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(54) **EXPANDABLE SPINAL INTERBODY SPACER AND METHOD OF USE**

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U.S. Applications:
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(51) **Int. Cl.**
A61F 2/44 (2006.01)
A61F 2/46 (2006.01)
A61F 2/30 (2006.01)

(52) **U.S. Cl.**
CPC .... ***A61F 2/442*** (2013.01); ***A61F 2/30771*** (2013.01); ***A61F 2/4455*** (2013.01); (Continued)

(58) **Field of Classification Search**
CPC A61F 2/4425; A61F 2002/443; A61F 2/4455; A61F 2/4611; A61F 2/4405
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,554,191 A 9/1996 Lahille et al.
5,665,122 A 9/1997 Kambin
(Continued)

FOREIGN PATENT DOCUMENTS

FR 2 717 068 A1 9/1995
WO 2014145766 A1 9/2014
(Continued)

OTHER PUBLICATIONS

European Search Report dated Aug. 7, 2017 issued in corresponding European Application No. 7157602.8-1501.
(Continued)

Primary Examiner — Cary E Wehner
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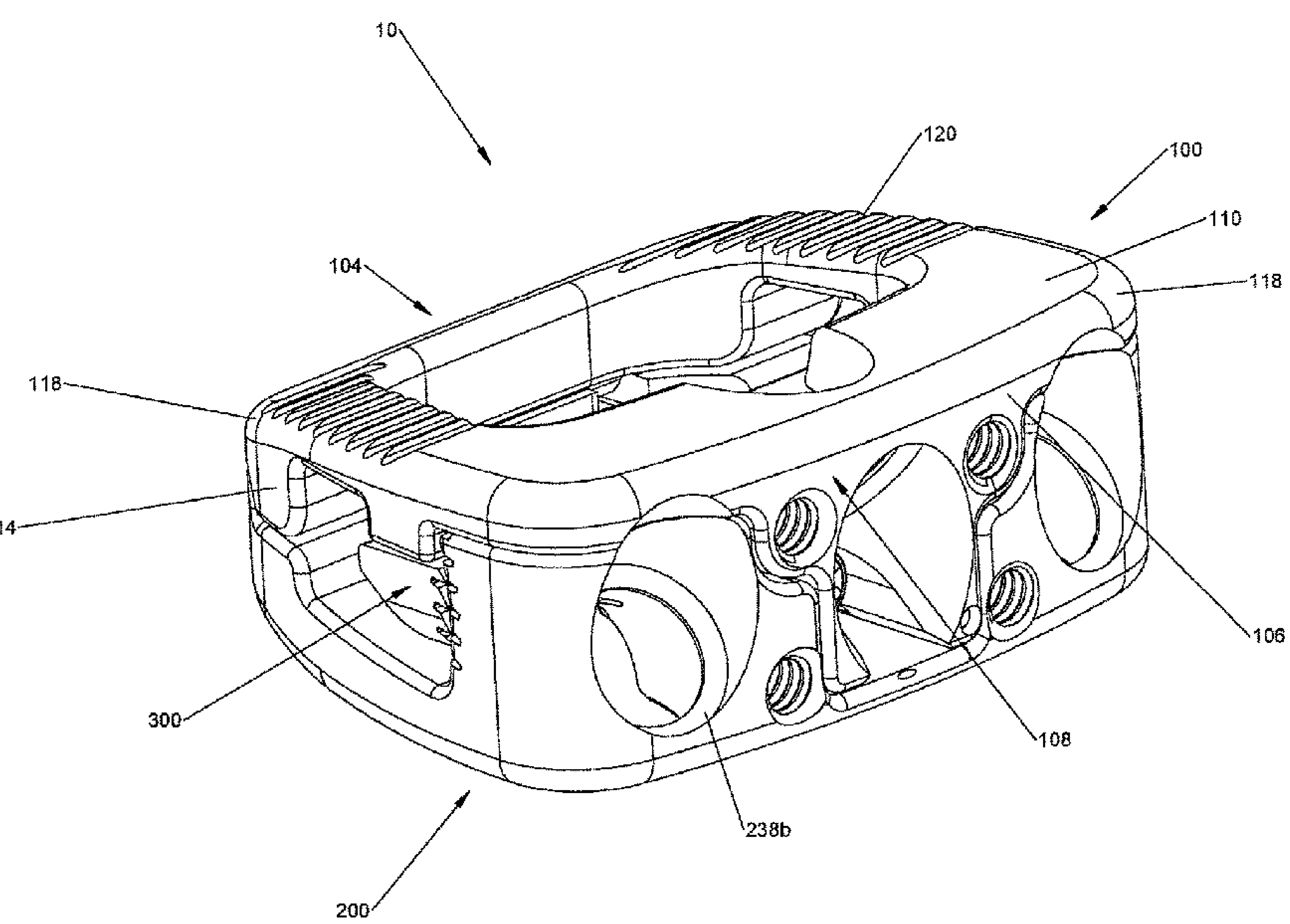
(57) **ABSTRACT**

