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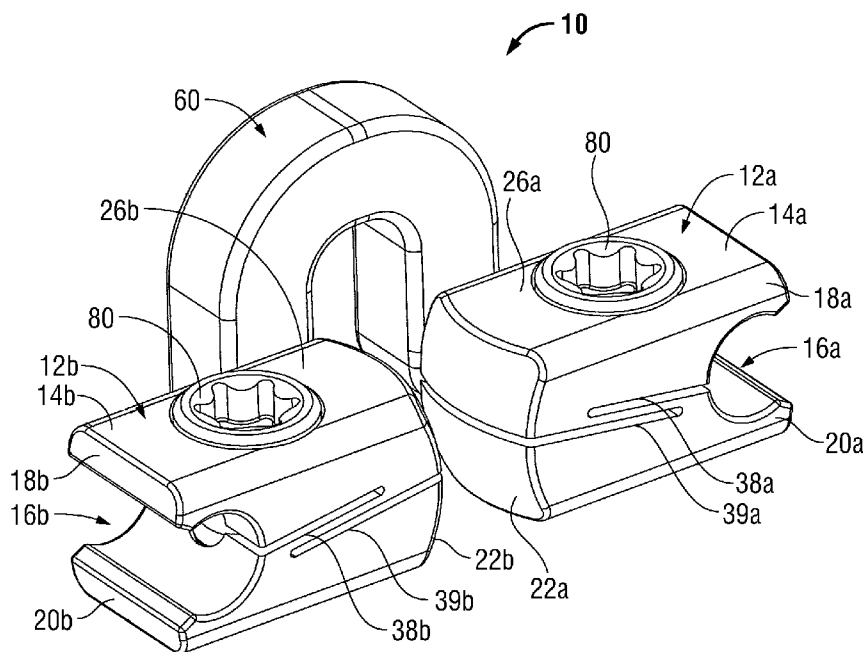


FIG. 1A

[Continued on next page]



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(57) Abstract: The present disclosure provides a transverse connector having a first and second spinal rod connecting member disposed at opposing ends thereof, each spinal rod connecting member having an outermost end configured to connect to a spinal rod and an innermost end having a multidirectional articulation joint at which a centrally disposed cross member is provided to attach the first and second spinal rod connecting members to each other.

TRANSVERSE CONNECTOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of, and priority to, U.S. Provisional Patent Application No. 61/270,657, filed July 10, 2009, the entire contents of which are incorporated by reference herein.

BACKGROUND

Technical Field

[0001] The present disclosure relates to a transverse connector for interconnecting a first and a second rod, which are in an approximately parallel relationship to each other. More particularly, the present disclosure relates to an offset transverse connector having opposing ends and being capable of independent multidirectional articulation while preserving space for the anatomy.

Background Art

[0002] Disease, the effects of aging, or physical trauma resulting in damage to the spine has been treated in many instances by fixation or stabilization of the effected vertebra. A wide variety of spinal fixation apparatuses have been employed in surgical procedures for correcting spinal injuries and the effects of spinal diseases. Many of these apparatuses commonly use a pair of longitudinal rods running in a relatively parallel relationship to each other and the spinal column. These rods are connected to coupling elements, which in turn are secured to the underlying vertebral bone by spinal bone fixation fasteners such as pedicle screws, hooks, and the like. The pair of longitudinal links can be held in position relative to one another by transverse connectors, also known as transverse bridge elements or cross-connectors.

[0003] As the technology of spinal surgery has developed and improved, each of the spinal fixation components has also undergone improvements and modifications to address

the shortcomings of conventional spinal appliances. The natural anatomical variations in the spinal column of a subject are such that implanted spinal rods while approximating a parallel relationship one to the other can vary from that parallel relationship considerably and in multiple planes. For this reason, any transverse connector used to attach the two rods to each other should not be of a rigid design without the ability to be re-configured as needed during the process of implanting and attaching to the two opposing rods. While some improvements have been made in the articulation and re-configuration operation of transverse connectors during the implantation and rod connecting process, a continuing need exists to provide a multidirectional articulating transverse connector that can adapt to a wide variance in the contours of the spinal column. Further, a need exists to provide such a transverse connector that can provide sufficient space for the underlying anatomy, most specifically, the dura and spinal cord, while still maintaining a low profile and a smooth contoured surface to thereby reduce the potentially negative impact of the implanted device on the underlying and surrounding soft tissue of the subject into which the device has been surgically implanted.

[0004] Conventional efforts to meet this need have fallen short of the desired transverse connector configuration. For example, U.S. Patent No. 6,554,832, issued to Shluzas, as best seen in Figs. 2 and 4 of that patent, provides a transverse connector, which includes first and second connector members for connecting to the respective first and second spinal rods. The two connector members are connected one to the other by a connecting rod, which can be withdrawn or extended in alignment with the longitudinal axis of the cross-connector for purpose of adjusting the length thereof. As shown in Figs. 2 and 4 of the Shluzas patent, the articulation of the connecting members to align with the two opposing spinal rods is limited to a single, centrally disposed ball joint (50). Importantly, the pivoting movement of the Shluzas connector is limited to movement within the same horizontal plane relative to the longitudinal axis of the spinal column. Thus, while the device of Shluzas does permit some

limited adjustment in length and azimuth of the device, it is configured to structurally prohibit any upward or downward movement in relation to the surface plane of the spinal column. That is, the elevation of one end of the Shluzas connector relative to the other end of the connector cannot be adjusted. Thus, while the Shluzas design does provide some flexibility in adapting the alignment of the transverse connector to the opposing spinal rods, it falls short of the greater degree of adaptability that could be obtained by a truly multi-planar transverse connector having multiple articulating points. In U.S. Patent No. 6,110,173, issued to Thomas, more specifically Figs. 1 and 3, show the rigid nature of the cross connecting rod which does not allow for sufficient space for spinal anatomy. In this regard, the current device affords an improvement in this area as well since the cross-connecting member is arched to allow for such anatomy.

[0005] For reasons discussed above a continuing need exists for a transverse connector that provides ease of operation by the surgeon to simultaneously adjust in multiple dimensions one spinal rod connecting end of the connector in relation to the other spinal rod connecting end of the connector and to provide a transverse connector having means for providing sufficient space for spinal anatomy and smooth contours for surfaces in contact with adjacent soft tissue.

SUMMARY

[0006] The offset transverse connector and method of application of the present disclosure provides an offset transverse connector having a first and second spinal rod connecting member at opposing ends of the transverse connector. Each spinal rod connecting member having a distal end configured to be capable of connecting to a spinal rod and a proximal end having a multidirectional articulation joint at which a centrally disposed cross member is provided to attach the first and second spinal rod connecting members to each

other. The first and second spinal rod connecting members are secured by the tightening of only two locking screws.

[0007] Also provided is an offset transverse connector having two opposing spinal rod connecting members, each located at an opposing end of the transverse connector and connected one to the other by an offset cross member.

[0008] Also provided is an offset transverse connector having a first and second spinal rod connecting member, each having a respective first or second articulation joint by which a cross member can connect the first and second spinal rod connecting members to each other to form the transverse connector. The transverse connector requires locking of the first or second spinal rod connecting member to a respective first or second spinal rod which simultaneously locks the respective articulation joint into a selected configuration relative to the cross member.

[0009] Also provided is an offset transverse connector having a first and second spinal rod connecting member, each having a respective first or second articulation joint by which a centrally disposed cross member can connect the first and second spinal rod connecting members to each other to form the transverse connector, the first and second spinal rod connecting members each having at least one compression slot configured to facilitate locking of the first or second spinal rod connecting member to a respective first or second spinal rod while simultaneously locking the respective articulation joint into a selected configuration relative to the cross member.

[0010] Also provided is a method of stabilizing spinal vertebrae, the method including providing an offset transverse connector having a first and second spinal rod connecting member at each respective end of the transverse connector, each connecting member having a distal end configured to be capable of connecting to a spinal rod and a proximal end having a multidirectional articulation joint at which a centrally disposed cross member is provided to

attach the first and second spinal rod connecting members to each other and implanting the offset transverse connector into a subject in need thereof each articulating joint provides at least 3 degrees of freedom.

[0011] Another embodiment includes a method of stabilizing spinal vertebrae, the method includes providing an offset transverse connector having a first and second spinal rod connecting member at each respective end of the transverse connector, each spinal rod connecting member having a distal end configured to be capable of connecting to a spinal rod and a proximal end having a multidirectional articulation joint at which a centrally disposed cross member, whereby the cross member is easily adjusted in length to adapt to the anatomy. The cross member is provided to attach the first and second spinal rod connecting members to each other and provides a secondary feature consisting of a rod, coupling and set screw, whereby the rod can slide in a coupling to provide adjustment to the length of the connecting member and the set screw fixes the rod in place. This allows for sufficient flexibility to accommodate the patient anatomy.

[0012] Also provided is a kit, which includes at least one offset transverse connector having a first and second spinal rod connecting member at each respective end of the transverse connector, each spinal rod connecting member having an outermost end configured to be capable of connecting to a spinal rod and a proximal end having a multidirectional articulation joint at which a centrally disposed offset, cross member is provided to attach the first and second spinal rod connecting members to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The foregoing and other features of the offset transverse connector will become apparent to one skilled in the art to which the disclosed transverse connectors relate upon consideration of the following description of exemplary embodiments with reference to the accompanying drawings, wherein:

[0014] Fig. 1A is a perspective view of an offset transverse connector, in accordance with an embodiment of the present disclosure;

[0015] Fig. 1B is an end view of the offset transverse connector of Fig. 1A;

[0016] Fig. 1C is a top view of the offset transverse connector of Fig. 1A;

[0017] Fig. 1D is a cross-sectional view taken along line A-A in Fig. 1C;

[0018] Fig. 2A is a top view of a spinal rod connecting member of the offset transverse connector of Fig. 1A;

[0019] Fig. 2B is a side cross-sectional view taken along line B-B in Fig. 2A;

[0020] Fig. 3A is a top view of a locking screw of the offset transverse connector of Fig. 1A;

[0021] Fig. 3B is a side cross-sectional view taken along line C-C in Fig. 3A;

[0022] Fig. 4A is a perspective view of another embodiment of an offset transverse connector, in accordance with the present disclosure;

[0023] Fig. 4B is an end view of the offset transverse connector of Fig. 4A;

[0024] Fig. 4C is a top view of the offset transverse connector of Fig. 4A;

[0025] Fig. 4D is an exploded view, with parts separated, of the offset transverse connector of Fig. 4A;

[0026] Fig. 5 is a side view of a cross member connecting element of the offset transverse connector of Fig. 4A;

[0027] Fig. 6A is a perspective view of yet another embodiment of an offset transverse connector, in accordance with the present disclosure;

[0028] Fig. 6B is a top view of the offset transverse connector of Fig. 6A;

[0029] Fig. 6C is a side cross-sectional view taken along line A-A in Fig. 6B;

[0030] Fig. 6D is an end view of the offset transverse connector of Fig. 6A;

[0031] Fig. 6E is an exploded view, with parts separated, of the offset transverse connector of Fig. 6A;

[0032] Fig. 7A is a perspective view of a spinal rod connecting member of the offset transverse connector of Fig. 6A;

[0033] Fig. 7B is an end view of the spinal rod connecting member of Fig. 7A;

[0034] Fig. 7C is a top view of the spinal rod connecting member of Fig. 7A;

[0035] Fig. 7D is a side cross-sectional view taken along line B-B in Fig. 7C;

[0036] Fig. 8A is a perspective view of a locking screw of the offset transverse connector of Fig. 6A;

[0037] Fig. 8B is a top view of the locking screw of Fig. 8A;

[0038] Fig. 8C is a side cross-sectional view taken along line C-C in Fig. 8B;

[0039] Fig. 9A is a perspective view of a cross-member of the offset transverse connector of Fig. 6A;

[0040] Fig. 9B is a side view of the cross member of Fig. 9A;

[0041] Fig. 10A is a perspective view of an insert of the offset transverse connector of Fig. 6A;

[0042] Fig. 10B is a side view of the insert of Fig. 9A;

[0043] Fig. 11A is a perspective view of another embodiment of an offset transverse connector, in accordance with the present disclosure;

[0044] Fig. 11B is an end view of the offset transverse connector of Fig. 11A;

[0045] Fig. 11C is a top view of the offset transverse connector of Fig. 11A;

[0046] Fig. 11D is a side cross-sectional view taken along line A-A in Fig. 11C;

[0047] Fig. 12A is a perspective view of yet another embodiment of an offset transverse connector, in accordance with the present disclosure;

[0048] Fig. 12B is an end view of the offset transverse connector of Fig. 12A;

[0049] Fig. 12C is a top view of the offset transverse connector of Fig. 12A; and

[0050] Fig. 12D is a side cross-sectional view taken along line A-A in Fig. 12C.

DETAILED DESCRIPTION

[0051] Detailed embodiments of the present disclosure are disclosed herein, however, it is understood that the following description and each of the accompanying figures are provided as being exemplary of the disclosure, which may be embodied in various forms without departing from the scope of the present disclosure. Thus, the specific structural and functional details provided in the following description are nonlimiting, but serve merely as a basis for the disclosure as defined by the claims provided herewith.

[0052] Figs. 1A-3B illustrate a transverse connector shown generally as 10. Transverse connector 10 includes first and second spinal rod connecting members 12a and 12b. The spinal rod connecting members 12a and 12b are coupled by a cross member 60.

[0053] The two spinal rod connecting members 12a and 12b are each configured to be selectively and releasably secured to a spinal rod 90 (as shown in Fig. 1B), which in turn can be secured to the underlying bone of a patient's spinal column as needed. As shown in Figs. 1A-1D, the spinal rod connecting members 12a and 12b are each configured at their outermost ends 14a and 14b, respectively, of the transverse connector 10 to define first and second spinal rod connecting passages 16a and 16b, the spinal rod connecting passages 16a and 16b being opened medial-laterally at respective first and second ends 14a and 14b of the transverse connector 10. The outermost edges of the respective medial-laterally opened spinal rod connecting passages 14a and 14b may be configured to provide upper spinal rod retention lips 18a and 18b and lower spinal rod retention lips 20a and 20b, each of which projects one toward the other so as to narrow the lateral opening of the spinal rod connecting passages 16a and 16b and to thus facilitate the spinal rod retention capability of the two spinal rod connecting passages 16a and 16b.

[0054] The first and second spinal rod connecting members 12a and 12b are each sized and configured at their innermost ends 22a and 22b to define a ball joint receptacle 24, each ball joint receptacles 24 has a lateral opening sized and configured to receive a correspondingly sized ball joint 68 and 72 of cross member 60 in a snap-fit manner.

