented and/or suppressed from backing out due to bone screw locks **803**. Bone screw locks **803** may be toggled between an unlocked position shown in FIG. **49** to a locked position shown in FIG. **50** by rotating the bone screw lock **803** about 90°. In operation, an end user such as a surgeon may place bone screws **511** through bone screw aperture **801** after the implant **800** is expanded to the desired height and inclination. Thereafter, the surgeon may move bone screw lock **803** from the unlocked position to the locked position to prevent bone screws **511** from backing out. In various embodiments, even after the bone screw lock **803** is engaged in the locked position the surgeon may drive bone screws **511**. FIG. **51** is a rear perspective view of implant **800** including a plurality of bone screws **511**.

[0230] FIG. **52** is an example side view of a bone screw **511**. As illustrated in the embodiment of FIG. **52**, bone screw **511** may include an inclined surface **512** extending around the circumference of bone screw **511** and terminating into a ring portion **513**. In various embodiments, the ring portion **513** may have a size and shape generally corresponding to a size and shape of circular ring portions **801***a* of bone screw aperture **801**, for example. Additionally, in various embodiments the cooperation between the circular ring portions **801***a*, inclined surface **512** and ring portion **513** may allow about +/−5° of freedom to the corresponding bone screw **511**, for example.

[0231] FIG. **53** is a reference diagram illustrating various cardinal directions and planes with respect to a patient that various spinal implants disclosed herein may operate, adjust, and/or move along in accordance with the principles of the present disclosure.

Additional Plate/Expandable Plate Embodiments

[0232] Referring generally to FIGS. **54-69** various plates, including expandable plate embodiments for coupling to various spinal implants are disclosed. FIGS. **54-61** illustrate a first expandable plate **1500** embodiment; FIGS. **62-67** illustrate a second expandable plate **1600** embodiment, and FIGS. **68-73** illustrate a third expandable plate **1700** embodiment. The various expandable plates **1500**, **1600**, **1700** may have the same, similar, and/or substantially the same components and functionality unless the context clearly indicates otherwise. For example, the various expandable plates **1500**, **1600**, and **1700** may each be designed for connecting and/or coupling to the various spinal implants disclosed herein, and may be used in conjunction with anterior endplate **810**, for example. However, the principles of the disclosed expandable plates **1500**, **1600**, **1700** are not necessarily limited to the specific implants disclosed herein and can, of course, be coupled and/or connected to other implants in the same, similar, and/or substantially the same manner.

[0233] FIGS. **54-55** are various perspective views of a first expandable plate **1500** embodiment for coupling to disclosed spinal implants. Expandable plate **1500** may include a superior portion **1505** (may also be referred to as superior plate) and an inferior portion **1503** (may also be referred to as an inferior plate) that are expandable and contractible relative to one another, for example. Superior portion **1505** may include a first bone screw aperture **1502***a* for supporting a first bone screw **1504***a* in a target trajectory and inferior portion **1503** may include a second bone screw aperture **1502***b* for supporting a second bone screw **1504***b* in a target trajectory, for example. Expandable plate **1500** may include an end cap **1501** that is rotatable between a locked position where the first and second bone screw apertures **1502***a*, **1502***b* are covered such that the first and second bone screws **1504***a*, **1504***b* are prevented and/or suppressed from backing out. Expandable plate **1500** may include a set screw **1507** for securing the superior portion **1505** and inferior portion **1503** at a particular positon relative to one another. For example, the superior portion **1505** and inferior portion **1503** are expandable in a vertical direction away from one another and set screw **1507** may lock the superior portion **1505** and inferior portion **1503** at any one of the various expanded positions.

[0234] FIG. **56** is a front view of a first expandable plate **1500** showing various axes and reference directions. Expandable plate **1500** may extend in a lengthwise direction along axis Y-Y (may also be referred to as the vertical direction depending on orientation), for example. In various embodiments, expandable plate **1500** may be roughly considered symmetrical on either side of axis Y-Y and/or at least because bone screw apertures **1502***a* and **1502***b* are vertically aligned. Additionally, expandable plate **1500** may extend in a widthwise direction along axis X-X (may also be referred to as a lateral direction depending on orientation), for example. In various embodiments, a thickness of expandable plate **1500** may extend in a proximal-to-distal direction. For example, as shown in FIG. **54**, a thickness may be measured in a proximal-to-distal direction from proximal side **1500***p* to distal side **1500***d*.

[0235] FIGS. **57-59** are various exploded parts views of a first expandable plate **1500**. In the example embodiment, it is shown that set screw **1507** extends in a proximal to distal direction and includes a thread pattern **1507***a* on an outside circumferential surface at the distal end and a head portion **1507***b* at the proximate end that is relatively larger than the maximum diameter of the thread pattern **1507***a*, for example. In various embodiments, set screw **1507** may include a hollow interior such that a rotation instrument such as a driver may extend through set screw **1507** in the proximal-to-distal direction. Set screw **1507** may extend through aperture **1501***a* of cover **1501**, aperture **1503***a* of inferior portion **1503**, aperture **1505***a* of superior portion **1505**, and thread into the threaded aperture **1509***a* of nut **1509**, for example. Additionally, in various embodiments head portion **1507***b* may be nested and/or seated within a circumferential indent **1501***b* such that the outside surfaces of head portion **1507***b* and the outside portion of end cap **1501** are flush and/or substantially flush, for example. Additionally, upper portion **1505** may include a lip **1505***d* projecting from a distal side of upper portion **1505** and extending in a widthwise direction. In various embodiments, lip **1505***d* may be positioned to sit on an apophyseal ring of an adjacent vertebrae and be utilized for determining an appropriate expansion setting of the upper portion **1505** relative to the lower portion **1503**, for example.