An expandable spinal implant configured for positioning within a space between adjacent vertebral bodies includes an upper body, a lower body, a ratchet mechanism, and a plurality of bone screws. The upper body and lower body are pivotably affixed at a first end and are capable of movement relative to each other. The ratchet mechanism is slidably disposed on one of the upper and lower body and is capable of engaging the opposite one of the upper and lower body thereby permitting movement of the upper and lower body relative to each other in a first direction, but not in a second direction. An insertion instrument capable of being attached to the expandable spinal instrument and a method of performing spinal surgery is also disclosed.

18 Claims, 18 Drawing Sheets



(52) **U.S. Cl.**
CPC ... ***A61F 2/4611*** (2013.01); *A61F 2002/30172* (2013.01); *A61F 2002/30383* (2013.01); *A61F 2002/30398* (2013.01); *A61F 2002/30405* (2013.01); *A61F 2002/30471* (2013.01); *A61F 2002/30487* (2013.01); *A61F 2002/30522* (2013.01); *A61F 2002/30538* (2013.01); *A61F 2002/30579* (2013.01); *A61F 2002/30593* (2013.01); *A61F 2002/30787* (2013.01); *A61F 2002/30797* (2013.01); *A61F 2002/30904* (2013.01); *A61F 2002/4627* (2013.01); *A61F 2220/0016* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,102,950	A	8/2000	Vaccaro
6,159,244	A	12/2000	Suddaby
6,174,334	B1	1/2001	Suddaby
6,176,882	B1	1/2001	Biedermann et al.
6,190,414	B1	2/2001	Young et al.
6,200,348	B1	3/2001	Biedermann et al.
6,332,895	B1	12/2001	Suddaby
6,395,031	B1	5/2002	Foley et al.
6,409,766	B1	6/2002	Brett
6,436,140	B1	8/2002	Liu et al.
6,443,989	B1	9/2002	Jackson
6,454,807	B1	9/2002	Jackson
6,491,724	B1	12/2002	Ferree
6,576,016	B1	6/2003	Hochshuler et al.
6,641,614	B1	11/2003	Wagner et al.
6,685,742	B1	2/2004	Jackson
6,709,458	B2	3/2004	Michelson
6,716,247	B2	4/2004	Michelson
6,773,460	B2	8/2004	Jackson
6,808,537	B2	10/2004	Michelson
6,814,756	B1	11/2004	Michelson
6,835,206	B2	12/2004	Jackson
6,852,129	B2	2/2005	Gerbec et al.
6,863,673	B2	3/2005	Gerbec et al.
6,962,606	B2	11/2005	Michelson
6,972,035	B2	12/2005	Michelson
7,008,453	B1	3/2006	Michelson
7,044,971	B2	5/2006	Suddaby
7,118,579	B2	10/2006	Michelson
7,211,112	B2	5/2007	Baynham et al.