[0055] Referring now to Fig. 1B-1D, the cross member 60 includes a cross member element 62 having a U-shaped configuration. Cross member element 62 includes a mid-portion 64, a first end 66 and a second end 70. First end 66 may be configured to provide articulating ball joint 68 and second end 70 may be configured to provide articulating ball joint 72. Cross member element 62 further includes an inner periphery 74 that defines an inner cavity 76 to provide space between first and second spinal rod connecting members 12a and 12b. In addition, cross member 60 provides an offset configuration such that first and second spinal rod connecting members 12a and 12b oppose each other and define a space 78 therebetween, as shown in Fig. 1C.

[0056] The features and operation of spinal rod connecting member 12b are substantially identical to spinal rod connecting member 12a and will be omitted in the interest of brevity. Referring now to Figs. 2A and 2B, spinal rod connecting member 12a includes an upper surface 26a and defines a spinal rod locking screw receptacle 28, which is sized and configured to receive a spinal rod locking screw 80 (as shown in Figs. 3A and 3B). The spinal rod locking screw receptacle 28, as best shown in Fig. 2B is provided with threads only in a lower portion 30 of receptacle 28. In addition, lower portion 30 of receptacle 28 is provided below the elevation of the spinal rod connecting passages 16a and 16b. An upper portion 32 of spinal rod locking screw receptacle 28 is provided located above the level of the spinal rod connecting passages 16a and 16b and is unthreaded. Upper portion 32 includes an inwardly directed annular restricting ledge 34 that is dimensioned and configured to abut an

outwardly directed flange 84 of spinal rod locking screw 80, which will be described further below.

[0057] Referring now to Figs. 3A and 3B, locking screw 80 a threaded portion 82 and outwardly directed flange 84 that is provided below a spinal rod locking screw head 86. During use, locking screw 80 is inserted within receptacle 28 of both spinal rod connecting members 12a and 12b (as shown in Fig. 1D), which permits threaded portion 82 of locking screw 80 to pass freely therethrough until threaded portion 82 engages lower threaded portion 30 of the spinal rod locking screw receptacle 28 of both first and second spinal rod connecting members 12a and 12b. In this configuration, as threaded portion 82 of locking screw 80 (as shown in Fig. 1D) is threaded further into threaded portion 30 of receptacle 28, outwardly directed flange 84 on the underside of the spinal rod locking screw head 86 is brought into contact with the inwardly directed annular restricting ledge 34 of the upper portion 32 of receptacle 28.

[0058] Spinal rod locking screw 80 further includes a tool cavity 88 so that a clinician may manually screw locking screw 80 with a suitable tool (not shown), for example, but not limited to a screwdriver or a TORX[®] wrench. As screw 80 is screwed into the threaded portion 30 of the spinal rod locking screw receptacle 28, flange 84 on the underside of screw head 86 exerts compressive forces against the inwardly directed annular restricting ledge 34, as will be described further below.

[0059] As shown in Figs. 1A and 2B, each of spinal rod connecting members 12a and 12b is configured to define first and second compression slots 38 and 39, which from opposing directions in the body of the spinal rod connecting members 12a and 12b can break the external integrity of the members 12a and 12b through the defining wall of the spinal rod connecting passage 28 and the ball joint receptacle 24 of members 12a and 12b. Each compression slot 38, 39 is defined to pass one over the other through only a limited portion of

the body of the spinal rod connecting members 12a and 12b. By configuring the pair of overlying compression slots 38 and 39 to have opposing sides of origin and, thus, opposing directions of penetration into the body of the spinal rod connecting members 12a and 12b, a connecting member is provided that can react to the above described compressive forces of an inwardly manipulated spinal rod locking screw 80 so as to bring those compressive forces to bear on both the spinal rod connecting passage 28 and the ball joint receptacle 24, which fixes the relationship between spinal rod connecting members 12a and 12b and cross member 60 is locked in place. That is, when each locking screw 80 of spinal rod connecting members 12a and 12b is tightened, spinal rod 90 and cross member 60 are locked in a desired position. Thus, by tightening and loosening each locking screw 80 of spinal rod connecting members 12a and 12b, the configuration of transverse connector 10 may be changed. In addition, the compression slots 38, 39 cooperate with the ball joint receptacle 24 to define a first compression region. Further still, the compression slots 38, 39 cooperate with the upper and lower spinal rod retention lips 18, 20 and the spinal rod connecting passage 16 to define a second compression region.

[0060] As discussed above and as shown in Figs. 1A-1D, opposing spinal rod connecting members 12a and 12b are connected to each other by cross member 60. In embodiments, cross member 60 is arched to provide sufficient space for spinal anatomy and therefore not impinge on surrounding tissue or spinal elements.

[0061] As shown in the non-limiting examples of Figs. 1-4, any articulating surface of the transverse connector can be treated, machined, scored, or in any known manner textured to provide a roughened or textured surface that can serve to increase the locking contact of those surfaces when the articulating members are set in place and the associated locking screws are manipulated to lock the transverse connector in the desired configuration.

[0062] In operation, a user, as indicated above, can manipulate the transverse connector 10 into a position relative to two opposing and relatively parallel spinal rods, independently connecting the first and second spinal rod connecting members 12a and 12b to their respective spinal rods and adjusting the alignment of the spinal rod connecting members 12a and 12b with the centrally connected cross member 20 by manipulating the respective first ball joint 68 within the ball joint receptacle 24 of spinal rod connecting member 12a and the second ball joint 72 with ball joint receptacle 24 of spinal rod connecting member 12b and selecting the appropriate length of the cross member 60. When all members of the transverse connector 10 are properly positioned, the user can tighten the provided locking screws 80, and lock the transverse connector into a selected configuration relative to the two opposing spinal rods. Adjustment or removal of the transverse connector can be easily achieved by loosening the locking screws 80.

[0063] As discussed above, first spinal rod connecting member 12a and second spinal rod connecting member 12b are connected to each other by cross member 60 which terminates at each end 66 and 70 with a respective articulating ball joint 68 and 72. Articulating ball joints 68 and 72 allow cross member 60 to rotatably connect to and articulate with spinal rod connecting members 12a and 12b, as described above. In this embodiment, transverse connector 10 simplifies the insertion and adjustment thereof and provides a fixed length between spinal rods during a surgical procedure.

[0064] The above described method of use of the transverse connector 10 can be employed with the use of a plurality of spinal rods 90 and associated bone connecting devices as a method of stabilizing or fixing injured or diseased vertebrae and if necessary, multiple transverse connectors 10 can be employed along the length of the opposing spinal rods 90.

[0065] Fig. 4A-4D illustrates another embodiment of the presently disclosed transverse connector shown generally as 100. Transverse connector 100 generally includes first and

second spinal rod connecting members 12a and 12b for connection to one or more spinal rods 90 (as shown in Fig. 4B). First and second spinal rod connecting members 12a and 12b of transverse connector 100 is substantially similar to the first and second spinal rod connecting members 12a and 12b used with transverse connector 10 and further description thereof will be omitted in the interest of brevity. Transverse connector further includes cross member connecting elements 130a and 130b that are coupled by a cross member element 120, which may be, for example but not limited to a rod. In this embodiment, cross member element 120 allows for adjustment to the length of the transverse connector 100 to custom fit the patient's anatomy. That is, the distance between the cross member connecting elements 130a and 130b may be adjusted to a particular surgical procedure. In still another embodiment, not shown, cross member element 120 may be contoured or bent in order to avoid interference with existing anatomy or aid in the fixation of the transverse connector.

[0066] Referring now to Fig. 5 in conjunction with Figs. 4A-4D, first and second cross member connecting elements 130a and 130b are provided and include a cross member clamp portion 132, a linking arm 134 coupled to an articulating ball joint 136. Articulating ball joint 136 is connected to linking arm 134 by a connecting member 138. Ball connecting member 138 may have a conical tapered configuration. For example, ball connecting member 138 may taper from a large radius to a smaller radius from linking arm 134 to articulating ball joint 136. First and second cross member connecting elements 130a and 130b further include a cross member receptacle 140 that is dimensioned and configured to receive a first end 120a or a second end 120b of cross member element.

[0067] Cross member clamp portion 132 of each cross member connecting element 130a, 130b includes a top portion 142, a bottom portion 144 and a cross member locking screw receptacle 148 that is defined orthogonally through top portion 142 and bottom portion 144.

Top portion 142 and bottom portion 144 are separated by a compression slot 146 that is defined therebetween.

[0068] As shown in Fig. 4D, cross member locking screws 180 are similar to locking screws 80, however, locking screws 180 may be shorter in length so as to fit within screw receptacle 148 of clamp portion 132 of each cross member connecting element 130a, 130b. Locking screw 180 includes a threaded portion 182, an outwardly facing flange portion 184 and a tool cavity 186 for removal of the screw thereof. Upon insertion of the cross member locking screw 180 within cross member locking screw receptacle 148, compression slot 146 is compressed such that top portions and portions 142 and 144 are approximated towards each other. In this manner, an inner dimension of cross member receptacle 148 decreases in size, for example, its diameter, to thereby retain cross member 120 in a compressed configuration.

[0069] Referring now to Figs. 6A-6F, another embodiment of a transverse connector is shown and generally depicted as 200. Transverse connector 200 includes an arcing cross member 220, spinal rod connecting members 230, and a cross member locking screw 280. In embodiments, cross member 220 is arched to provide sufficient space for spinal anatomy and therefore not impinge on surrounding tissue or spinal elements.

[0070] Referring to Figs. 9A and 9B, arcing cross member 220 includes a ball joint 226 on each end 222, respectively, that is connected by a ball connecting member 224. Ball connecting member 224 may have a conical tapered configuration. For example, ball connecting member 224 may taper from a larger radius to a smaller radius from end 222 to ball joint 226. Each ball joint 226 includes a recess 228 that will be described further below.

[0071] Referring now to Figs. 7A-7D in conjunction with Figs. 6A-6D, a spinal rod connecting member 230 is shown including a body 232 having a top portion 232a and a bottom portion 232b. Top portion 232a defines a cross member locking screw receptacle 234

and bottom portion 232b defines a spinal rod passage 236 adapted to receive and contain a spinal rod 90 (as shown in Fig. 6D). Cross member locking screw receptacle 234 includes threads 238 along its periphery, an inner cavity 240, a ball joint receptacle 241, and an inwardly facing ledge 242 at the bottom surface of inner cavity 240. In embodiments, cross member 230 may also include an aperture 244 for reception of a screw (not shown) to facilitate retaining of an insert 290, which will be described further below.

[0072] Referring now to Figs. 8A-8C, a locking screw 280 includes a threaded portion 282 and a concave cavity 284 that is provided below the threaded portion 282 and on an underside of locking screw 280. In embodiments, concave cavity 284 may be dimensioned to have a substantially perfect fit with an arcuate top portion of ball joint 226. Spinal rod locking screw 280 further includes a tool cavity 286 so that a clinician may manually screw locking screw 280 with a suitable tool (not shown), for example, but not limited to a screwdriver or a TORX® wrench.

[0073] Referring now to Figs. 10A and 10B, an insert 290 is shown to include a top portion 292 and a bottom portion 294 that is dimensioned to have a curved bottom surface 295. Top portion 292 includes a concave cavity 296 and a post 297 that is provided in the center of the cavity 296. Concave cavity 296 is configured to receive a bottom portion of ball joint 226 during assembly. A saddle 298 is provided alongside a segment of top portion 292. Saddle 298 defines a space that is configured to receive ball connecting member 224 when ball joint 226 is sandwiched between screw 280 and insert 290. Insert 290 further includes a radial groove 299 that is annularly defined alongside a middle portion thereof. In embodiments, radial groove 299 is configured to receive a screw (not shown) via aperture 244 such that the screw may retain insert 290 at a certain position in a compressive fashion.

[0074] During use and assembly of transverse connector 200 and referring back to Fig. 6F, insert 290 is positioned within inner cavity 240 of locking screw receptacle 234 such that

curved bottom portion 295 abuts inwardly facing ledge 242 of inner cavity 240. Subsequently, ball joints 226 of cross member 220 are positioned within their respective ball joint receptacles 241, while inserts 290 are configured and adjustably turned such that saddles 298 provide a securing seat for their respective ball connecting members 224. In addition, post 297 of insert 290 loosely fits within recess 228 of ball joint 226 to provide predefined amount of rotation of ball joint 226 within ball joint receptacle 241, while a bottom portion 226a of ball joint 226 is seated within concave cavity 296 of insert 290.

[0075] Subsequently, locking screw 280 is placed and rotated (e.g., screwed) into the threaded portion 238 of locking screw receptacle 238, while concave cavity 284 on the underside of screw 280 exerts compressive forces against the convex top portion of ball joint 226. At the same time, bottom portion 226a of ball joint 226 exerts compressive forces against the top portion 292 of insert 290. That is, the bottom arcuate portion of ball joint 226 abuts the top arcuate cavity of insert 290. As discussed above, recess 228 of ball joint 226 is configured to receive post 297 of top portion 292, which thereby constricts the articulating movement of ball joint 226 to a limited amount of movement and adjustment. In this configuration, as threaded portion 282 of locking screw 280 is threaded further into threaded portion 238 of receptacle 234, bottom portion 226a of ball joint 226 exerts compressive forces against the top portion 292 of insert 290, which in turn 295 on the underside of insert 290 is brought into contact with the inwardly directed annular restricting ledge 242 of inner cavity 240 of receptacle 234 to create a tight fit.

[0076] It is envisioned that transverse connector 200 provides a low profile means for attaching to the rod, such that none of the transverse connector compromises the anatomy (dura and spinal cord) that resides between the rods. It is also envisioned that this embodiment still provides the ball joint feature as means of attachment of the cross member to the spinal rod attaching member, which allows for at least 3 degrees of freedom for

attachment. In addition, this embodiment still allows for various lengths of cross member 220 to accommodate various sized patients. Spinal rod connecting member 230 is biased laterally with respect to cross member 220 so as to provide the maximum amount of space possible for critical anatomical structures (dura and spinal cord). As discussed above, cross member 220 may also be designed to have an adjustable length or can come in various predetermined lengths to accommodate patient anatomy.

[0077] Referring now to Figs. 11A-11D, another embodiment of a transverse connector is shown and generally depicted as 300. Transverse connector 300 includes an adjustable cross member 310, spinal rod connecting members 230, and a cross member locking screw 280. In embodiments, cross member 310 is offset from spinal rod connecting members 230 to provide sufficient space for spinal anatomy and to therefore not impinge on surrounding tissue or spinal elements. Transverse connector 300 includes spinal rod connecting member 230, similar to transverse connector 200, which defines a spinal rod passage 236 adapted to receive and contain a spinal rod 90 (as shown in Fig. 11B). Spinal rod connecting member 230 of transverse connector 300 is substantially similar to the spinal rod connecting member 230 used with transverse connector 200, thus further description thereof will be omitted in the interest of brevity.