[0236] As seen best in FIG. **58**, lower portion **1503** may include a receiving cavity **1503***c* having a size and shape that corresponds to a lower end of upper portion **1505**, for example. Receiving cavity **1503***c* may have a size and shape generally corresponding to a size and shape of a lower end of the upper portion **1505**. Lower portion **1503** may include a rack portion **1503***b* comprising a plurality of raised rails and indented grooves that extend in a widthwise direction, for example. In various embodiments, rack portion **1503***b* may be disposed within cavity **1503***c* proximate to and on both sides of aperture **1503***a*. Additionally, rack portion **1503***b* may face the proximal direction of expandable plate **1500**. As seen best in FIG. **57**, upper portion **1505** may include a rack portion **1505***b* comprising a plurality of raised rails and indented grooves that extend in a widthwise direction, for example. In various embodiments, rack portion **1505***b* may be disposed on a distal end of upper portion **1505** such that when upper portion **1505** is insert within receiving cavity **1503***c* rack portion **1505***b* faces rack portion **1503***b*, for example. In this way, rack portion **1505***b* may mesh with rack portion **1503***b* within any of the various plurality of positions defined by the plurality of raised rails and indented grooves, for example.

[0237] In various embodiments, upper portion **1505** may move up and down in a vertical direction within receiving cavity **1503***c* such that expandable plate **1500** may be selectively expanded and contracted. Additionally, nut **1509** may nest within channel **1503***e* of lower portion **1503**, for example. In the example embodiment, channel **1503***e* may be understood as a slotted channel that extends in a vertical direction for a distance greater than the diameter of nut **1509** and extends in the widthwise direction for a distance approximating a width of nut **1509**. For example, nut **1509** may include planar side surfaces **1509***b* and a distance in the widthwise direction of channel **1503***e* may correspond to the distance between the two planar side surfaces **1509***b*. Additionally, planar side surfaces **1509***b* may prevent the nut **1509** from rotating while set screw **1507** is tightened to nut **1509**. Accordingly, an end user such as a surgeon may expand the top portion **1505** relative to the bottom portion **1503** (or vice versa) and tighten set screw **1507** to nut **1509** such that rack portions **1505***b* and **1503***b* are urged together and/or directly engage with one another. In this way, an end user can securely couple the top portion **1505** to the bottom portion **1503** in any one of the various viable expanded positions.

[0238] With reference to FIGS. **59** and **61**, set screw **1507** may include a tapered portion **1507***c* disposed between a circumferential indent **1507***d* at a proximal side and a threaded portion **1507***a*, for example. In some embodiments, tapered portion **1507***c* may be referred to as a conical tapered portion, for example. Tapered portion **1507***c* may be widest at a proximal end of screw **1507** and narrowest at an end thereof closest to a distal side and before and/or adjoining threaded portion **1507***a*, for example. In various embodiments, tapered portion **1507***c*, In various embodiments, engagement surfaces of the upper portion **1505** and/or lower portion **1503** may be seated within circumferential indent **1507***d* (see FIG. **61**). Additionally, in various embodiments tapered portion **1507***c* may interfere with aperture **1505***a* such that set screw **1507** may rotate therein while also remaining coupled to nut **1509**, for example. Additionally, tapered portion **1507***c* may facilitate and/or allow the upper portion **1505** and lower portion **1503** to expand and contract while also allowing the cover **1501** to rotate. For example, cover **1501** may rotate around tapered portion **1507***c* between a locked position and an unlocked position.

[0239] FIG. **60** is a front view of a first expandable plate **1500** embodiment coupled to an endplate **810** of a spinal implant **800** and FIG. **61** is a cross section view of FIG. **60**. In the example embodiment, it is shown that the distal side of expandable plate **1500** is in contact with the proximal side of endplate **810**. Additionally, it is shown that the first and second set screws **252**, **254** of moving mechanism **250** are accessible through an aperture of set screw **1507** of expandable plate **1500**. Furthermore, it is shown that a target trajectory of the first and second bone screws **1504***a*, **1504***b* extends substantially perpendicular to the face of expandable plate **1500** in a proximal-to-distal-direction. For example, the first and second bone screws **1504***a*, **1504***b* extend straight back from the proximal end towards the distal end in a plane that approximates the centerline of implant **800** and expandable plate **1500**. Furthermore, in various embodiments the first bone screw aperture **1502***a* and second bone screw aperture **1502***b* may be conically shaped, tapered, and/or cylindrical with or without a retaining lip and may also allow for about +/−9 degrees of relative freedom of movement. In various embodiments, in a contracted position, a vertical distance between the first bone screw aperture **1502***a* and second bone screw aperture **1502***b* may be about 15 mm to about 25 mm and in some embodiments about 21.5 mm, for example. In various embodiments, in an expanded position, a vertical distance between the first bone screw aperture **1502***a* and second bone screw aperture **1502***b* may about 20 mm to about 35 mm and in some embodiments about 27.5 mm, for example.

[0240] FIGS. **62**-**63** are various perspective views of a second expandable plate **1600** embodiment for coupling to disclosed spinal implants. Expandable plate **1600** may include a superior portion **1605** (may also be referred to as superior plate) and an inferior portion **1603** (may also be referred to as an inferior plate) that are expandable and contractible relative to one another, for example. Superior portion **1605** may include a first bone screw aperture **1602***a* for supporting a first bone screw **1604***a* in a target trajectory and a second bone screw aperture **1602***b* for supporting a second bone screw **1604***b* in a target trajectory, for example. Additionally, inferior portion **1603** may include a third bone screw aperture **1602***c* for supporting a third bone screw **1604***c* in a target trajectory, for example. Expandable plate **1600** may include an end cap **1601** that is rotatable between a locked position where the first, second, and third bone screw apertures **1602***a*, **1602***b*, and **1602***c* are covered such that the first, second, and third bone screws **1604***a*, **1604***b*, **1604***c* are prevented and/or suppressed from backing out. Expandable plate **1600** may include a set screw **1607** for securing the superior portion **1605** and inferior portion **1603** at a particular positon relative to one another. For example, the superior portion **1605** and inferior portion **1603** are expandable in a vertical direction away from one another and set screw **1607** may lock the superior portion **1605** and inferior portion **1603** at any one of the various expanded positions as will be explained in further detail below.

[0241] FIG. **64** is a front view of a second expandable plate **1600** showing various axes and reference directions. Expandable plate **1600** may extend in a lengthwise direction along axis Y-Y (may also be referred to as the vertical direction depending on orientation), for example. In various embodiments, expandable plate **1600** may be roughly considered symmetrical on either side of axis Y-Y. For example, a left side of expandable plate **1700** may be symmetrical with respect to a right side of expandable plate **1700**. Additionally, expandable plate **1600** may extend in a widthwise direction along axis X-X (may also be referred to as a lateral direction depending on orientation), for example. In various embodiments, a thickness of expandable plate **1600** may extend in a proximal-to-distal direction. For example, as shown in FIG. **62**, a thickness may be measured in a proximal-to-distal direction from proximal side **1600***p* to distal side **1600***d*.