7,217,291	B2	5/2007	Zucherman et al.
7,217,293	B2	5/2007	Branch, Jr.
7,588,573	B2	9/2009	Berry
7,618,458	B2	11/2009	Biedermann et al.
7,655,027	B2	2/2010	Michelson
7,678,148	B2	3/2010	Peterman
7,691,147	B2	4/2010	Gutlin et al.
7,708,779	B2	5/2010	Edie et al.
7,722,674	B1	5/2010	Grotz
7,731,751	B2	6/2010	Butler et al.
7,771,473	B2	8/2010	Thramann
7,776,091	B2	8/2010	Mastrorio et al.
7,794,501	B2	9/2010	Edie et al.
7,799,081	B2	9/2010	McKinley
7,828,849	B2	11/2010	Lim
7,850,733	B2	12/2010	Baynham et al.
7,883,542	B2	2/2011	Zipnick
7,909,870	B2	3/2011	Kraus
7,922,729	B2	4/2011	Michelson
7,967,867	B2	6/2011	Barreiro et al.
8,062,366	B2	11/2011	Melkent
8,062,375	B2	11/2011	Glerum et al.
8,075,621	B2	12/2011	Michelson
8,097,034	B2	1/2012	Michelson
8,105,382	B2	1/2012	Olmos et al.
8,110,004	B2	2/2012	Valdevit et al.
8,118,871	B2	2/2012	Gordon et al.
8,123,810	B2	2/2012	Gordon et al.
8,133,232	B2	3/2012	Levy et al.
8,137,405	B2	3/2012	Kostuik et al.
8,147,550	B2	4/2012	Gordon et al.
8,152,851	B2	4/2012	Mueller et al.
8,152,852	B2	4/2012	Biyani
8,172,903	B2	5/2012	Gordon et al.
8,182,537	B2	5/2012	Refai et al.
8,187,331	B2	5/2012	Strohkirch, Jr. et al.
8,192,495	B2	6/2012	Simpson et al.
8,197,546	B2	6/2012	Doubler et al.
8,211,178	B2	7/2012	Melkent et al.
8,221,502	B2	7/2012	Branch, Jr.
8,231,656	B2	7/2012	Lee et al.
8,257,440	B2	9/2012	Gordon et al.
8,257,442	B2	9/2012	Edie et al.
8,273,126	B2	9/2012	Lindner
8,303,663	B2	11/2012	Jimenez et al.
8,308,802	B2	11/2012	Rhoda et al.
8,328,871	B2	12/2012	Capote et al.
8,337,558	B2	12/2012	Lindner
8,337,559	B2	12/2012	Hansell et al.
8,349,014	B2	1/2013	Barreiro et al.
8,353,961	B2	1/2013	McClintock et al.
8,366,777	B2	2/2013	Matthis et al.
8,382,842	B2	2/2013	Greenhalgh et al.
8,394,143	B2	3/2013	Grotz et al.
8,398,713	B2	3/2013	Weiman
8,425,608	B2	4/2013	Dewey et al.
8,435,296	B2	5/2013	Kadaba et al.
8,480,738	B2	7/2013	Edie et al.
8,496,706	B2	7/2013	Ragab et al.
8,512,406	B2	8/2013	White et al.
8,518,114	B2	8/2013	Marik
8,628,578	B2	1/2014	Miller et al.
8,663,329	B2	3/2014	Ernst
8,679,183	B2	3/2014	Glerum et al.
8,721,723	B2	5/2014	Hansell et al.
8,795,366	B2	8/2014	Varela
8,845,733	B2	9/2014	O'Neil et al.
8,894,711	B2	11/2014	Varela
9,034,045	B2	5/2015	Davenport et al.