[0078] Adjustable cross member 310 includes a receiving arm 312, an insertion arm 314, a cross member locking screw 316 and a cross member locking screw receptacle 317. During use, as cross member locking screw 316 is tightened, cross member locking screw 316 is configured to exert pressure against insertion arm 314 to maintain insertion arm 314 at a specific position. In this manner, adjustable cross member 310 may be adjusted to a desired length in accordance to a surgeon's specification by loosening and tightening cross member locking screw 316. Adjustable cross member 310 is connected to spinal rod connecting member 230 in a similar manner as arcing cross member 220 is connected to spinal rod

connecting member 230, as described above. For example, adjustable cross member 310 includes a ball joint 320 on each arm 312 and 314, respectively, that is connected by a ball connecting member 318. As shown in Fig. 11D, each ball joint 320 defines a recess 322 that is disposed within a cross member locking screw receptacle 234. In this configuration, recess 322 of ball joint 320 is configured to receive a post 297 of an insert 290 in a similar fashion as described above. Spinal rod connecting member 230 of transverse connector 300 is substantially similar to the spinal rod connecting member 230 used with transverse connector 200, described above, thus further description thereof will be omitted in the interest of brevity.

[0079] Referring now to Figs. 12A-12D, another embodiment of a transverse connector is shown and generally depicted as 400. Transverse connector 400 includes a receiving arm assembly 410, an insertion arm assembly 430, and a spinal rod connecting member 450.

[0080] Receiving arm assembly 410 includes a receiving arm 412 and a receiving arm extension 414 having an articulating ball joint 418 connected via a ball connecting member 416. Ball joint 418 includes a top surface 418a that defines a cavity 418b. Receiving arm assembly 410 further includes receiving arm guides 420a and 420b that define an opening 422 therebetween and configured to receive insertion arm assembly 430.

[0081] Insertion arm assembly 430 includes an insertion arm 432 and an insertion arm extension 434 having an articulating ball joint 438 connected via a ball connecting member 436. Similar to ball joint 418, ball joint 438 includes a top surface 438b that defines a cavity 438a. Insertion arm 432 includes a screw receptacle 440 having threads 442 disposed alongside an inner periphery therewithin for receiving an insertion arm locking screw 490.

[0082] Referring to Fig. 12D, insertion arm locking screw 490 is shown having threads 492, a bottom surface 494, and a tool cavity 496 so that a clinician may manually screw locking screw 480 with a suitable tool (not shown).

[0083] Spinal rod connecting member 450 includes a top portion 452 and a bottom portion 454, which each define compression slots 456a and 456b, respectively (as shown in Fig. 12B). Spinal rod connecting member 450 further includes a locking screw receptacle 458 that is configured to receive a cross member connection locking screw 480, as will be described further below. Each spinal rod connecting member 450 defines a spinal rod connecting passage 460 that is provided on a bottom portion of spinal rod connecting member 450. Spinal rod connecting passage 460 is configured to receive and securely retain a spinal rod 90 (as shown in Fig. 12B).

[0084] Still referring to Fig. 12D, cross member connecting locking screw 480 is shown having threads 482 alongside of locking screw 480. On a top portion, locking screw 480 includes a tool cavity 486 so that a clinician may manually screw locking screw 480 with a suitable tool (not shown), for example, but not limited to a screwdriver or a TORX® wrench. On a bottom portion, locking screw 480 includes a concave cavity 488 and a post 484 that is provided in the center of the concave cavity 488. Post 484 is configured to be inserted within cavity 438a of top surface 438b of ball joint 438 during assembly to provide a friction fit.

[0085] During use and assembly of transverse connector 400 and referring back to Fig. 6F, locking screw 480 is positioned within locking screw receptacle 458 such that concave cavity 488 and post 484 is positioned within cavity 438a of top surface 438b of ball joint 438 during assembly to provide a friction fit.

[0086] Subsequently, as locking screw 480 is placed and rotated (e.g., screwed) into locking screw receptacle 458, concave cavity 488 and post 484 on the underside of screw 480 exert compressive forces against and within cavity 438a of top surface 438b of ball joint 438 during assembly to provide a friction fit.

[0087] It is envisioned that transverse connector 400 provides a low profile means for attaching to the rod, such that none of the connector compromises the anatomy (dura and

spinal cord) that resides between the rods. It is also envisioned that this embodiment still provides the ball joint feature as means of attachment of the cross member to the spinal rod attaching member, which allows for at least 3 degrees of freedom for attachment. In addition, this embodiment still allows for various lengths of receiving arm assembly 410 and insertion arm assembly 430 to accommodate various sized patients. Spinal rod connecting member 450 is biased laterally with respect to receiving arm assembly 410 and insertion arm assembly 430 so as to provide the maximum amount of space possible for critical anatomical structures (dura and spinal cord).

[0088] The transverse connector 10, 100, 200, 300, 400 can be manufactured as components by methods known in the art, to include, for example, molding, casting, forming or extruding, and machining processes. The components can be manufactured using materials having sufficient strength, resiliency and biocompatibility as is well known in the art for such connectors. By way of example only, suitable materials can include implant grade metallic materials, such as titanium, cobalt chromium alloys, stainless steel, or other suitable materials for this purpose. It is also conceivable that some components of the connector can be made from plastics, composite materials, and the like.

[0089] It is also within the concept of the inventors to provide a kit, which includes at least one of the transverse connectors. The kit can also include additional orthopedic devices and instruments; such as for example, instruments for tightening or loosening the locking screws, spinal rods, hooks or links and any additional instruments or tools associated therewith. Such a kit can be provided with sterile packaging to facilitate opening and immediate use in an operating room.

[0090] Each of the embodiments described above are provided for illustrative purposes only and it is within the concept of the present disclosure to include modifications and

varying configurations without departing from the scope of the disclosure that is limited only by the claims included herewith.

In the Claims:**1. A transverse connector comprising:**

a cross member element, the cross member element including opposing first and second ends;

first and second ball joint joints disposed at respective first and second ends of the cross member element and defining a space therebetween;

first and second spinal rod connecting members being disposed at respective first and second ends of the cross member element, each of the first and second spinal rod connecting members having a first compression region, the compression region configured to selectively and releasably secure to a spinal rod, each spinal rod connecting member adapted to receive a locking screw, each locking screw operatively coupled to its respective ball joint such that rotation of the locking screw retains the spinal rod connecting member in a fixed relationship with the cross member element.

2. The transverse connector according to claim 1, wherein each of the spinal rod connecting members include first and second compression slots, each of the first and second compression slots dimensioned to pass one over the other through a portion of the spinal rod connecting members, the compression slots having opposing sides of origin and opposing directions of penetration into the spinal rod connecting members, wherein manipulation of the locking screw approximates the opposing sides of origin thereby retaining each of the first and second spinal rod connecting members in the fixed relationship with the cross member element.

3. The transverse connector according to claim 2, wherein the first and second spinal rod connecting members include spinal rod connecting passages, each spinal rod connecting passage includes upper and lower spinal rod retention lips, each of the upper and lower spinal

rod retention lips projecting one toward the other so as to narrow the lateral opening of the spinal rod connecting passage and to facilitate retention of the spinal rod.

4. The transverse connector according to claim 3, wherein at least one of the compression slots originate adjacent to the spinal rod connecting passage such that the at least one compression slot, the upper spinal rod retention lip, and the lower spinal rod retention lip define a second compression region.

5. The transverse connector according to claim 1, wherein the first and second spinal rod connecting members are configured at a portion of first and second innermost ends to define a ball joint receptacle, each ball joint receptacle having a lateral opening configured to receive a correspondingly sized ball joint of cross member.

6. The transverse connector according to any of the preceding claims, wherein the cross member element includes a U-shaped configuration.

7. The transverse connector according to any one of the preceding claims, further comprising an offset cross member providing an offset configuration such that first and second spinal rod connecting members exist in a first plane and at least a portion of the offset cross member exists in a second plane that is spaced apart and parallel to the first plane.

8. The transverse connector according to claim 4, wherein at least one compression slot cooperates with a corresponding ball joint receptacle to define the first compression region.

9. The transverse connector according to claim 1, further comprising first and second cross member connecting elements including a cross member clamp portion and a linking arm, the linking arm having an articulating ball joint, the first and second cross member connecting elements further including a cross member receptacle being dimensioned and configured to receive at least one end of the cross member element.

10. The transverse connector according to claim 9, wherein the cross member clamp portion of each cross member connecting element includes a top portion, a bottom portion,

and a cross member locking screw receptacle being defined orthogonally through the top and bottom portions, wherein the top and bottom portions are separated by a compression slot defined therebetween.

11. The transverse connector according to claim 1, wherein the cross member element includes an insertion arm and a receiving arm defining a space therein, the receiving arm being configured to receive the insertion arm to thereby adjust the length of the cross member element, at least one of the insertion arm and the receiving arm having a cross member locking screw receptacle configured to receive a cross member locking screw such that manipulation of the cross member locking screw exerts pressure against at least one of the insertion arm and the receiving arm to thereby maintain the insertion arm and the receiving arm at a specific position.

12. The transverse connector according to any of claims 1-7, wherein rotation of the locking screw fixes the relationship between the spinal rod connecting member and the cross member element, and secures the spinal rod to the spinal rod connecting member.

13. The transverse connector according to claim 10, wherein rotation of the cross member locking screw in a first direction allows at least one of the spinal rod connecting members to move relative to the cross member.

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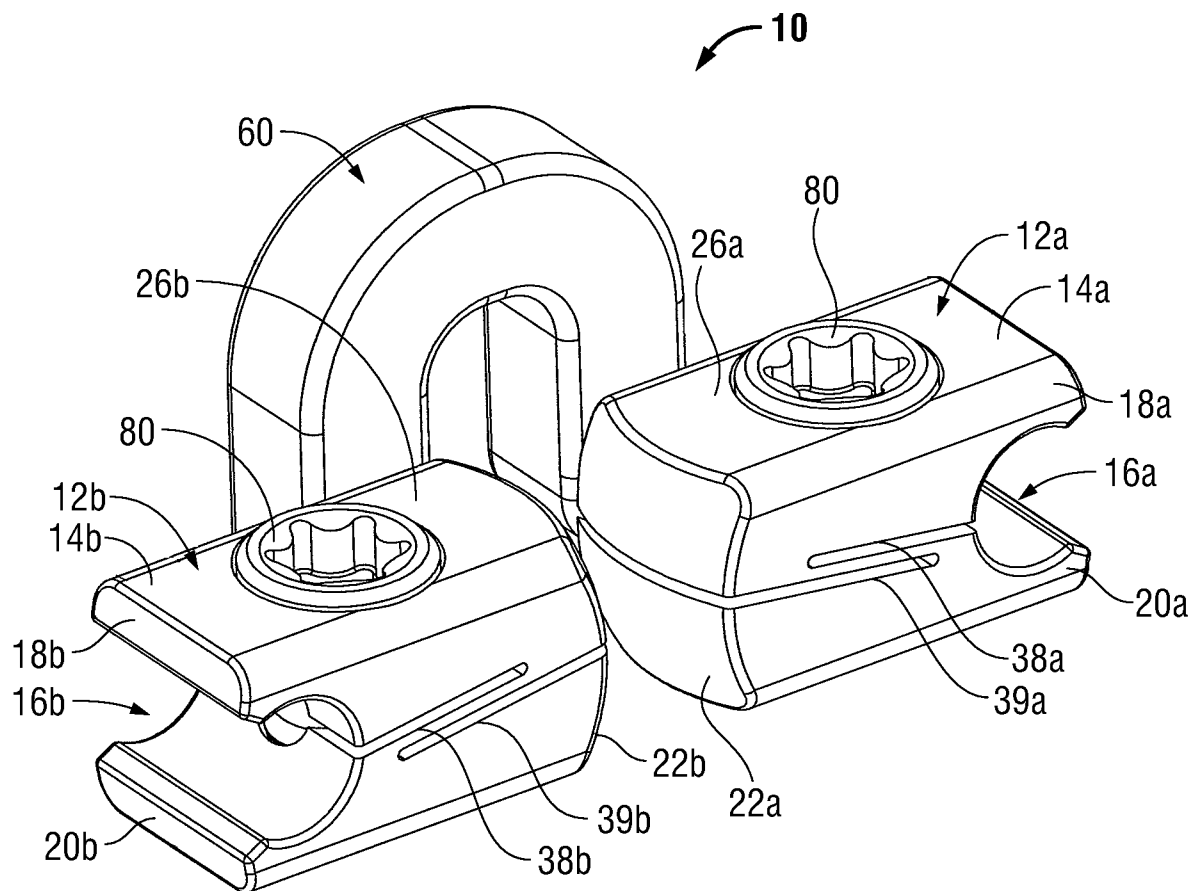