[0242] FIG. **65** is an exploded parts view of a second expandable plate **1600**. In the example embodiment, it is shown that set screw **1607** extends in a proximal-to-distal direction and includes a thread pattern **1607***a* on an outside circumferential surface at the distal end and a head portion **1607***b* at the proximate end that is relatively larger than the maximum diameter of the thread pattern **1607***a*, for example. Set screw **1607** may extend through aperture **1601***a* of cover **1601**, aperture **1603***a* of inferior portion

1603, aperture 1605*a* of superior portion 1605, and thread into the threaded aperture 1609*a* of nut 1609, for example. In various embodiments, set screw 1607 may include a hollow interior such that a rotation instrument such as a driver may extend through set screw 1607 in the proximal-to-distal direction. Additionally, in various embodiments head portion 1607*b* may be nested and/or seated within a circumferential indent 1601*b* such that the outside surfaces of head portion 1607*b* and the outside portion of end cap 1601 are flush and/or substantially flush, for example. Furthermore, upper portion 1605 may include a lip 1605*d* projecting from a distal side of upper portion 1605 and extending in a widthwise direction. Similarly, lower portion 1603 may include a lip 1603*d* projecting from a distal side of lower portion 1603 and extending in a widthwise direction. In various embodiments, lips 1605*d*, 1603*d* may be positioned to sit on an apophyseal ring of an adjacent vertebrae, respectively, and be utilized for determining an appropriate expansion setting of the upper portion 1605 relative to the lower portion 1603, for example. For example, an end user such as a surgeon may position lip 1605*d* to sit and/or contact an apophyseal ring of a superior vertebrae and position lip 1603*d* to sit and/or contact an apophyseal ring of an inferior vertebrae. In doing so, an appropriate expansion and/or relative height of expandable plate 1600 may be established.

[0243] As seen best in FIG. 65, upper portion 1605 may include a receiving cavity 1605*c* having a size and shape that corresponds to an upper end of lower portion 1603, for example. Receiving cavity 1605*c* may have a size and shape generally corresponding to a size and shape of an upper end of the lower portion 1603. Upper portion 1605 may include a rack portion 1605*b* comprising a plurality of raised rails and indented grooves that extend in a widthwise direction, for example. In various embodiments, rack portion 1605*b* may be disposed within cavity 1605*c* proximate to and on both sides of aperture 1605*a*. Additionally, rack portion 1605*b* may face the proximal direction of expandable plate 1600. As seen best in FIG. 65 and FIG. 67, lower portion 1603 may include a rack portion 1603*b* comprising a plurality of raised rails and indented grooves that extend in a widthwise direction, for example. In various embodiments, rack portion 1603*b* may be disposed on a distal end of lower portion 1603 such that when lower portion 1603 is insert within receiving cavity 1605*c*, rack portion 1603*b* faces rack portion 1605*b*, for example. In this way, rack portion 1603*b* may mesh with rack portion 1605*b* within any of the various plurality of positions defined by the plurality of raised rails and indented grooves, for example.

[0244] In various embodiments, lower portion 1603 may move up and down in a vertical direction within receiving cavity 1605*c* such that expandable plate 1600 may be selectively expanded and contracted. Additionally, nut 1609 may nest within channel 1605*e* of upper portion 1605, for example as seen best in FIG. 67. In the example embodiment, channel 1605*e* may be understood as a slotted channel that extends in a vertical direction for a distance greater than the diameter of nut 1609 and extends in the widthwise direction for a distance approximating a width of nut 1609. For example, nut 1609 may include planar side surfaces 1609*b* and a distance in the widthwise direction of channel 1605*e* may correspond to the distance between the two planar side surfaces 1609*b*. Additionally, planar side surfaces 1609*b* may prevent the nut 1609 from rotating while set screw 1607 is tightened to nut 1609. Accordingly, an end user such as a surgeon may expand the bottom portion 1603 relative to the top portion 1605 (or vice versa) and tighten set screw 1607 to nut 1609 such that rack portions 1605*b* and 1603*b* are urged together and/or directly engage with one another. In this way, an end user can securely couple the top portion 1605 to the bottom portion 1603 in any one of the various viable expanded positions.

[0245] FIGS. 66 and 67 are various perspective views of a second expandable plate 1600 embodiment in an expanded position. Although not illustrated, second expandable plate 1600 may couple to an implant and/or endplate 810 in the same, substantially the same, and/or similar manner as explained above in reference to first expandable plate 1500. Accordingly, duplicative description will be omitted. In the example embodiment, it is shown that the first, second, and third bone screws 1604*a*, 1604*b*, 1604*c* extend from the proximal end towards the distal end in a diverging pattern. Additionally, in various embodiments, the first and second bone screws may converge towards one another, at least partially. Furthermore, in various embodiments the first bone screw aperture 1602*a*, second bone screw aperture 1602*b*, and third bone screw aperture 1602*c* may be conically shaped, tapered, and/or cylindrical with or without a retaining lip and may also allow for about +/−9 degrees of relative freedom of movement. In various embodiments, in a contracted position, a vertical distance between the first bone screw aperture 1602*a* and second bone screw aperture 1602*b* may be about 16 mm to about 25 mm and in some embodiments about 21.5 mm, for example. In various embodiments, in an expanded position, a vertical distance between the first bone screw aperture 1602*a* and second bone screw aperture 1602*b* may be about 20 mm to about 35 mm and in some embodiments about 27.5 mm, for example.