9,198,769	B2	12/2015	Perrow et al.
9,271,846	B2	3/2016	Lim et al.
9,393,130	B2	7/2016	Suddaby et al.
9,572,680	B2	2/2017	Theofilos et al.
9,585,762	B2	3/2017	Suddaby et al.
9,839,528	B2	12/2017	Weiman et al.
9,872,777	B2	1/2018	Ganter et al.
2002/0068976	A1	6/2002	Jackson
2002/0128712	A1 *	9/2002	Michelson A61F 2/446 623/17.11
2002/0128713	A1	9/2002	Ferree
2002/0177897	A1	11/2002	Michelson
2004/0059421	A1	3/2004	Glenn et al.
2004/0087947	A1	5/2004	Lim et al.
2004/0249461	A1	12/2004	Ferree
2004/0254643	A1	12/2004	Jackson
2005/0015149	A1	1/2005	Michelson
2005/0125061	A1	6/2005	Zucherman et al.
2006/0030943	A1	2/2006	Peterman
2006/0122701	A1	6/2006	Kiester
2006/0167547	A1	7/2006	Suddaby
2006/0195095	A1	8/2006	Mueller et al.
2006/0200244	A1	9/2006	Assaker
2007/0016221	A1	1/2007	Beyersdorff et al.
2007/0270964	A1	11/2007	Strohkirch et al.
2008/0004705	A1	1/2008	Rogeau et al.
2008/0045968	A1	2/2008	Yu et al.
2009/0099568	A1	4/2009	Lowry et al.
2009/0204215	A1	8/2009	McClintock et al.
2009/0281625	A1	11/2009	Enayati
2010/0057208	A1	3/2010	Dryer et al.
2010/0094424	A1	4/2010	Woodburn et al.
2010/0145455	A1	6/2010	Simpson et al.
2010/0262247	A1	10/2010	Amin
2010/0280616	A1	11/2010	Frasier
2010/0286777	A1	11/2010	Errico et al.
2010/0324687	A1	12/2010	Melkent et al.
2011/0172774	A1	7/2011	Varela
2011/0319997	A1	12/2011	Glerum et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2012/0029636	A1*	2/2012	Ragab	A61F 2/447 623/17.11
2012/0029637	A1	2/2012	Ragab et al.	
2012/0185045	A1	7/2012	Morris et al.	
2012/0185049	A1	7/2012	Varela	
2012/0226357	A1	9/2012	Varela	
2012/0310350	A1	12/2012	Farris et al.	
2013/0116791	A1	5/2013	Theofilos	
2013/0158663	A1	6/2013	Miller et al.	
2013/0158664	A1	6/2013	Palmatier et al.	
2013/0197642	A1	8/2013	Ernst	
2013/0211526	A1	8/2013	Alheidt et al.	
2014/0188225	A1	7/2014	Dmuschewsky	
2014/0214166	A1	7/2014	Theofilos	
2014/0243982	A1	8/2014	Miller	
2014/0277479	A1	9/2014	Raymond et al.	
2014/0277502	A1*	9/2014	Schiffman	A61F 2/447 623/17.16
2014/0343678	A1	11/2014	Suddaby et al.	
2015/0012098	A1	1/2015	Eastlack et al.	
2015/0057755	A1*	2/2015	Suddaby	A61F 2/4425 623/17.16
2015/0250609	A1	9/2015	McLean et al.	
2016/0022433	A1	1/2016	Davenport	
2016/0100951	A1	4/2016	Suddaby et al.	