FIG. 1A

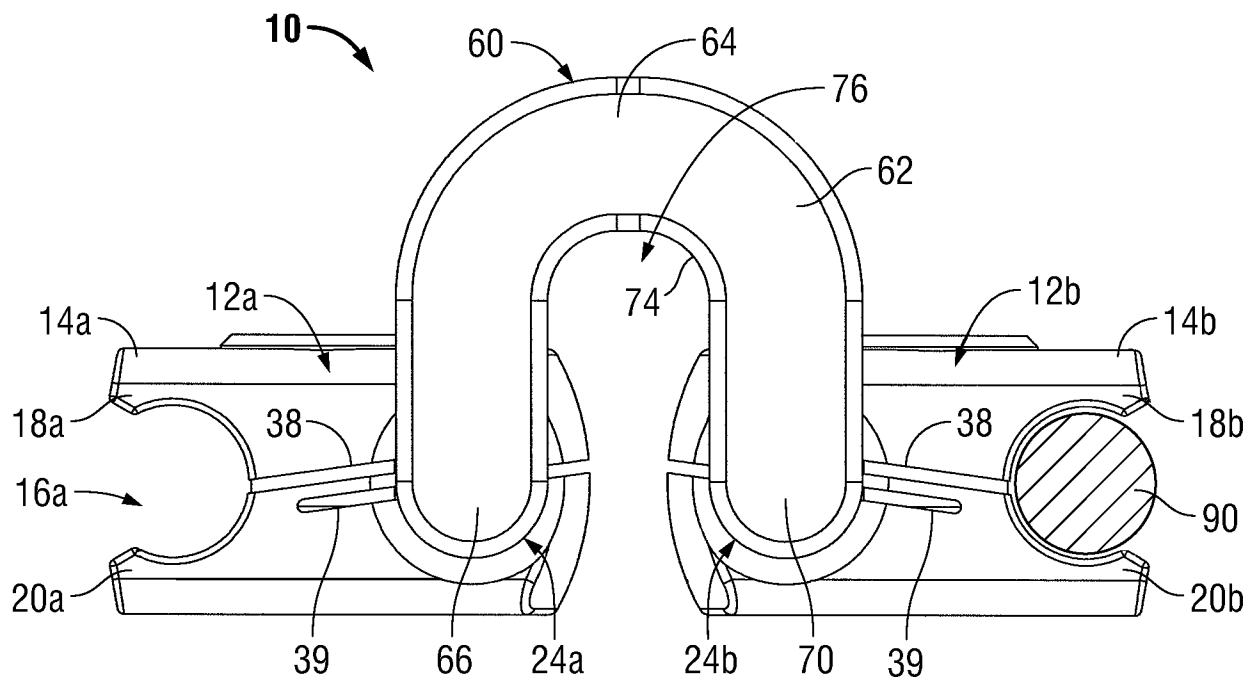


FIG. 1B

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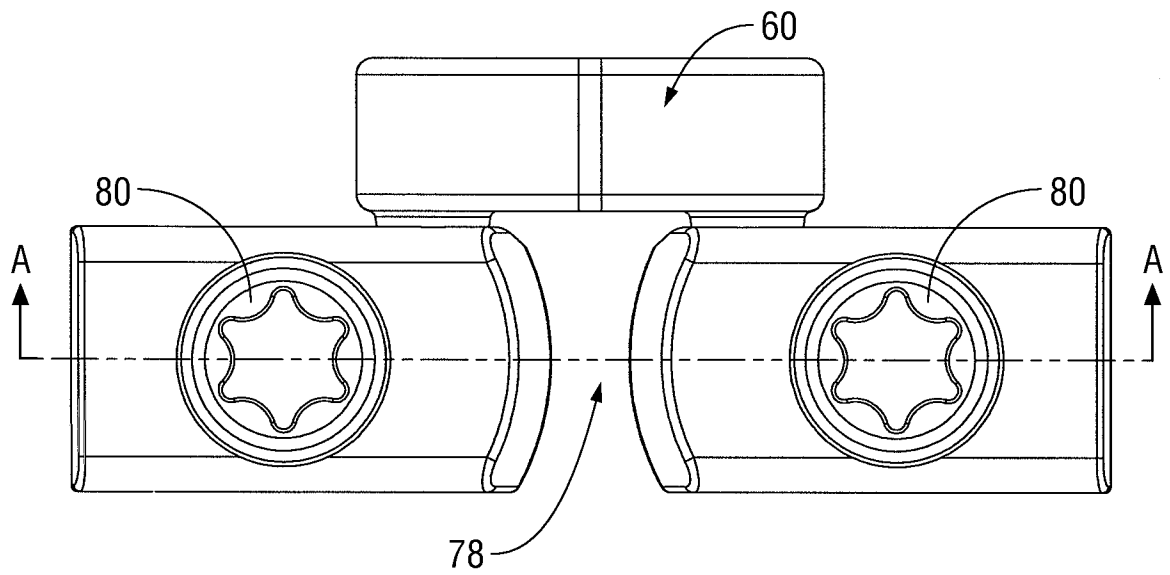


FIG. 1C

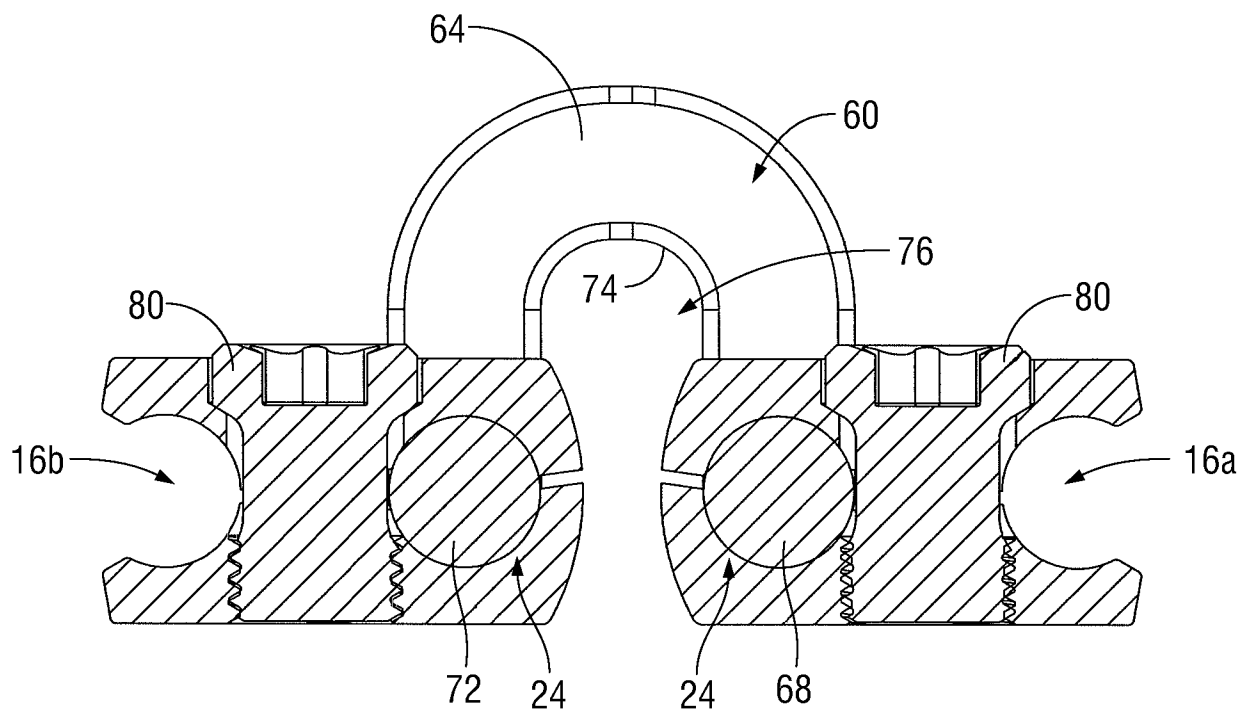


FIG. 1D

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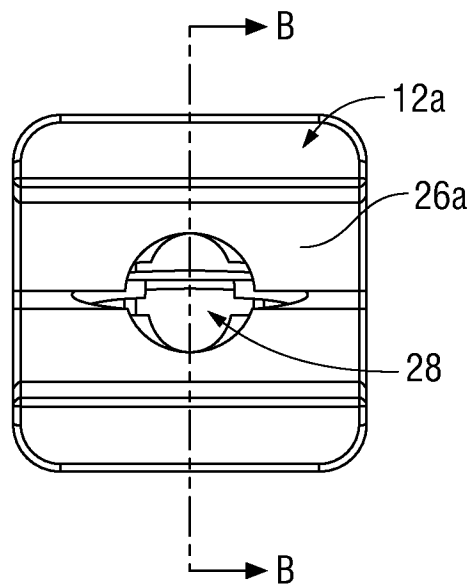


FIG. 2A

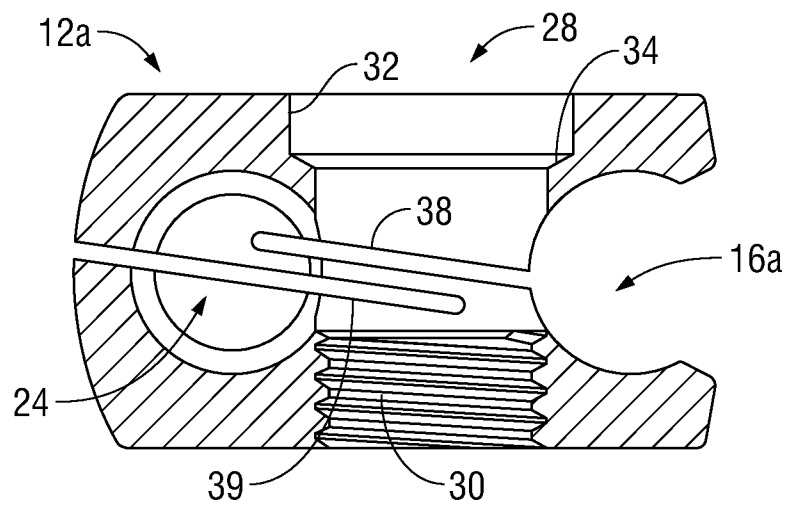


FIG. 2B

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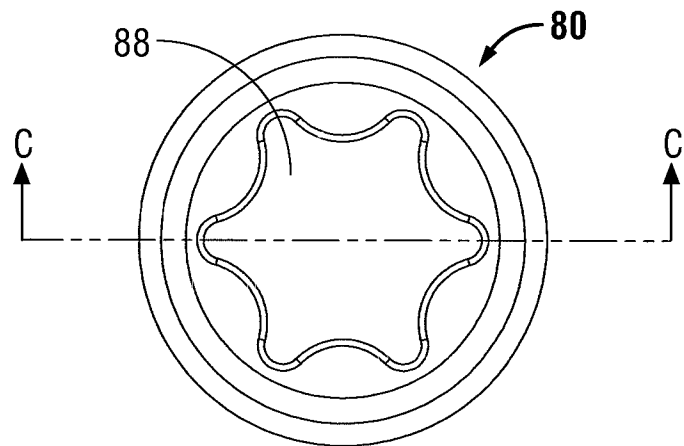


FIG. 3A

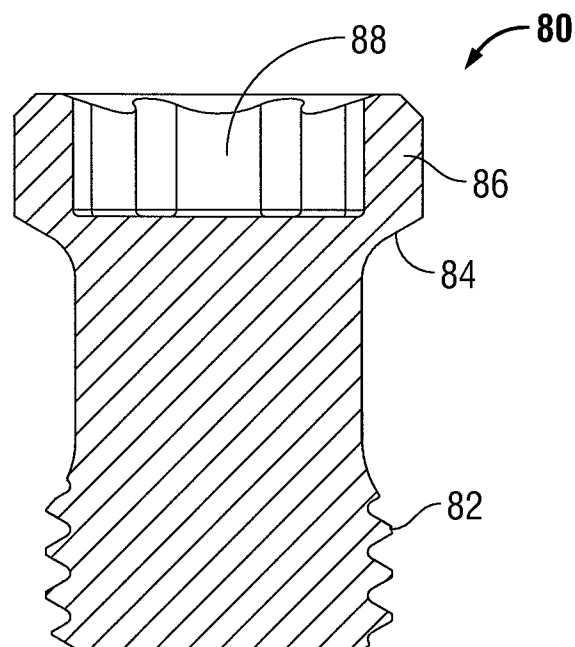


FIG. 3B

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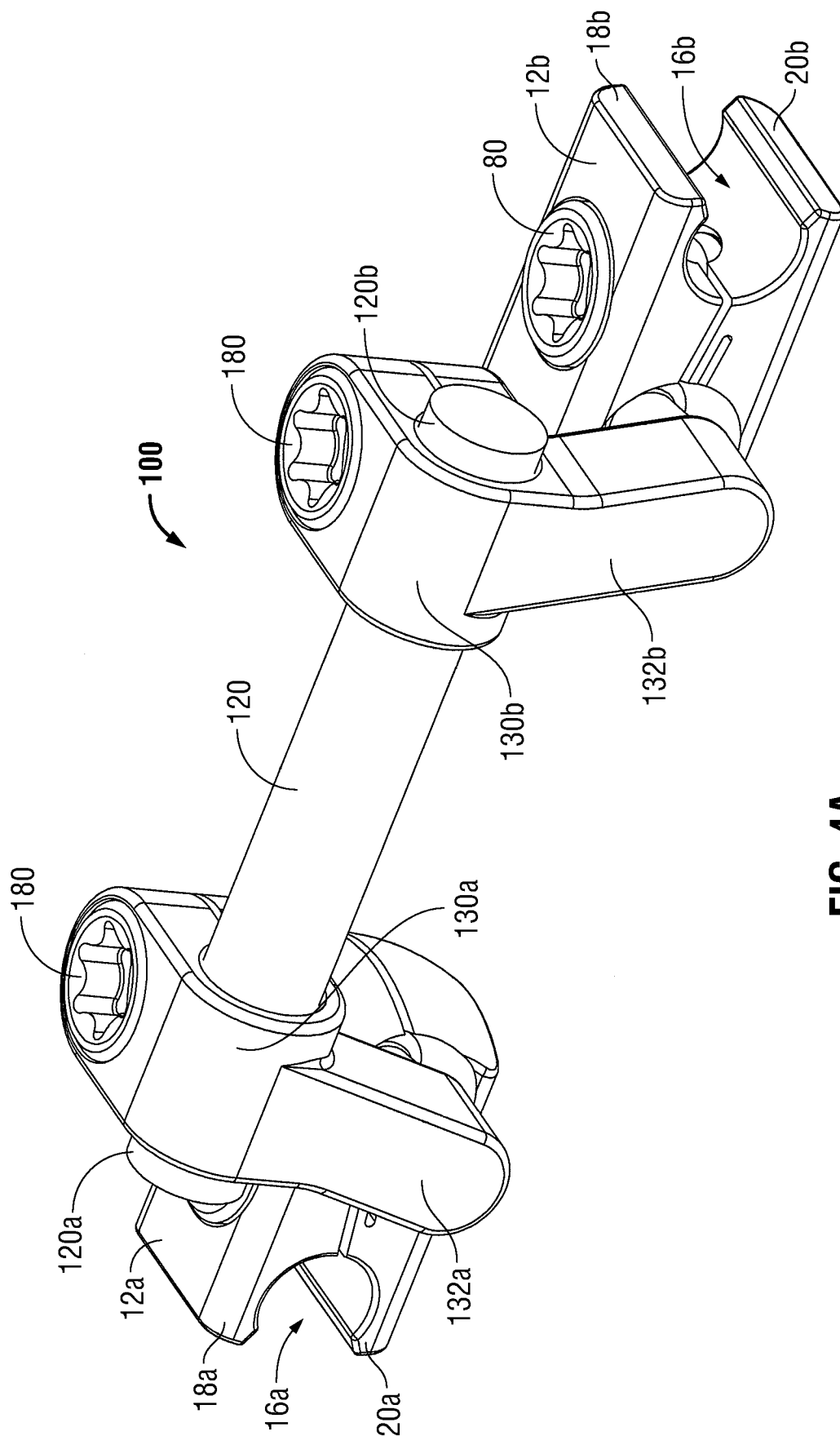