[0246] FIGS. 68-73 are various perspective views of a third expandable plate 1700 embodiment for coupling to disclosed spinal implants. With reference to FIGS. 68 and 69, expandable plate 1700 may include a superior portion 1705 (may also be referred to as superior plate) and an inferior portion 1703 (may also be referred to as an inferior plate) that are expandable and contractible relative to one another, for example. Superior portion 1705 may include a first bone screw aperture 1702*a* for supporting a first bone screw 1704*a* in a target trajectory and a second bone screw aperture 1702*b* for supporting a second bone screw 1704*b* in a target trajectory, for example. Additionally, inferior portion 1703 may include a third bone screw aperture 1702*c* for supporting a third bone screw 1704*c* in a target trajectory, and a fourth bone screw aperture 1702*d* for supporting a fourth bone screw 1704*d*, for example. Expandable plate 1700 may include an end cap 1701 that is rotatable between a locked position where the first, second, third, and fourth bone screw apertures 1702*a*, 1702*b*, 1702*c*, and 1702*d*, are covered such that the first, second, third, and fourth bone screws 1704*a*, 1704*b*, 1704*c*, and 1702*d* are prevented and/or suppressed from backing out. Expandable plate 1700 may include a set screw 1707 for securing the superior portion 1705 and inferior portion 1703 at a particular positon relative to one another. For example, the superior portion 1705 and inferior portion 1703 are expandable in a vertical direction away from one another and set screw 1707 may lock the superior portion 1705 and inferior portion 1703 at any one of the various expanded positions as will be explained in further detail below.

[0247] FIG. **70** is a front view of a third expandable plate **1700** showing various axes and reference directions. Expandable plate **1700** may extend in a lengthwise direction along axis Y-Y (may also be referred to as the vertical direction depending on orientation), for example. In various embodiments, expandable plate **1700** may be roughly considered symmetrical on either side of axis Y-Y. For example, a left side of expandable plate **1700** may be symmetrical with respect to a right side of expandable plate **1700**. Additionally, expandable plate **1700** may extend in a widthwise direction along axis X-X (may also be referred to as a lateral direction depending on orientation), for example. In various embodiments, a thickness of expandable plate **1700** may extend in a proximal-to-distal direction. For example, as shown in FIG. **68**, a thickness may be measured in a proximal-to-distal direction from proximal side **1700*p*** to distal side **1700*d***.

[0248] FIG. **71** is an exploded parts view of a third expandable plate **1700**. In the example embodiment, it is shown that set screw **1707** extends in a proximal-to-distal direction and includes a thread pattern **1707*a*** on an outside circumferential surface at the distal end and a head portion **1707*b*** at the proximate end that is relatively larger than the maximum diameter of the thread pattern **1707*a***, for example. Set screw **1707** may extend through aperture **1701*a*** of cover **1701**, aperture **1703*a*** of inferior portion **1703**, aperture **1705*a*** of superior portion **1705**, and thread into the threaded aperture **1709*a*** of nut **1709**, for example. In various embodiments, set screw **1707** may include a hollow interior such that a rotation instrument such as a driver may extend through set screw **1707** in the proximal-to-distal direction. Additionally, in various embodiments head portion **1707*b*** may be nested and/or seated within a circumferential indent **1701*b*** such that the outside surfaces of head portion **1707*b*** and the outside portion of end cap **1701** are flush and/or substantially flush, for example. Furthermore, upper portion **1705** may include a lip **1705*d*** projecting from a distal side of upper portion **1705** and extending in a widthwise direction. Similarly, lower portion **1703** may include a lip **1703*d*** projecting from a distal side of lower portion **1703** and extending in a widthwise direction. In various embodiments, lips **1705*d***, **1703*d*** may be positioned to sit on an apophyseal ring of an adjacent vertebrae, respectively, and be utilized for determining an appropriate expansion setting of the upper portion **1705** relative to the lower portion **1703**, for example. For example, an end user such as a surgeon may position lip **1705*d*** to sit and/or contact an apophyseal ring of a superior vertebrae and position lip **1703*d*** to sit and/or contact an apophyseal ring of an inferior vertebrae. In doing so, an appropriate expansion and/or relative height of expandable plate **1700** may be established.

[0249] As seen best in FIG. **71**, upper portion **1705** may include a receiving cavity **1705*c*** having a size and shape that corresponds to an upper end of lower portion **1703**, for example. Receiving cavity **1705*c*** may have a size and shape generally corresponding to a size and shape of a lower end of the upper portion **1705**. Upper portion **1705** may include a rack portion **1705*b*** comprising a plurality of raised rails and indented grooves that extend in a widthwise direction, for example. In various embodiments, rack portion **1705*b*** may be disposed within cavity **1705*c*** proximate to and on both sides of aperture **1705*a***. Additionally, rack portion **1705*b*** may face the proximal direction of expandable plate **1700**. As seen best in FIG. **71**, lower portion **1703** may include a rack portion **1703*b*** comprising a plurality of raised rails and indented grooves that extend in a widthwise direction, for example. In various embodiments, rack portion **1703*b*** may be disposed on a distal end of lower portion **1703** such that when lower portion **1703** is insert within receiving cavity **1705*c***, rack portion **1703*b*** faces rack portion **1705*b***, for example. In this way, rack portion **1703*b*** may mesh with rack portion **1705*b*** within any of the various plurality of positions defined by the plurality of raised rails and indented grooves, for example.

[0250] In various embodiments, lower portion **1703** may move up and down in a vertical direction within receiving cavity **1705*c*** such that expandable plate **1700** may be selectively expanded and contracted. Additionally, nut **1709** may nest within channel **1705*e*** of upper portion **1705**, for example as shown in FIG. **73**. In the example embodiment, channel **1705*e*** may be understood as a slotted channel that extends in a vertical direction for a distance greater than the diameter of nut **1709** and extends in the widthwise direction for a distance approximating a width of nut **1709**. For example, nut **1709** may include planar side surfaces **1709*b*** and a distance in the widthwise direction of channel **1705*e*** may correspond to the distance between the two planar side surfaces **1709*b***. Additionally, planar side surfaces **1709*b*** may prevent the nut **1709** from rotating while set screw **1707** is tightened to nut **1709**. Accordingly, an end user such as a surgeon may expand the bottom portion **1703** relative to the top portion **1705** (or vice versa) and tighten set screw **1707** to nut **1709** such that rack portions **1705*b*** and **1703*b*** are urged together and/or directly engage with one another. In this way, an end user can securely couple the top portion **1705** to the bottom portion **1703** in any one of the various viable expanded positions.