FOREIGN PATENT DOCUMENTS

WO	2015063721	A1	5/2015
WO	2016057940	A1	4/2016

OTHER PUBLICATIONS

European Search Report dated Dec. 12, 2016, issued in EP Application No. 14801054.

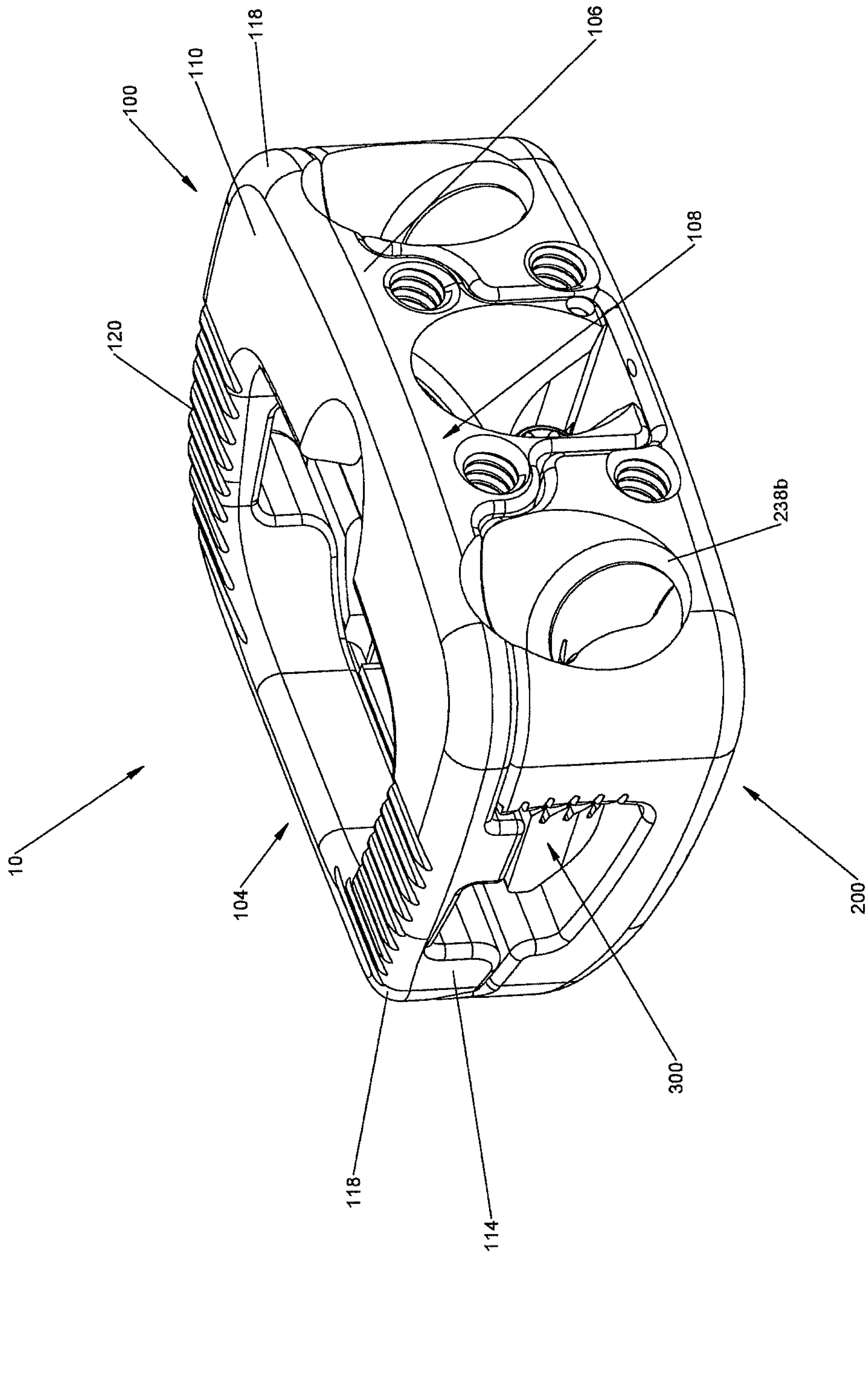
International Preliminary Report on Patentability dated Nov. 24, 2015, issued in PCT/US2014/038726.

International Search Report dated Sep. 30, 2014 issued in PCT/US2014/038726.

Australian Search Report for Application No. 2015330678, dated Jul. 5, 2019, p. 1.

International Search Report for PCT/US2015/054969 dated Jan. 8, 2016.