FIG. 4A

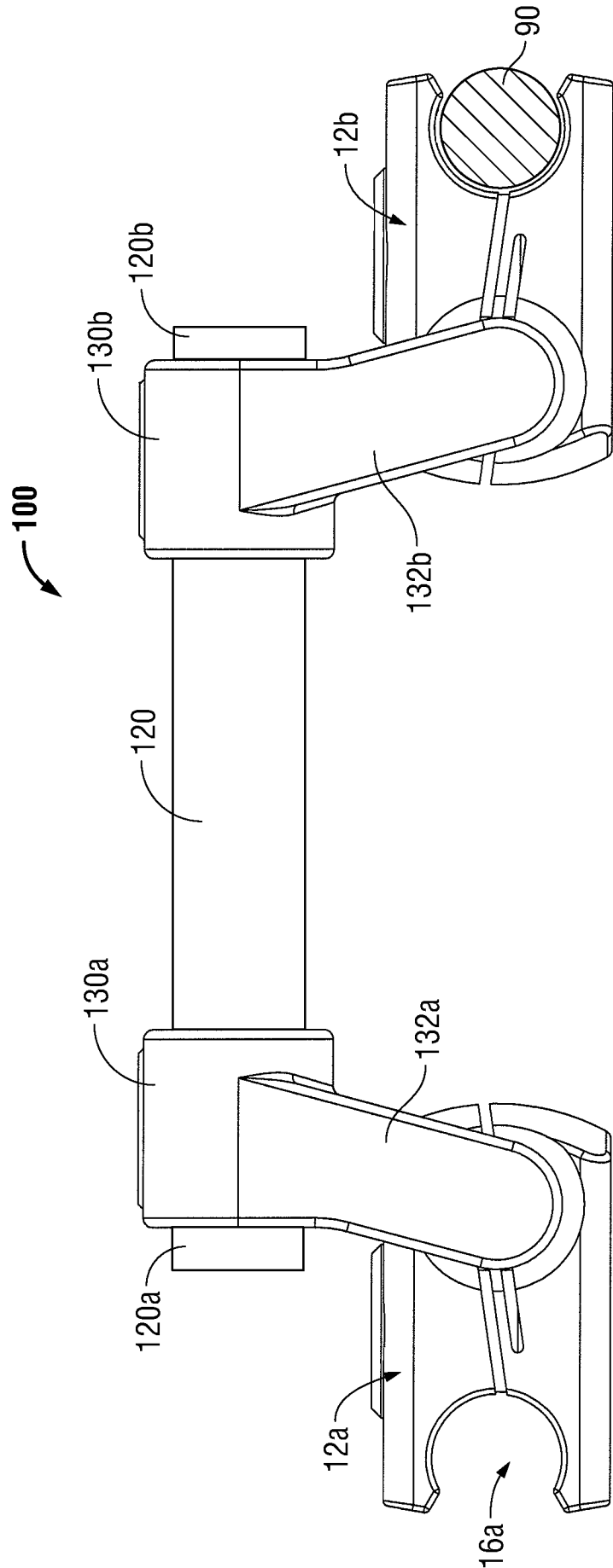


FIG. 4B

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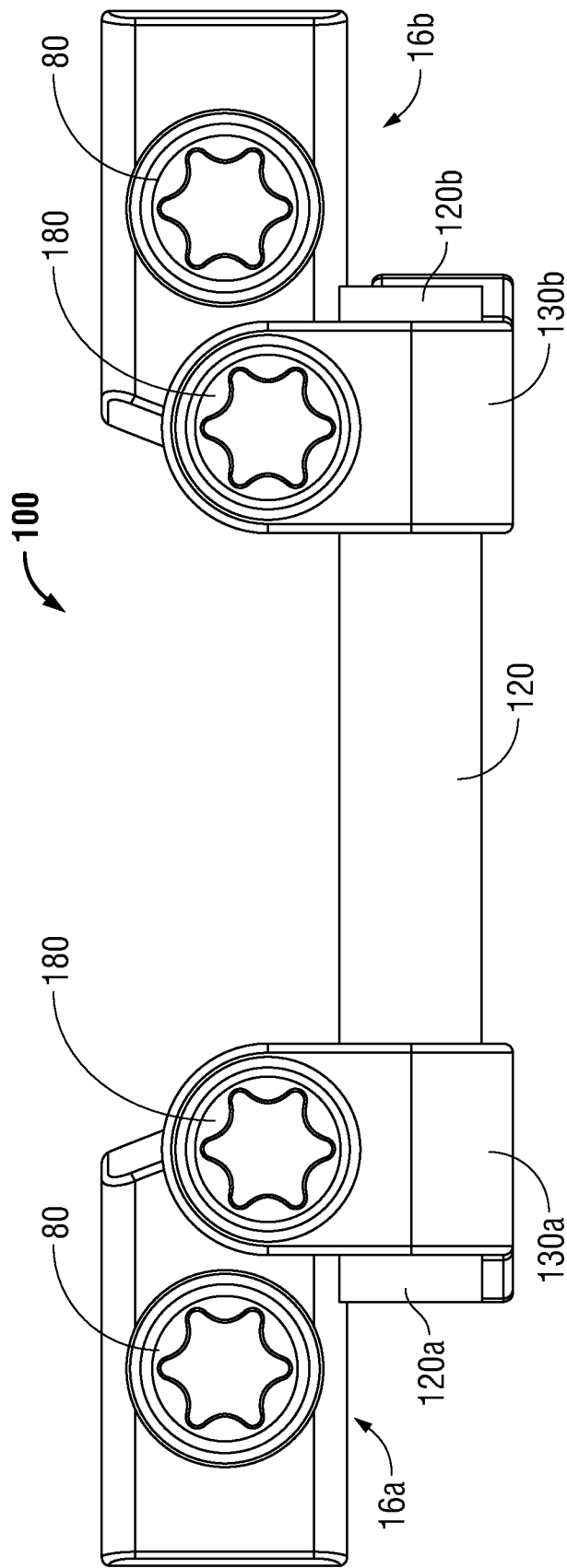


FIG. 4C

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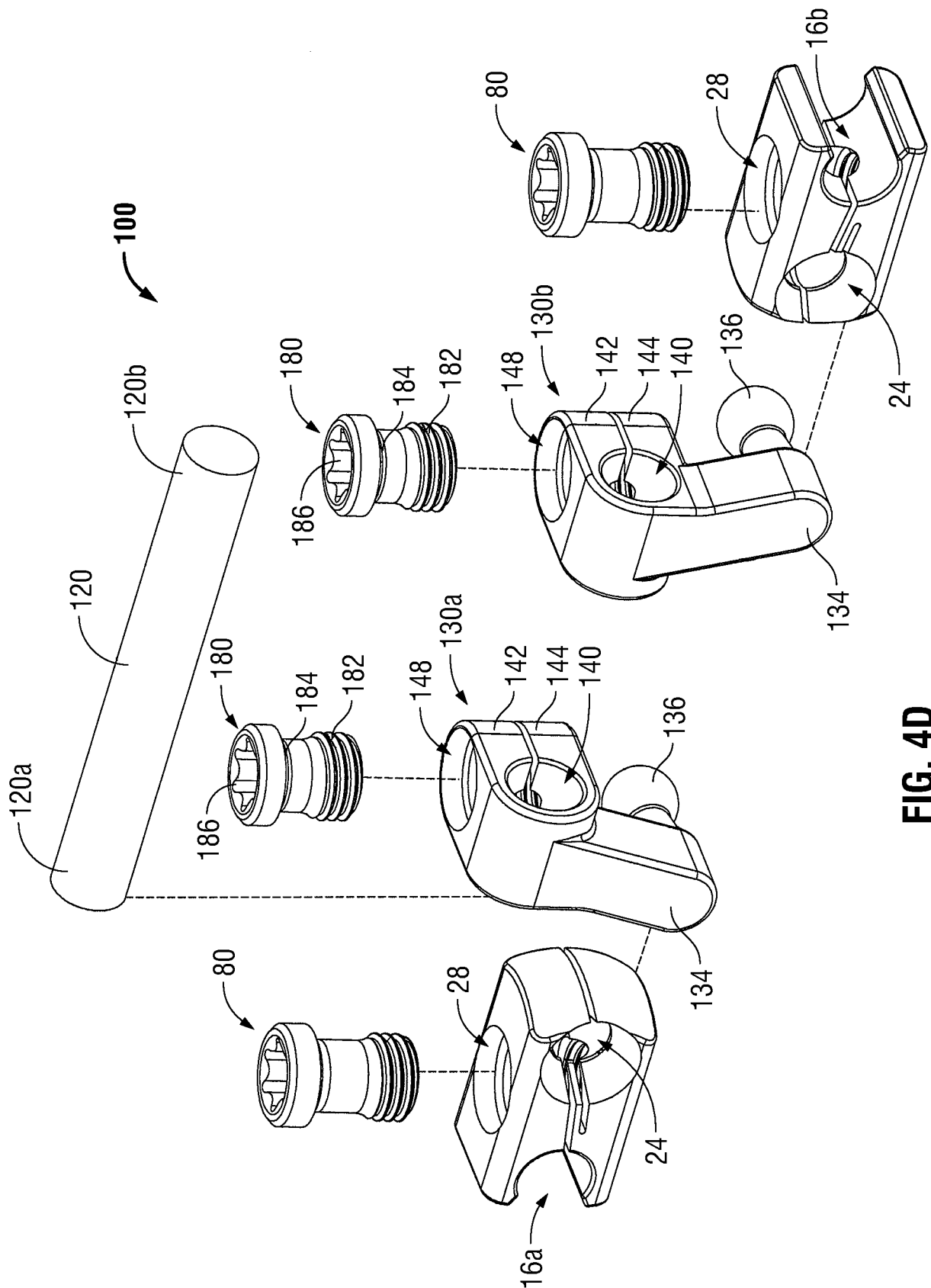


FIG. 4D

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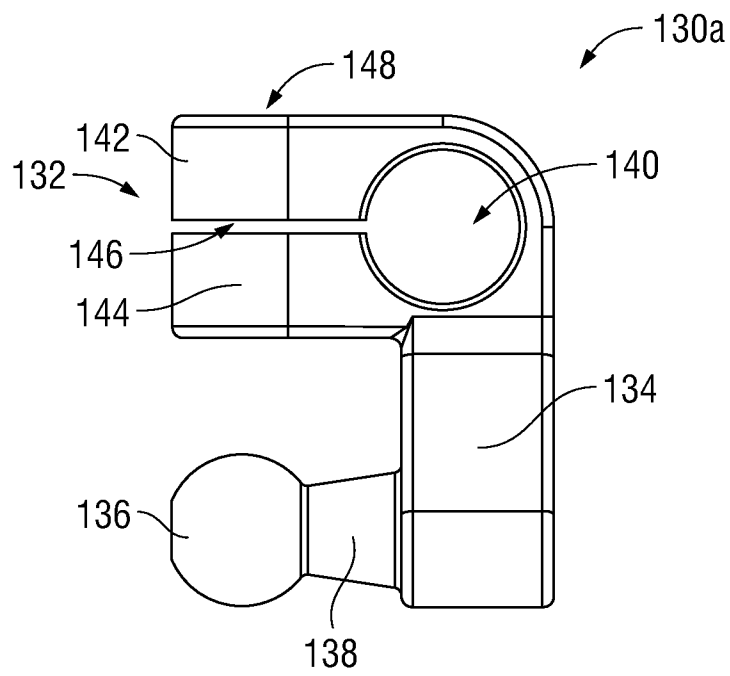


FIG. 5

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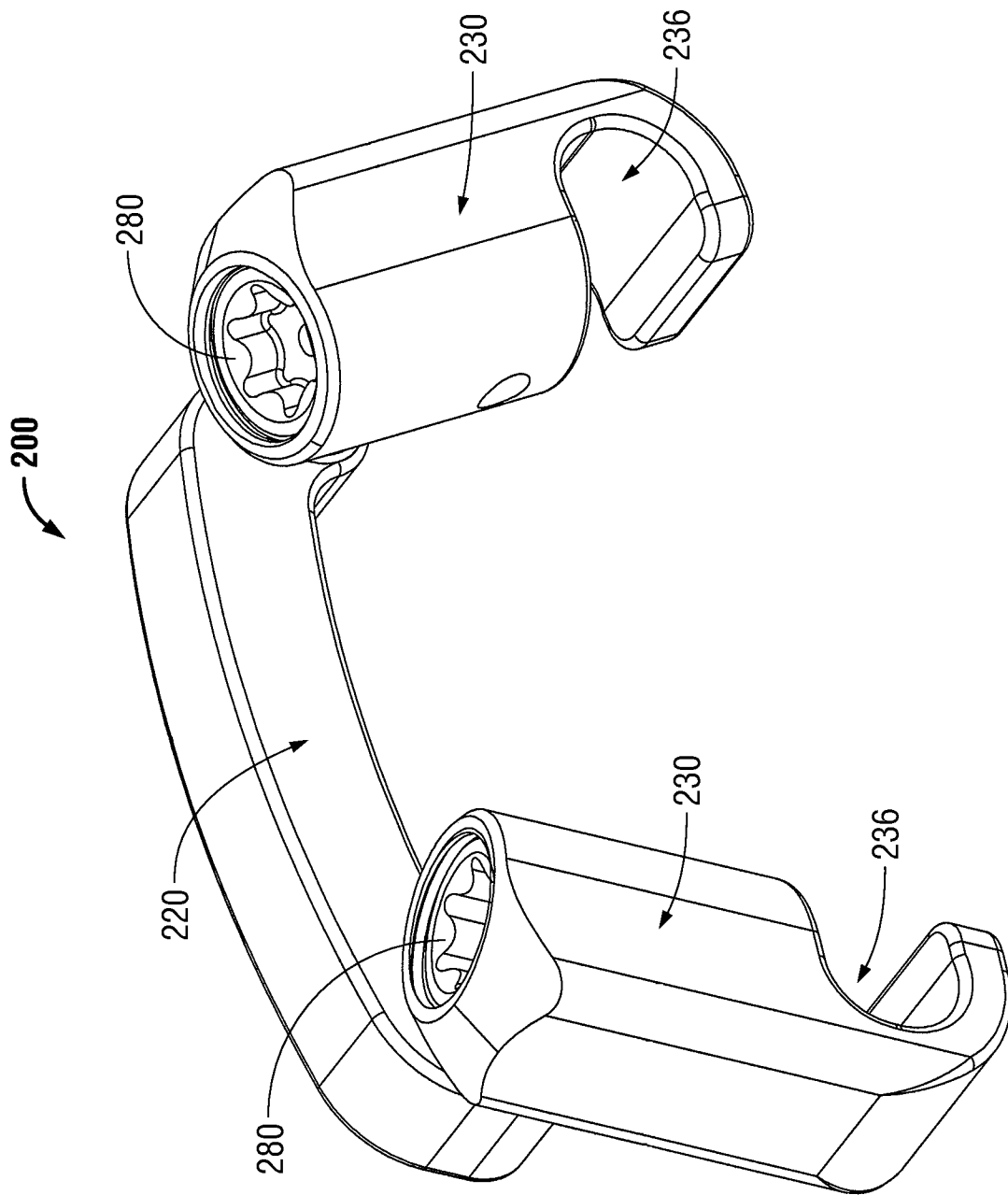