[0251] FIGS. **72** and **73** are various perspective views of a third expandable plate **1700** embodiment in an expanded position. Although not illustrated, third expandable plate **1700** may couple to an implant and/or endplate **810** in the same, substantially the same, and/or similar manner as explained above in reference to first expandable plate **1500**. Accordingly, duplicative description will be omitted. In the example embodiment, it is shown that the first, second, third and fourth bone screws **1704*a***, **1704*b***, **1704*c***, **1704*d*** extend from the proximal end towards the distal end in a converging pattern. Furthermore, in various embodiments the first bone screw aperture **1702*a***, second bone screw aperture **1702*b***, third bone screw aperture **1702*c***, and fourth bone screw aperture **1702*d*** may be conically shaped, tapered, and/or cylindrical with or without a retaining lip and may also allow for about +/−9 degrees of relative freedom of movement. In various embodiments, in a contracted position, a vertical distance between the first bone screw aperture **1702*a*** and third bone screw aperture **1702*b*** may be about 17 mm to about 25 mm and in some embodiments about 21.5 mm, for example. Similarly, in various embodiments, in a contracted position, a vertical distance between the second bone screw aperture **1702*b*** and fourth bone screw aperture **1702*d*** may be about 17 mm to about 25 mm and in some embodiments about 21.5 mm, for example. In various embodiments, in an expanded position, a vertical distance between the first bone screw aperture **1702*a*** and third bone screw aperture **1702*c*** may about 20 mm to about 35 mm and in some embodiments about 27.5 mm, for example. Similarly, in various embodiments, in an expanded position, a vertical distance between the second bone screw aperture **1702***b* and fourth bone screw aperture **1702***d* may about 20 mm to about 35 mm and in some embodiments about 27.5 mm, for example.

[0252] FIG. **74** is a flow chart method of operation **1800** for installing an expandable plate and an expandable implant between adjacent vertebrae of a patient. The various method steps below may be explained in the context of the various disclosed expandable plates **1500**, **1600**, and **1700**. Although the various expandable plates **1500**, **1600**, **1700** and the various spinal implants disclosed herein may be used to perform the method of operation **18000** the method of operation is not limited to the embodiments disclosed herein. Furthermore, the following steps need not be performed in sequence and can be performed in any alternate sequence with or without all of the disclosed method steps.

[0253] At step **1802** an expandable plate and/or an expandable spinal implant may be provided, for example. At step **1804**, an end user may prepare a space between adjacent boney structures by removal and/or cleaning of the space. For example, an end user may remove a degenerative disc between a superior vertebrae and an inferior vertebrae. At step **1806**, an end user may insert the spinal implant between the superior vertebrae and inferior vertebrae. In some embodiments, the spinal implant and expandable plate may be simultaneously insert into the patient anatomy, although the spinal implant may be insert within the disc space between the superior and inferior vertebrae while the expandable plate remains on the outside of the disc space. At step **1808**, an end user may install at least one bone screw in a boney structure. For example, an end user may install a bone screw that extends through an upper portion and/or lower portion of an expandable plate. In various embodiments, the at least one bone screw may be partially installed, i.e., the one screw may not be fully tightened into the patient anatomy. At step **1810**, an end user may expand the expandable plate and/or spinal implant. For example, an end user may insert an inserter through a set screw of the expandable plate and activate an expansion mechanism inside of the spinal implant to effectuate expansion of the spinal implant within the disc space. Additionally, an end user may move the upper portion and/or lower portion to expand the expandable plate on the outside of the disc space. At step **1812**, an end user may position a portion of the expandable plate against an apophyseal ring. For example, an end user may ensure that a lip portion of at least one of the upper portion and/or lower portion abuts an apophyseal ring of a corresponding vertebrae. At step **1814**, an end user may fully tighten any remaining bone screws to be installed. For example, an end user may tighten any remaining bone screws of an expandable plate and/or any remaining bone screws of a spinal implant.

Additional Expandable Embodiments

[0254] Referring generally to FIGS. **75-90** expandable spinal implants **310**, **320**, **330**, and **340** are disclosed. Implants **310**, **320**, **330**, and **340** may include the same, similar, and/or substantially the same components and functionality as the other implant embodiments previously disclosed. Spinal implants **310**, **320**, **330**, and **340** may also be used in conjunction or as a substitute for any previously disclosed system and method. In many embodiments, implants **310**, **320**, **330**, and **340** may include similar components and functionality to implant **300** previously described in conjunction with FIGS. **32A-35**. In various embodiments, implants **310**, **320**, **330** and **340** may be configured for lateral, oblique, antero-lateral etc. insertion type techniques although those with skill in the art will readily recognize that implants **310**, **320**, **330**, and **340** may also be optimized and utilized for other surgical techniques.

[0255] FIG. **75** is a front perspective view of expandable spinal implant **310** and FIG. **76** is a rear perspective view of expandable spinal implant **310**. In the example embodiment, implant **310** may include a first endplate **110** (superior endplate or cephalad endplate) and a second endplate **120** (inferior endplate or caudal endplate) that are movable with respect to one another via a moving mechanism **250**. In some embodiments, outside surfaces of endplates **110** and **120** may have a substantially linear surface profile across exposed faces of endplates and in other embodiments endplates **110** and **120** may have curved surface profiles across faces of textured, microtextured, or non-textured surfaces. Similarly as previously explained, implant **310** may include various contours, guides, cavities, and other operable characteristics that cooperate with moving mechanism **250** to facilitate movement and/or provide mechanical advantage to other corresponding parts to facilitate expansion, contraction, angular adjustment, lateral bending, absorption of compression forces, shear forces, etc.

[0256] In the example embodiment, implant **310** may extend in a proximal-to-distal direction from a proximal end **101** to a distal end **102**. Similarly, implant **310** may extend in a widthwise direction between a first lateral end **103** and a second lateral end **104**, for example. In various embodiments, the proximal end **101** may include an exposed screw guide endplate **105** defining a corresponding screw guide aperture **107**, disposed between endplates **110** and **120**. The screw guide endplate **105** and guide aperture **107** may be the same as or substantially the same as described above. With reference back to FIG. **53**, when implant **310** is inserted in a disc space, implant **310** may extend in the proximal-to-distal direction in the coronal plane, for example. Hence, in some embodiments implant **310** may be referred to as a "coronal expandable implant."