FIG. 6A

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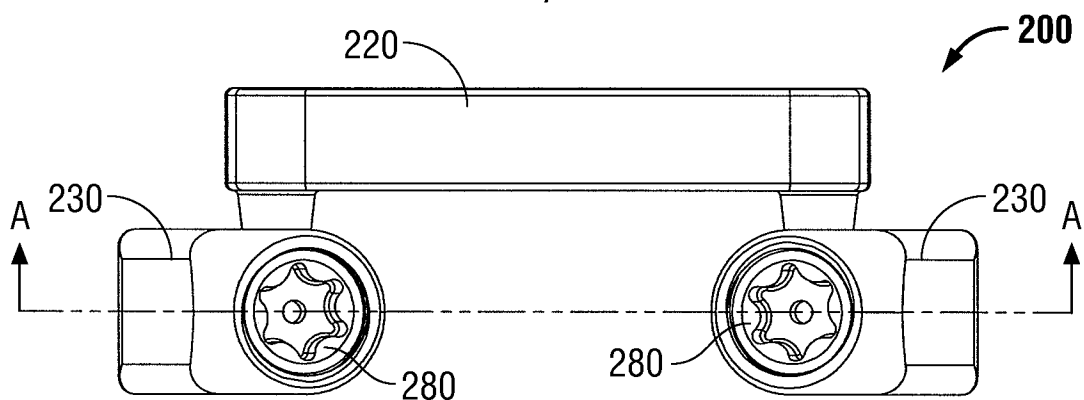


FIG. 6B

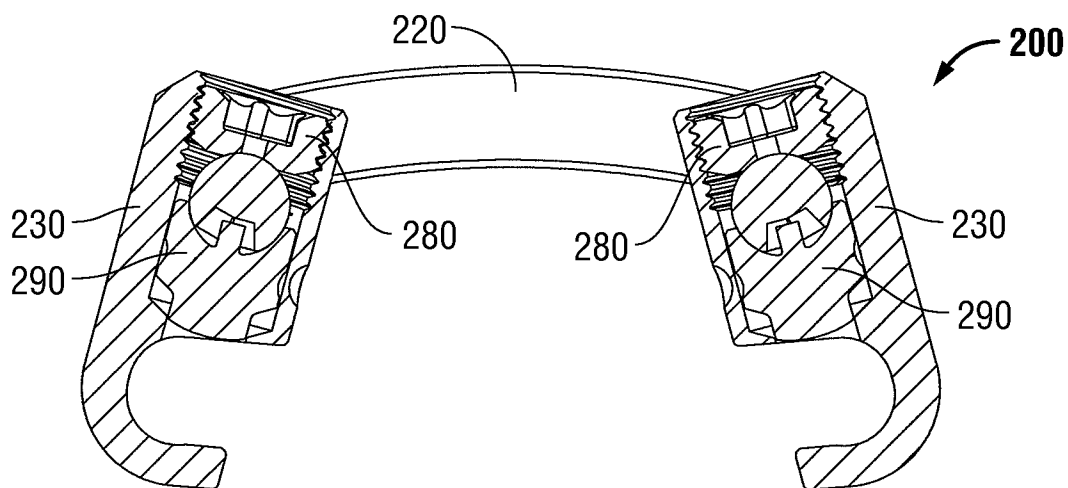


FIG. 6C

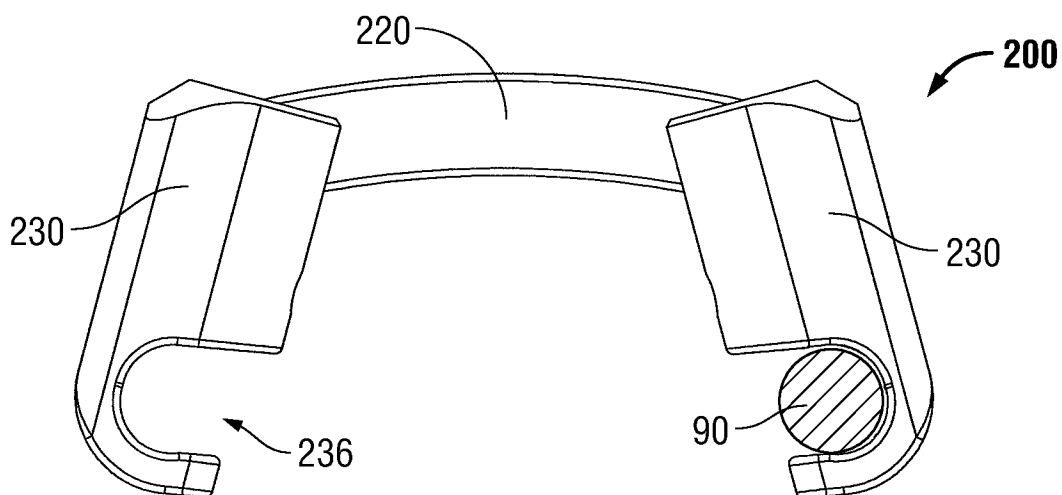


FIG. 6D

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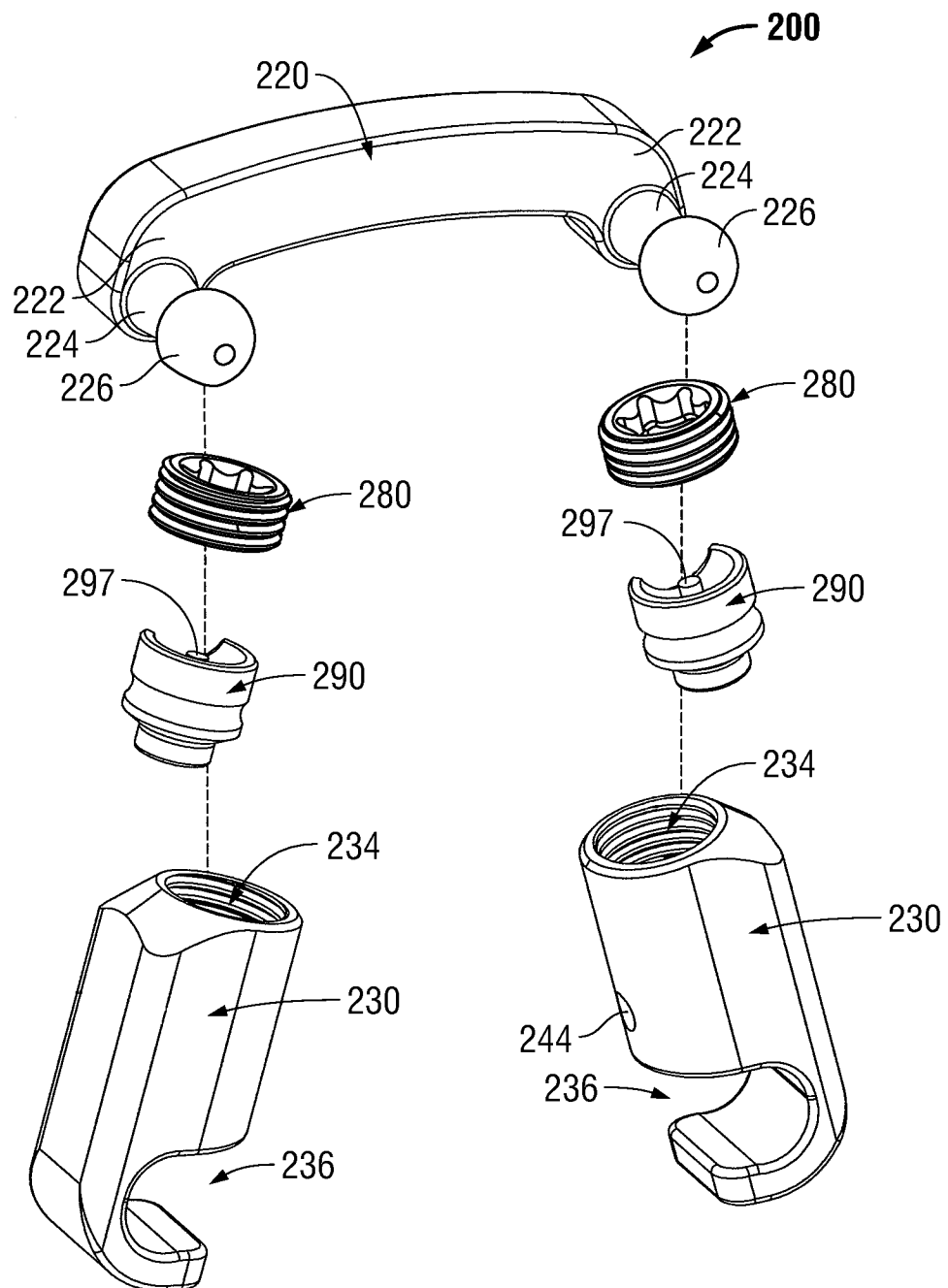


FIG. 6E

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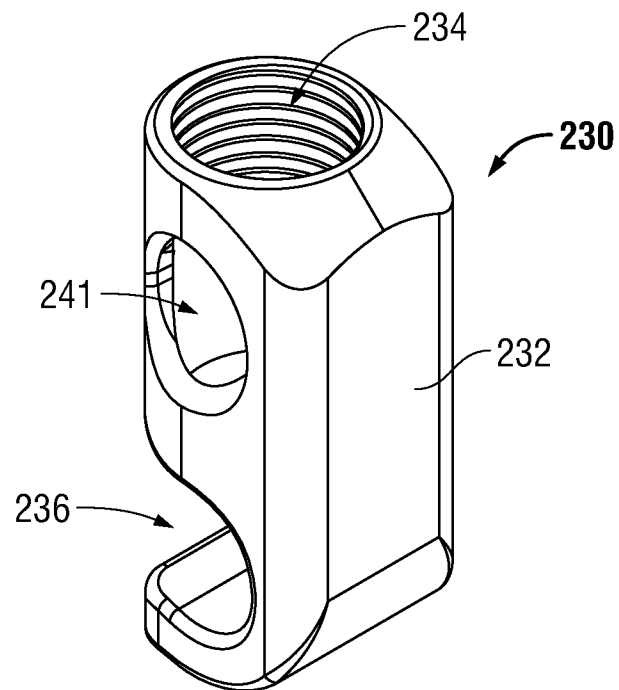


FIG. 7A

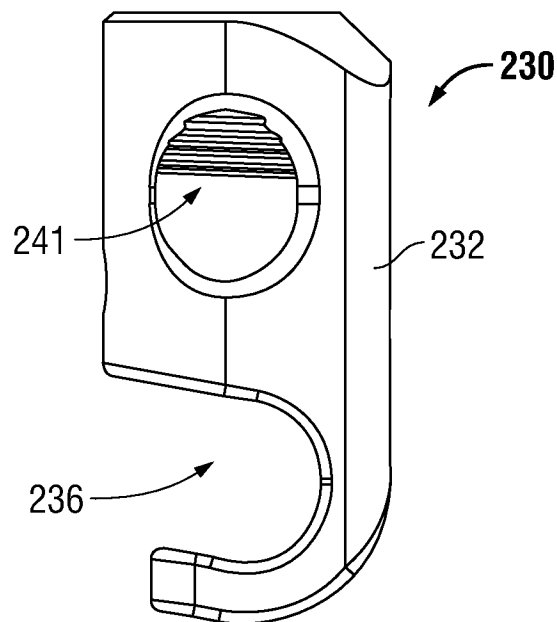


FIG. 7B

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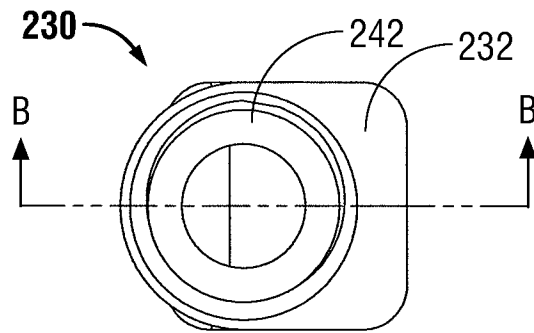


FIG. 7C

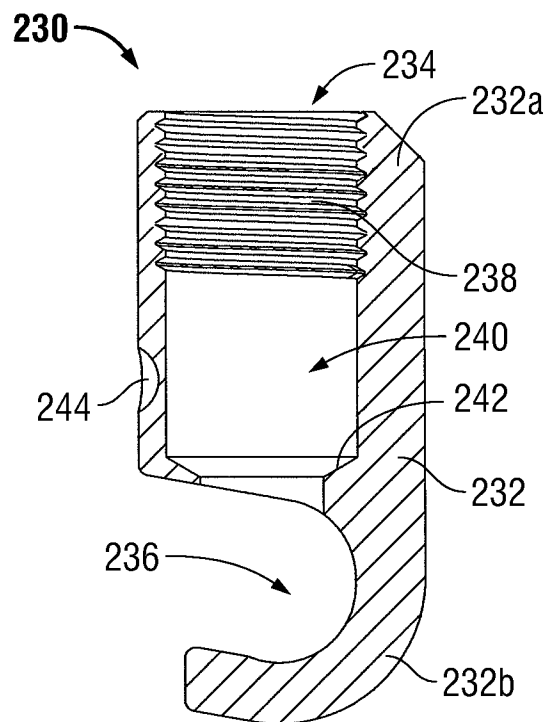


FIG. 7D

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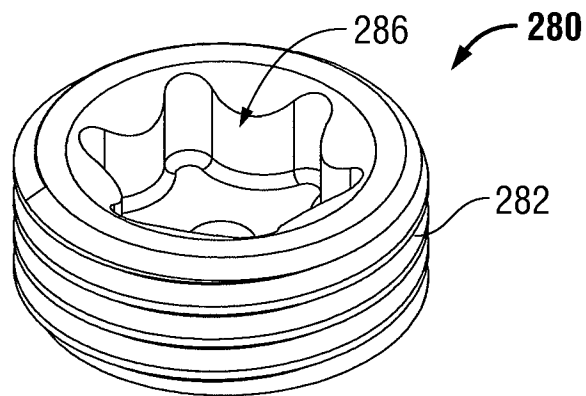


FIG. 8A

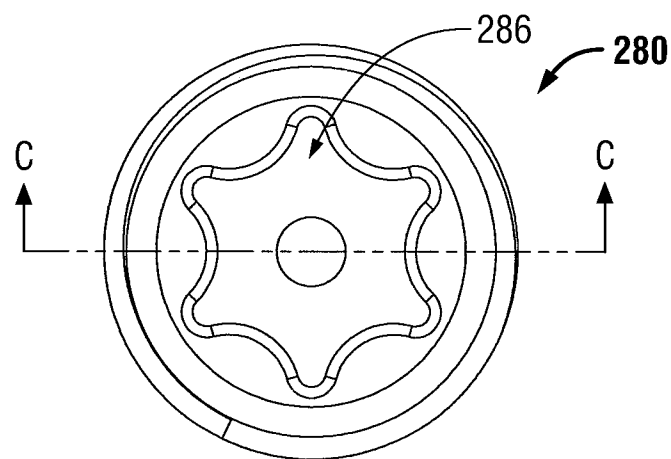


FIG. 8B

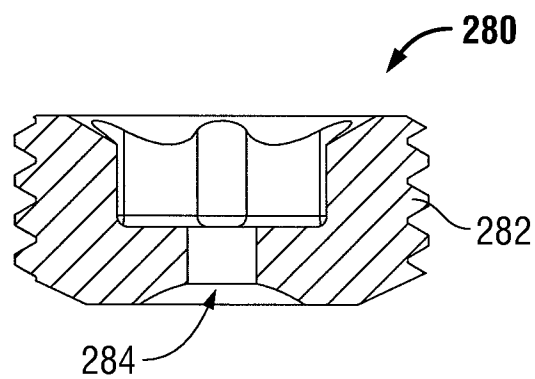


FIG. 8C

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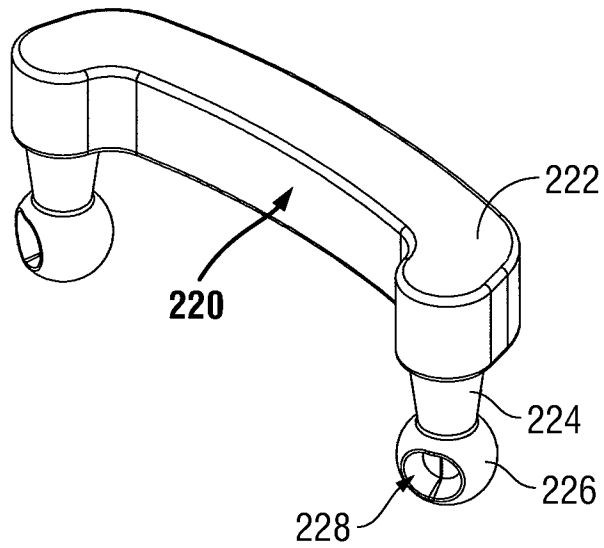


FIG. 9A

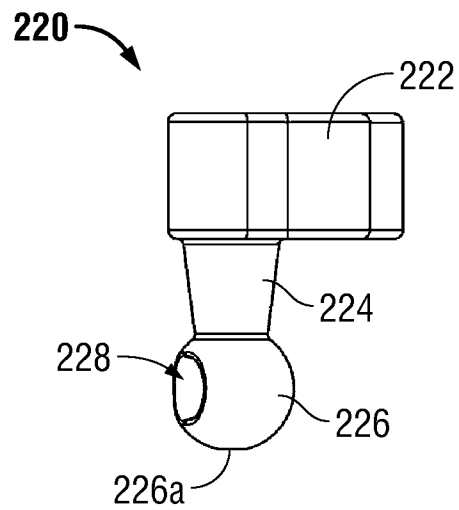


FIG. 9B

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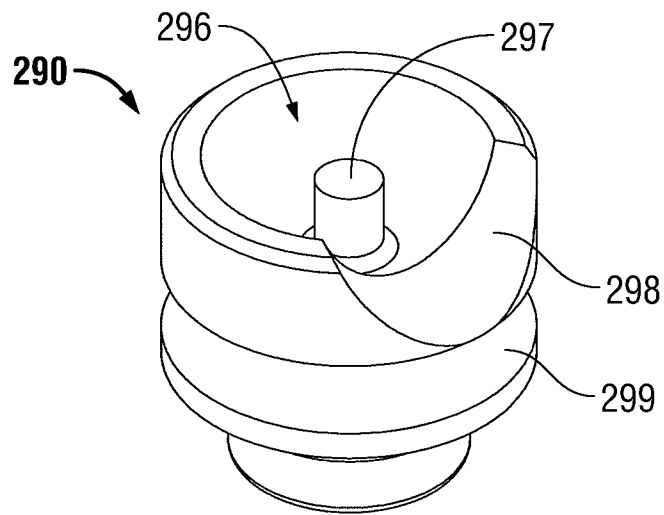