[0257] FIG. **77** is a first exploded parts view of implant **310** and FIG. **78** is a second exploded parts view of implant **310** from an alternate and substantially opposite viewing angle. In the example embodiment, first endplate **110** may include a pair of first proximal ramps **114** and a pair of first distal ramps **116** opposite the first proximal ramps **114**. Each ramp of the first proximal ramps **114** may include an inclined surface extending away from an inside surface of first endplate **110** and moving mechanism **250**. Although the example embodiment illustrates corresponding "pairs" of proximal ramps **114** and distal ramps **116** other embodiments may include at least one proximal ramp **114** and at least one distal ramp **116**, for example a single proximal ramp **114** and a single distal ramp **116**. Each ramp of first distal ramps **116** may include an inclined surface extending away from an inside surface of first endplate **110** and moving mechanism **250**. Similarly, second endplate **120** may include a pair of second proximal ramps **124** and a pair of second distal ramps **126** opposite the second proximal ramps **124**. Each ramp of the second proximal ramps **124** may include an inclined surface extending away from an inside surface of second endplate **120** and moving mechanism **250**. Each ramp of second distal ramps **126** may include an inclined surface extending away from an inside surface of second endplate **120** and moving mechanism **250**. Although the example embodiment illustrates corresponding "pairs" of proximal ramps **124** and distal ramps **126** other embodiments may include at least one proximal ramp **124** and at least one distal ramp **126**, for example a single proximal ramp **124** and a single distal ramp **126**. In various embodiments, the ramps **116**, **114** of the superior endplate **110** may not be (or may not be) aligned vertically with the ramps **126**, **124** of the inferior endplate **120**.

[0258] As previously explained, moving mechanism **250** may be operably coupled to top endplate **110** and bottom endplate **120** in any suitable way. In the illustrated embodiment, moving mechanism **250** may include a support block **257** rotatably supporting a first set screw **252** and a second set screw **254** which are threadably coupled to a first trolley **256** and a second trolley **258**, respectively. In the example embodiment, the first trolley **256** and second trolley **258** may include ramped surfaces **260**. In various embodiments, ramped surfaces **260** may be a lateral protrusion having a shape resembling a chamfered diamond that may simultaneously push against and/or directly contact a corresponding ramped surface of the first endplate **110** and second endplate **120**. In the example embodiment, first trolley **256** and second trolley **258** may each include at least one catch surface **261** in the form of an inclined protrusion that may be disposed within a corresponding guide wall **130** (may also be referred to as a channel **130**). At least one advantage of this configuration may be that catch surfaces **261** and guide walls **130** may facilitate closing of implant **310**, i.e., decreasing a vertical distance between first endplate **110** and second endplate **210**. In the example embodiment, each lateral end of the first trolley **256** and second trolley **258** includes a superior catch surface **261** and an inferior catch surface **261**. Additionally, in this embodiment support block **257** may be constrained from moving in the proximal-to-distal direction due to lateral protrusions **259** being seated in vertical slots **359** of endplates **110**, **120**, for example. In this way, support block **257** may slide up and down vertically within vertical slots **359** as implant **310** expands and contracts. Additionally, in some embodiments, support block **257** may be inclinable during expansion of implant **310** on account of vertical slots **359** having gap spaces and/or chamfered ends. In some embodiments, screw guide housing **105** may include support tangs **106** that extend through an opening of second trolley **258** and couple to support block **257**. In this way, movement of second trolley **258** may not interfere with a position of screw guide housing **105** and screw guide housing **105** may be rigidly coupled to support block **257**, for example.

[0259] A first functional feature of the example moving mechanism **250** is that it may be further configured to increase and decrease a spacing between the top and bottom endplates **110**, **120** at the proximal end **101** and distal end **102** equally upon simultaneous rotation of first and second set screws **252**, **254**. This type of expansion may be referred to as "parallel" expansion and/or "parallel" distraction. A second functional feature of moving mechanism **250** is that it may be further configured to increase and decrease an angle of inclination between top and bottom endplates **110**, **120** at a proximal end **101** upon rotation of the first set screw **252** in a clockwise and counterclockwise direction, respectively. A third functional feature of moving mechanism **250** is that it may be further configured to increase and decrease an angle of inclination between top and bottom endplates **110**, **120** at a distal end **102** upon rotation of the second set screw **254** in a clockwise and counterclockwise direction, respectively. Accordingly, moving mechanism **250** may be considered to have at least three different modalities of expansion and each modality may be performed independently of the other modalities.

[0260] FIG. **79** is a top view showing various section lines taken through implant **310**. Section line A_1 may extend in a proximal-to-distal direction lengthwise through a center of implant **310**. In some embodiments, section line A_1 may be coextensive and/or coaxial with a rotation axis of the first and second set screws **252**, **254**. Section line A_3 may extend in a proximal-to-distal direction lengthwise through a first side portion of implant **310** corresponding to a location of ramped surfaces **114**, **116**. Similarly, Section line A_4 may extend in a proximal-to-distal direction lengthwise through a second side portion of implant **310** corresponding to a location of ramped surfaces **124**, **126**.

[0261] FIG. **80** is a perspective cross section drawing through section A_3 of FIG. **79**. In the example embodiment, ramped surfaces **260** of trolley **256** resemble a chamfered diamond that can act against corresponding inclined surfaces of ramped surfaces **116**. Similarly, ramped surfaces **260** of trolley **258** resemble a chamfered diamond that can act against corresponding inclined surfaces of ramped surfaces **114**. Additionally, catch surfaces **261** may be slidably disposed within guide walls **130**. Furthermore, lateral protrusion **259** may be disposed within vertical slot **359**.

[0262] FIG. **81** is a perspective cross section drawing through section A_1 of FIG. **79**. In the example embodiment, first and second set screws **252**, **254** are rotatably coupled to support block **257** such that the first and second set screws **252**, **254** may be constrained from moving in the proximal-to-distal direction. In this way, rotation of set screw **252** may independently move trolley **256** and rotation of set screw **242** may independently move trolley **258**.