FIG. 10A

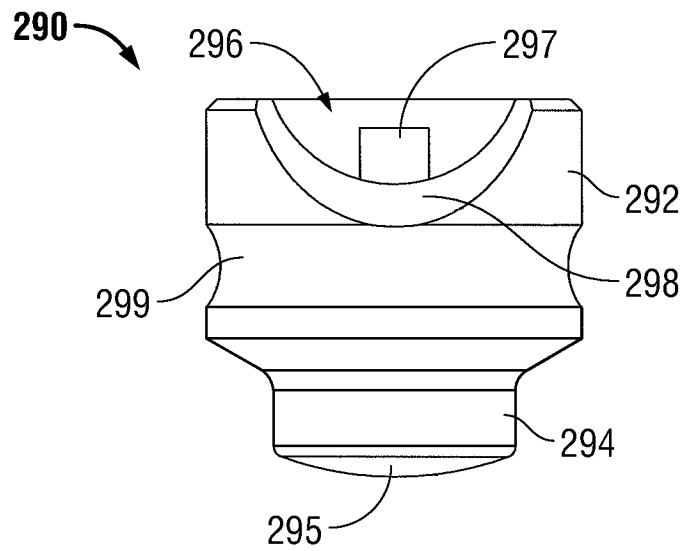


FIG. 10B

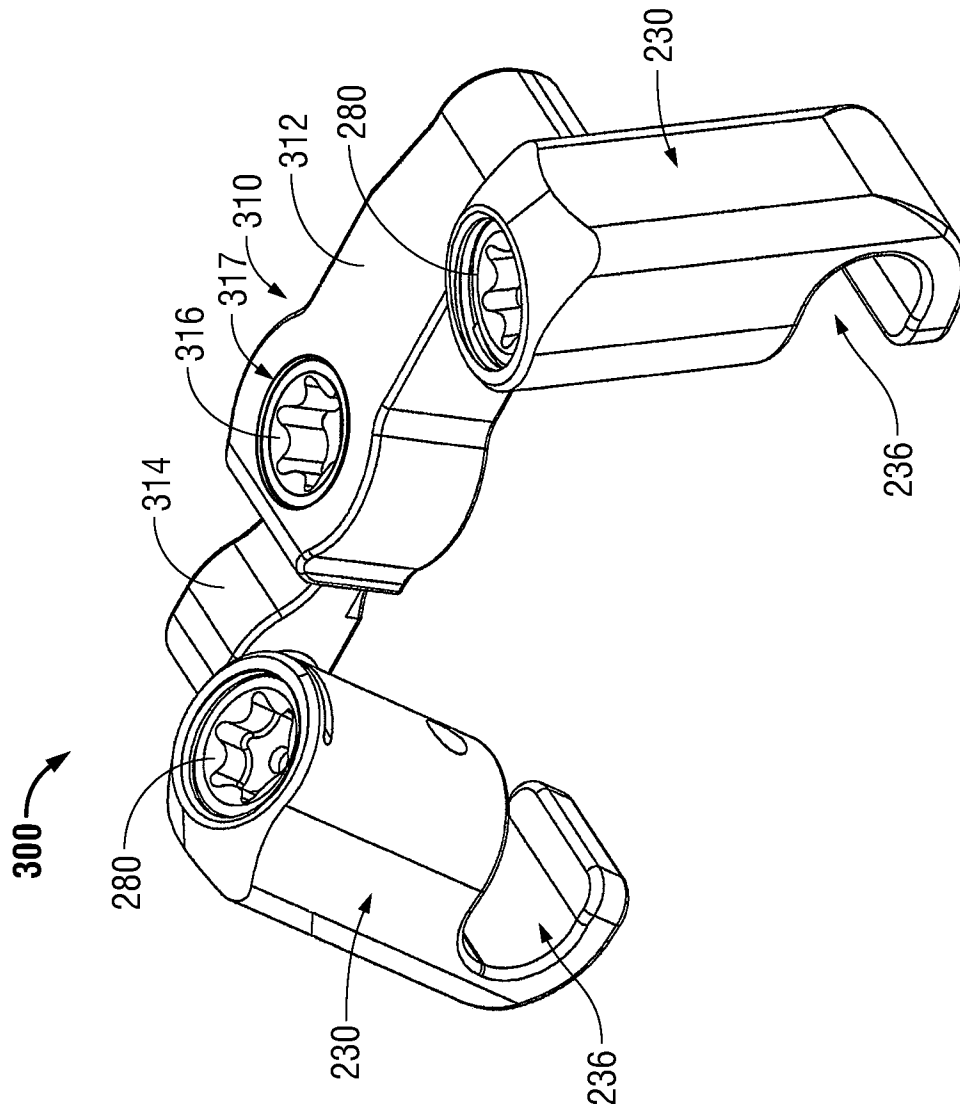


FIG. 11A

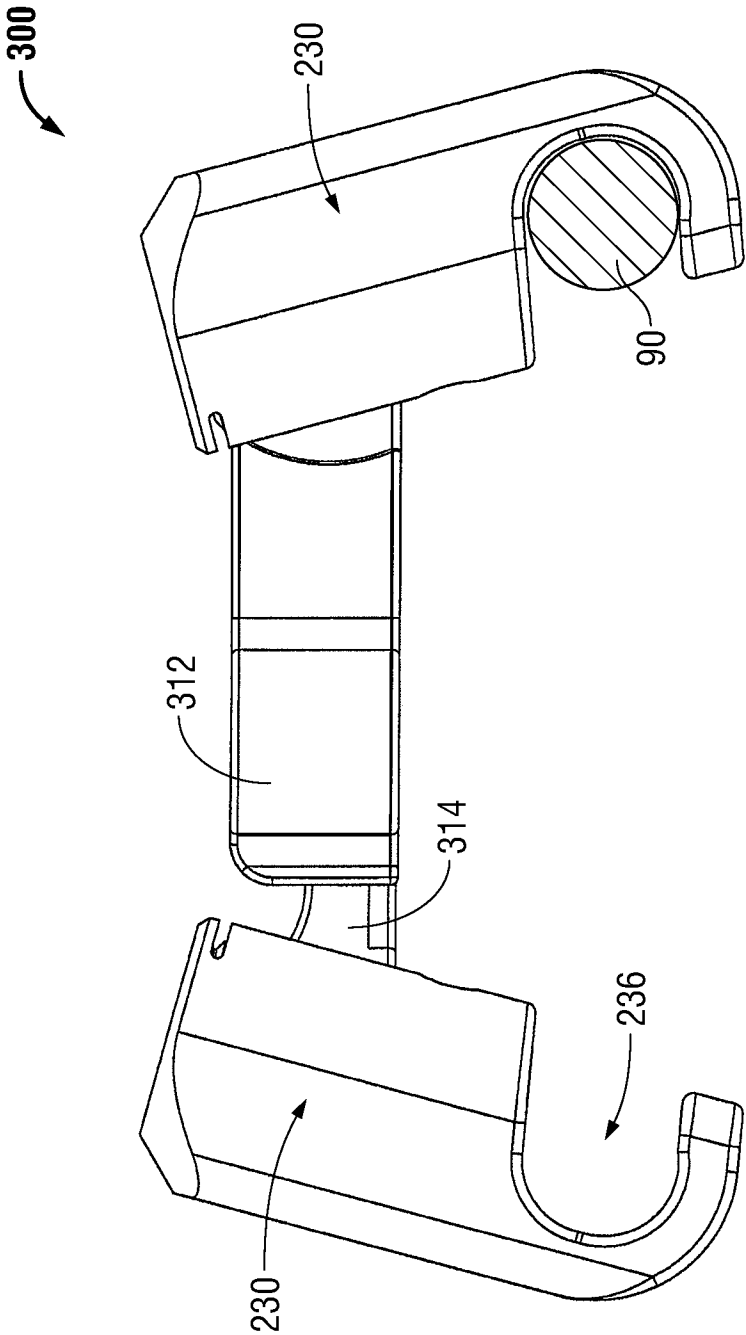


FIG. 11B

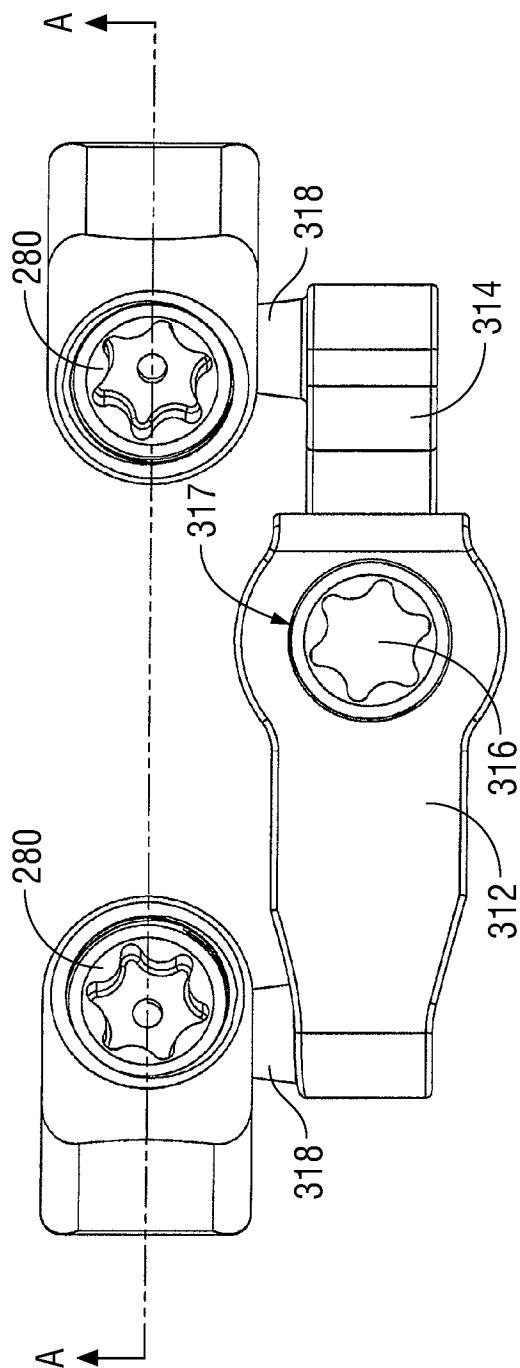


FIG. 11C

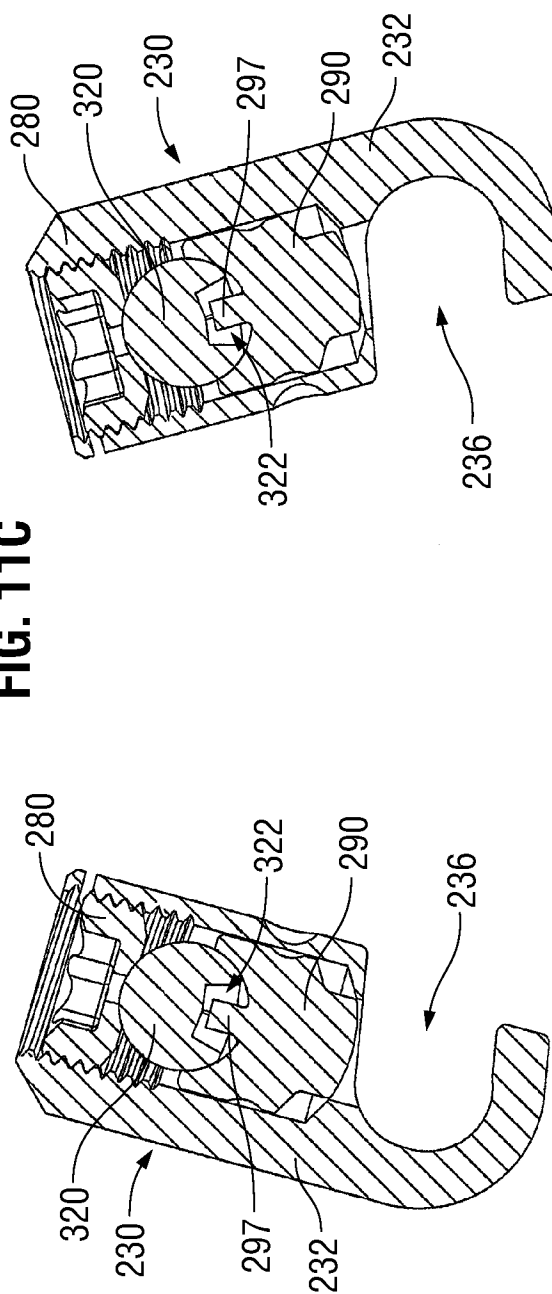


FIG. 11D

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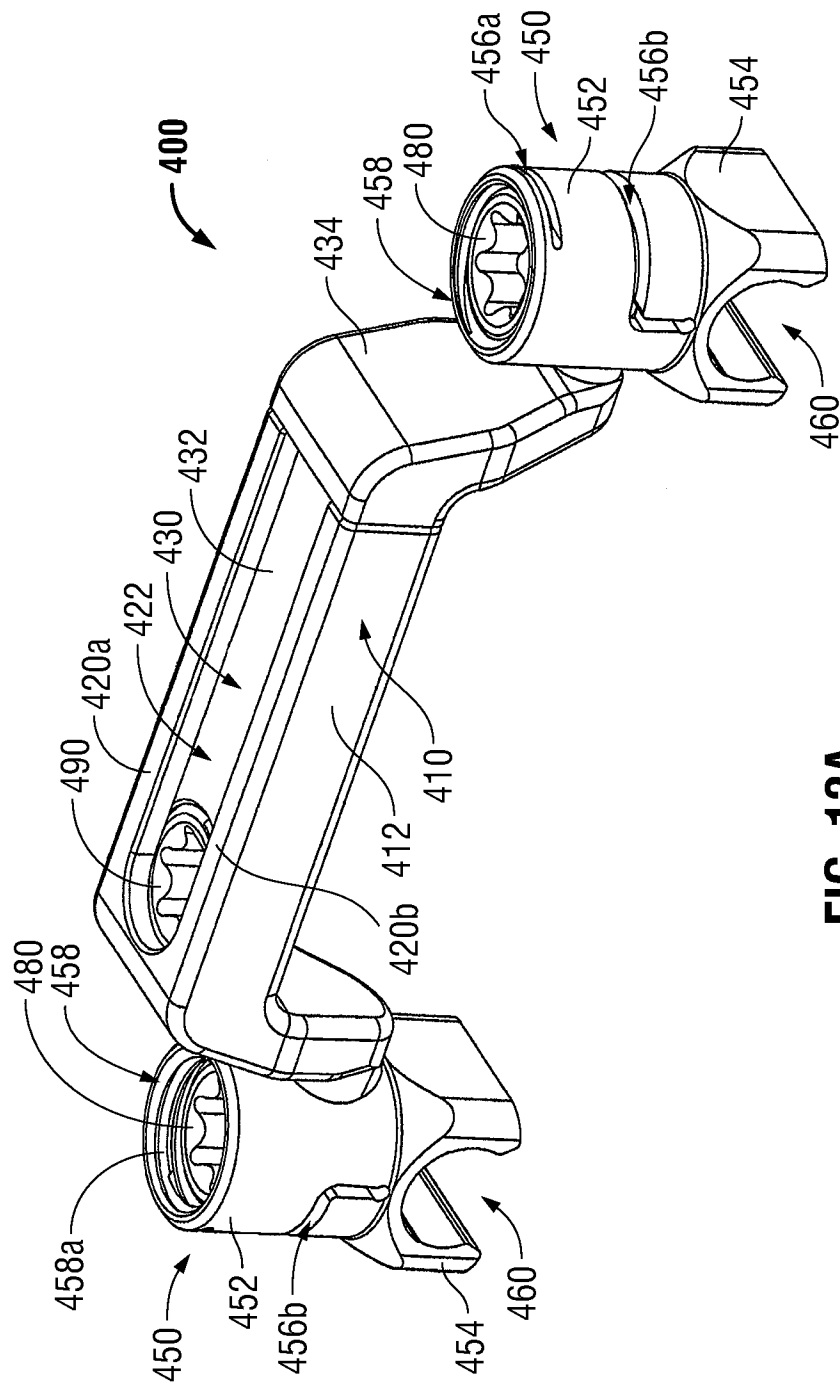


FIG. 12A

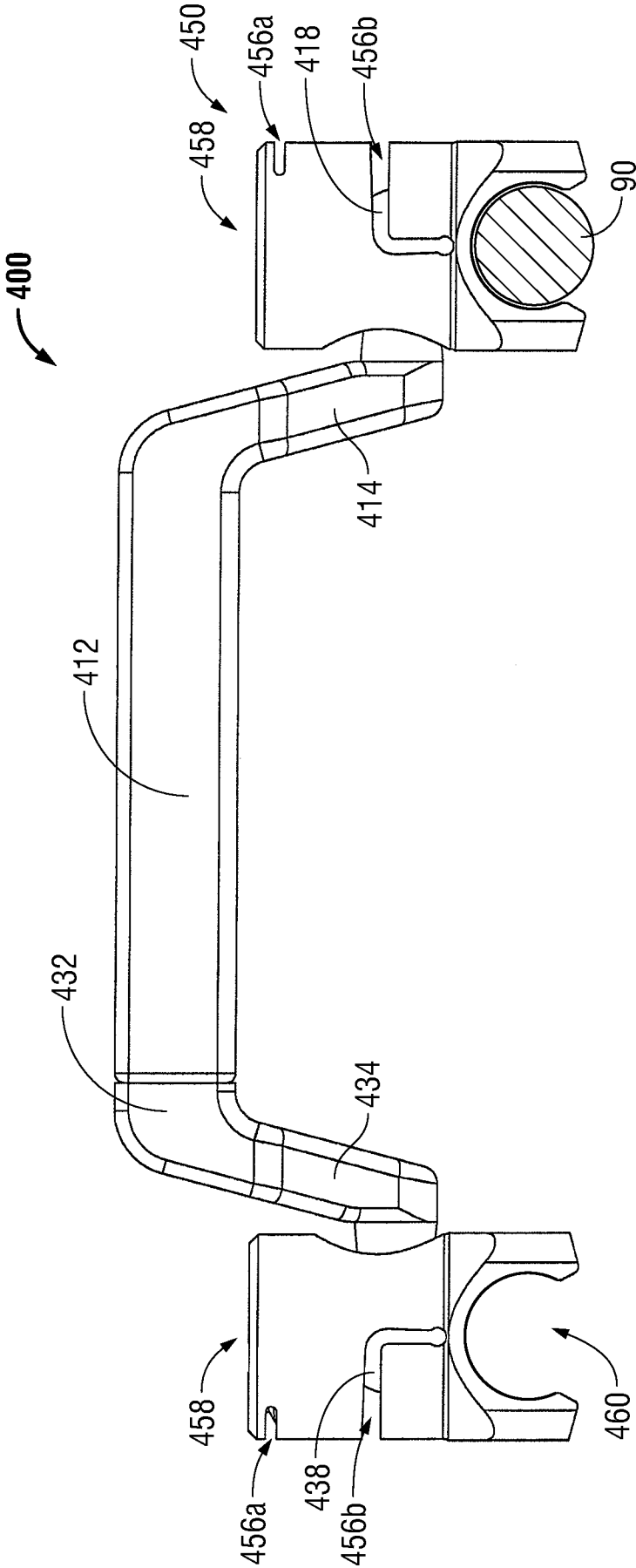


FIG. 12B

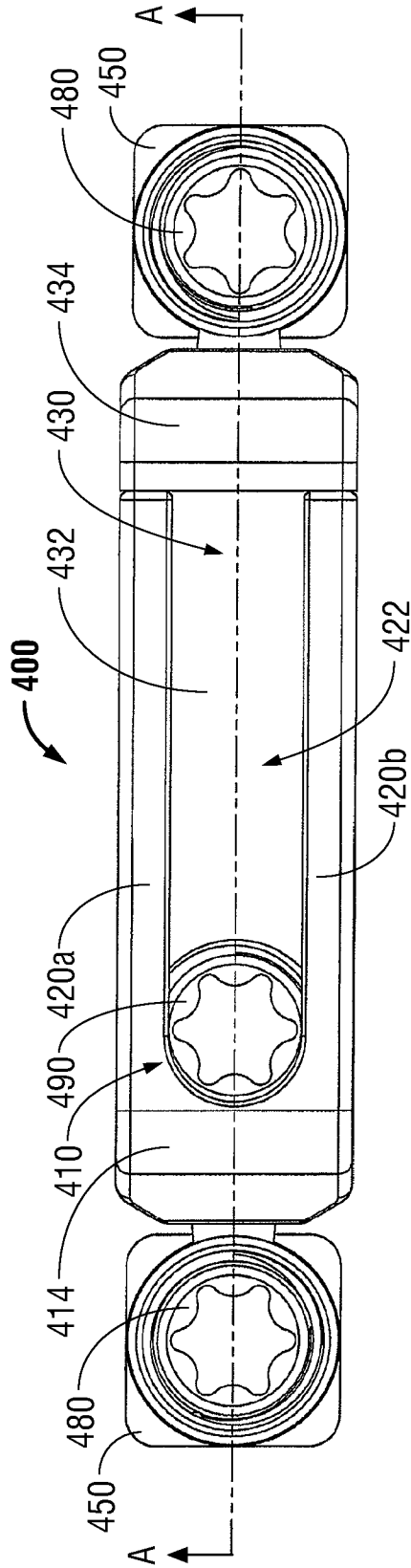


FIG. 12C

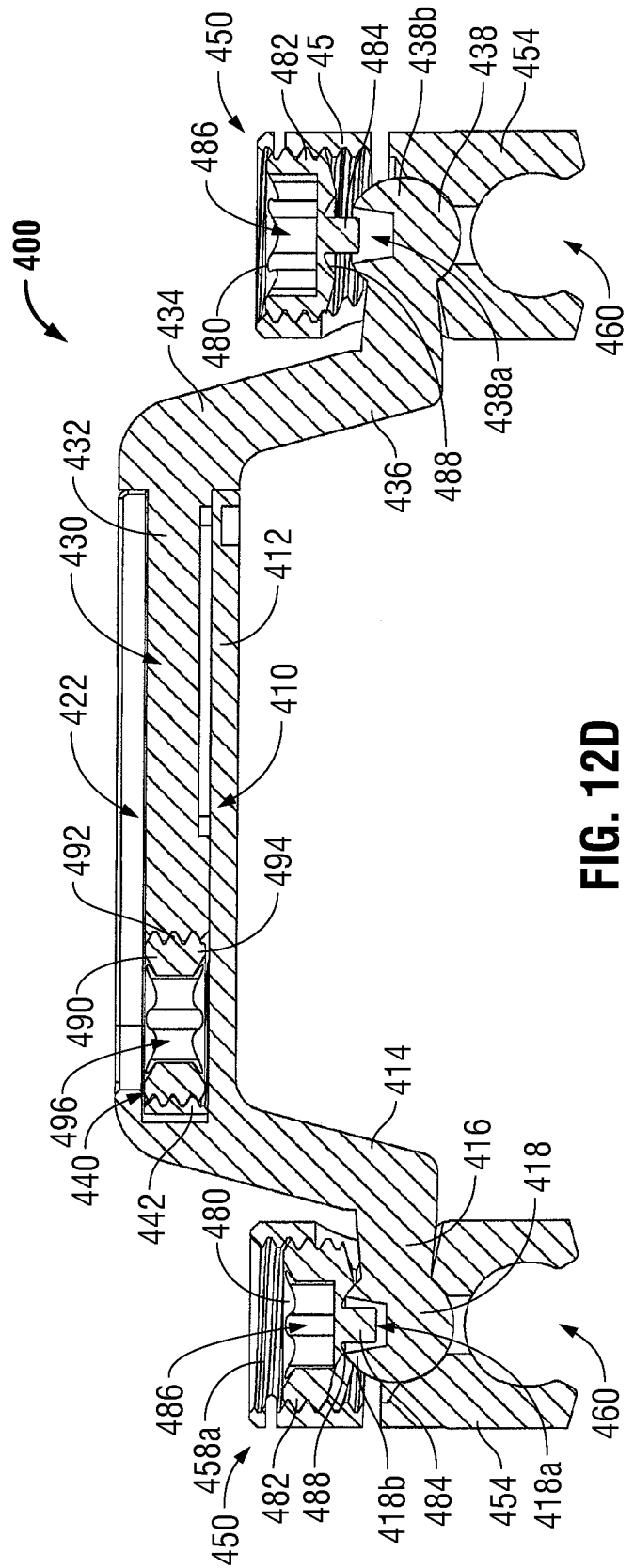


FIG. 12D

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2010/041693

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61B 17/70 (2010.01)

USPC - 606/260

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - A61B 17/70 (2010.01)

USPC - 606/250-253, 258-260

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

MicroPatent, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/0306538 A1 (MOORE et al) 11 December 2008 (11.12.2008) entire document	1-5, 8, 11
---		-----
Y		6, 9, 10, 13
Y	US 5,601,554 A (HOWLAND et al) 11 February 1997 (11.02.1997) entire document	6
Y	US 2006/0052785 A1 (AUGOSTINO et al) 09 March 2006 (09.03.2006) entire document	9, 10, 13
A	US 2006/0259038 A1 (CORDARO) 16 November 2006 (16.11.2006) entire document	1-6, 8-11, 13

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 August 2010

Date of mailing of the international search report

01 SEP 2010

Name and mailing address of the ISA/US

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Facsimile No. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2010/041693

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 7, 12
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.