[0263] FIG. **82** is a perspective cross section drawing through section A_4 of FIG. **79**. In the example embodiment, a first distance between section A_4 and section A_1 may be slightly less than a second distance between section A_3 and section A_1. Accordingly, the cross section drawing of FIG. **82** illustrates superior catch surfaces **261** (rather than inferior catch surfaces **261** shown in FIG. **80**) and a portion of ramped protrusion **260** that has a different cross sectional shape from the chamfered diamond portion shown in FIG. **80**. However, it shall be appreciated that in various embodiments, the geometry of ramped surfaces **260** of each trolley **256**, **258** may include corresponding geometry to both sections A_4 and A_3 or either section A_4 or A_3. In FIG. **82**, upper ends of ramped surfaces **260** of trolley **256** may act against corresponding inclined lower surfaces of ramped surfaces **126**. Similarly, upper ends of ramped surfaces **260** of trolley **258** may act against corresponding inclined lower surfaces of ramped surfaces **124**. Additionally, superior catch surfaces **261** may be slidably disposed within guide walls **130**. Furthermore, lateral protrusion **259** may be disposed within vertical slot **359**.

[0264] FIG. **83** is a front perspective view of an expandable spinal implant **320** including a proximal plate **850**. Implant **320** may have the same, similar, and or substantially the same features and functionality as explained above with respect to implant **310**. Accordingly, duplicative description will be omitted or only briefly described. In the example embodiment, implant **320** may include a proximal plate **850** in lieu of screw guide endplate **105**. Proximal plate **850** may be coupled to support block **257** in the same, similar, and/or substantially the same way as explained above with respect to screw guide endplate **105**. In some embodiments, proximal plate **850** may be rigidly coupled to support block **257** and in other embodiments proximal plate **850** may be pivotally coupled to support block **257** to allow for some lateral movement and/or vertical movement. Additionally, in some embodiments, proximal plate **850** may be rotationally coupled to support block **257** to allow for about +/−10 degrees of relative movement in any direction. Furthermore, in various embodiments, proximal plate **850** may not be directly coupled (directly contact) endplates **110**, **120**. In this embodiment, proximal plate **850** may include a superior bone screw aperture **852** and an inferior bone screw aperture **851**. In various embodiments, each bone screw aperture **852**, **851** may be configured to orient and support a bone screw in a target trajectory while allowing for some angular deviation of a respective bone screw of about +/−5 degrees of relative movement in any direction. In the example embodiment, the superior bone screw aperture **852** and inferior bone screw aperture **851** are vertically aligned and oriented to one lateral side of the proximal plate **850**. For example, the superior bone screw aperture **852** and inferior bone screw aperture **851** are offset towards a lateral side of implant **320** with respect to a rotation axis of the first set screw **252**, and second set screw **254**.

[0265] Additionally, each endplate **110**, **120** may include a bone screw cutout **822** such that the target bone screw trajectory of a respective bone screw aperture **851**, **852** may prevent the corresponding bone screw from contacting the corresponding endplate **110**, **120**. Furthermore, proximal plate **850** may include at least one bone screw lock **803**. In the example embodiment, bone screw lock **803** may be rotated between an unlocked position in which each of the bone screw apertures **851**, **852** are freely exposed and a locked position in which each of the bone screw apertures **851**, **852** are blocked (or at least partially blocked). In this embodiment, in the locked position bone screw lock **803** may be configured to simultaneously lock a first bone screw disposed in the superior bone screw aperture **852** and a second bone screw disposed in the inferior bone screw aperture **851**. For example, bone screw lock **803** includes a first wing **804** and a second wing **805** opposite the first wing **804**. Additionally, in some embodiments wings **804**, **805** may flare outward in a proximal-to-distal direction, at least partly. At least one advantage of this configuration may be that this geometry of wings **804**, **805** provides for a stop surface (or face) that extends in a direction substantially perpendicular to the target trajectory of the corresponding bone screw aperture **852**, **851**. For example, a rear surface defined by wing **804** may extend, or at least partly extend, in a first plane that is substantially perpendicular to the bone screw trajectory defined by superior bone screw trajectory **852**. Similarly, a rear surface defined by wing **806** may extend, or at least partly extend, in a second plane that is substantially perpendicular to the bone screw trajectory defined by the inferior bone screw trajectory **851**. However, in other embodiments proximal plate **850** may include a first bone screw lock **803** configured to lock a first bone screw disposed within the superior bone screw aperture **852** and a second bone screw lock **803** configured to lock a second bone screw disposed within the inferior bone screw aperture **851** (not illustrated). Additionally, in various embodiments bone screw lock **803** may include a drive feature **809** disposed between first wing **804** and second wing **806**. Accordingly, an end user can rotate the bone screw lock **803** with any corresponding drive tool, e.g., hexaganol, hexolobular, torx, square, polygonal, etc. In at least one embodiment, drive feature **809** may be driven by the same drive tool that rotates set screws **252**, **254**.

[0266] FIG. **84** is a front perspective view of the embodiment of FIG. **83** in a partially expanded first position. In the example configuration, it may be seen that the distal end **102** is expanded and the proximal end **101** is collapsed. For example, trolley **256** has moved distally to expand the distal end **102** while trolley **258** has remained unmoved and/or insubstantially moved.

[0267] FIG. **85** is a front perspective view of the embodiment of FIG. **83** in a partially expanded second position. In the example configuration, it may be seen that the proximal end **101** is expanded and the distal end **102** is collapsed and/or semi collapsed. For example, trolley **258** has moved proximally to expand the proximal end **101** while trolley **256** has remained unmoved and/or insubstantially moved.

[0268] FIG. **86** is a front perspective view of the embodiment of FIGS. **83**-**85** in a fully expanded position. FIG. **87** is a partial parts view of the embodiment of FIG. **86** with the superior endplate **110** removed for ease of understanding. In the example configuration, it may be seen that the proximal end **101** and distal end **102** are each expanded. For example, trolley **258** has moved proximally to expand the proximal end **101** and trolley **256** has moved distally to expand the distal end **102**.

[0269] FIGS. **88** and **89** are various front perspective views of an expandable spinal implant **330**. Spinal implant **330** may have the same, similar, and/or substantially the same components and functionality as explained above with respect to spinal implant **310**. Accordingly, duplicative description will be omitted. In the example embodiment, it can be seen that a first height H_1 between the outside surface of the superior endplate **110** and the outside surface of the inferior endplate **120** is greater on a first lateral side **103** than a second height H_2 between the outside surface of the superior endplate **110** and the outside surface of the inferior endplate **120** on the second lateral side **104**. At least one advantage of this configuration may be that when implant **330** is inserted within a disc space from a lateral perspective it may provide additional correction of the disc space. For example, depending on a chosen side of insertion, implant **330** may provide for additional kyphotic correction or lordotic correction.

[0270] FIG. **90** is a top-down comparative view of an expandable spinal implant **340** and an expandable spinal implant **310**. Spinal implant **340** may have the same, similar, and/or substantially the same components and functionality as explained above with respect to spinal implant **310**. Accordingly, duplicative description will be omitted. In the example embodiment, it can be seen that a first length L_1 of implant **340** in a proximal to distal direction may be relatively greater than a second length L_2 of implant **310**. Accordingly, it shall be appreciated that various implants in accordance with the principles of this description may have various lengths, widths, heights, etc. to suit a particular patient's anatomy in view of any particular surgical technique(s). For example, some lateral embodiments may be relatively longer to accommodate different portions of the spine and/or differently sized patients. It shall also be appreciated that various components, features, and functionality of any one specific implant embodiment disclosed herein may be substituted, modified, and/or replaced with any other component, feature, or functionality of any other specific implant embodiment unless the context clearly indicates otherwise.

What is claimed is:

1. An expandable interbody implant, comprising:

an expandable body defined by a superior endplate and an inferior endplate, the expandable body having a length extending from a proximal end to a distal end in a proximal-to-distal direction, and a width extending from a first lateral side to a second lateral side in a widthwise direction, the length being greater than the width;

the superior endplate including first proximal ramps and first distal ramps disposed opposite the first proximal ramps; and

the inferior endplate including second proximal ramps and second distal ramps disposed opposite the second proximal ramps; and

a moving mechanism for expanding the superior endplate and the inferior endplate, the moving mechanism including:

a support block coupled to the superior endplate and the inferior endplate, the support block rotatably supporting a proximal set screw and a distal set screw along a rotation axis;

a proximal trolley movably coupled to the proximal set screw and including a plurality of inclined surfaces; and

a distal trolley movably coupled to the distal set screw and including a plurality of inclined surfaces.

2. The expandable implant of claim **1**, wherein the support block further includes a first lateral protrusion movably disposed in a first slot of the superior endplate.

3. The expandable implant of claim **2**, wherein the support block further includes a second lateral protrusion movably disposed in a second slot of the inferior endplate.

4. The expandable implant of claim **3**, wherein the first lateral protrusion and the second lateral protrusion extend in substantially opposite directions.

5. The expandable implant of claim **1**, wherein:

the first inside surface of the superior endplate further comprises at least one guide wall; and

the proximal trolley comprises at least one catch surface, each catch surface of the proximal trolley being disposed within a respective guide wall of the at least one guide wall of the superior endplate.

6. The expandable implant of claim **5**, wherein:

the second inside surface of the inferior endplate further comprises at least one guide wall; and

the distal trolley comprises at least one catch surface, each catch surface of the distal trolley being disposed within a respective guide wall of the at least one guide wall of the inferior endplate.

7. The expandable implant of claim **1**, wherein:

the first inside surface of the superior endplate further comprises proximal guide walls and distal guide walls,

the proximal guide walls being adjacent to and inclined at substantially the same orientation as the first proximal ramps, and

the distal guide walls being adjacent to and inclined at substantially the same orientation as the first distal ramps.

8. The expandable implant of claim **1**, wherein in the first expanded position, the proximal trolley contacts the first proximal ramps and the second proximal ramps and is disposed proximate the proximal side of the expandable body.

9. The expandable implant of claim **8**, wherein in the second expanded position, the distal trolley contacts the first distal ramps and the second distal ramps and is disposed proximate a distal side of the expandable body, with respect to the medial position.

10. The expandable implant of claim **1**, wherein:

the proximal set screw and the distal set screw are coaxially aligned in the proximal-to-distal direction along the length of the expandable body, and

a screw adjusting aperture extends through the proximal trolley, the proximal set screw, the support block, and the distal set screw.

11. The expandable implant of claim **1**, further comprising a proximal plate including at least one bone screw aperture that defines a bone screw trajectory.

12. The expandable implant of claim **11**, wherein the proximal plate further comprises at least one rotatable bone screw lock having at least one wing, each wing comprising a surface extending in a plane that is substantially perpendicular to a corresponding bone screw trajectory.

13. The expandable implant of claim **12**, wherein at least one of the superior endplate and the inferior endplate comprises at least one bone screw relief.

14. The expandable spinal implant of claim **1**, further comprising a proximal plate including a first bone screw aperture and a second bone screw aperture.

15. The expandable spinal implant of claim **14**, wherein the proximal plate comprises a bone screw lock configured to block, at least partially, the first bone screw aperture and the second bone screw aperture.

16. The expandable spinal implant of claim **15**, wherein the superior endplate comprises a first bone screw relief and the inferior endplate comprises a second bone screw relief.

17. The expandable spinal implant of claim **1**, wherein at least one of the superior endplate and the inferior endplate is concave in the proximal-to-distal direction.

18. The expandable spinal implant of claim **1**, wherein at least one of the superior endplate and the inferior endplate is concave in the widthwise direction.

19. The expandable spinal implant of claim **1**, wherein:

in a contracted position, the proximal trolley and the distal trolley are disposed in a medial position within the expandable body,

in a first expanded position, the proximal trolley is disposed adjacent a proximal side of the expandable body and a spacing between the superior and inferior endplates at the proximal end of the expandable body is greater than a spacing between the superior and inferior endplates at the proximal end of the expandable body in the contracted position, and

in a second expanded position, a spacing between the superior and inferior endplates at the distal end of the expandable body is greater than a spacing between the superior and inferior endplates at the distal end of the expandable body in the contracted position.

20. The expandable spinal implant of claim **1**, wherein the support block is constrained from moving in the proximal to distal direction.

* * * * *