* cited by examiner



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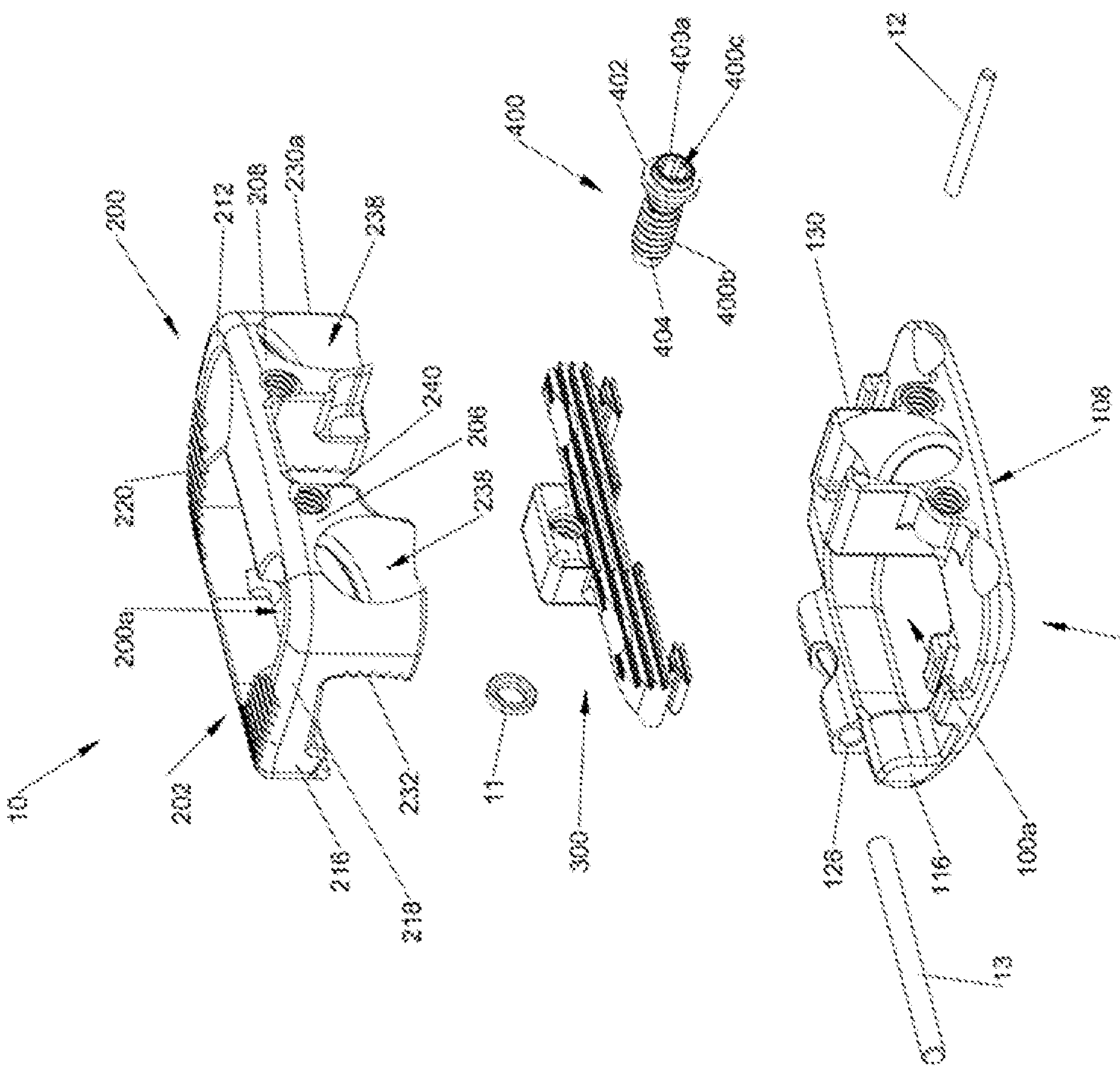

FIG. 2

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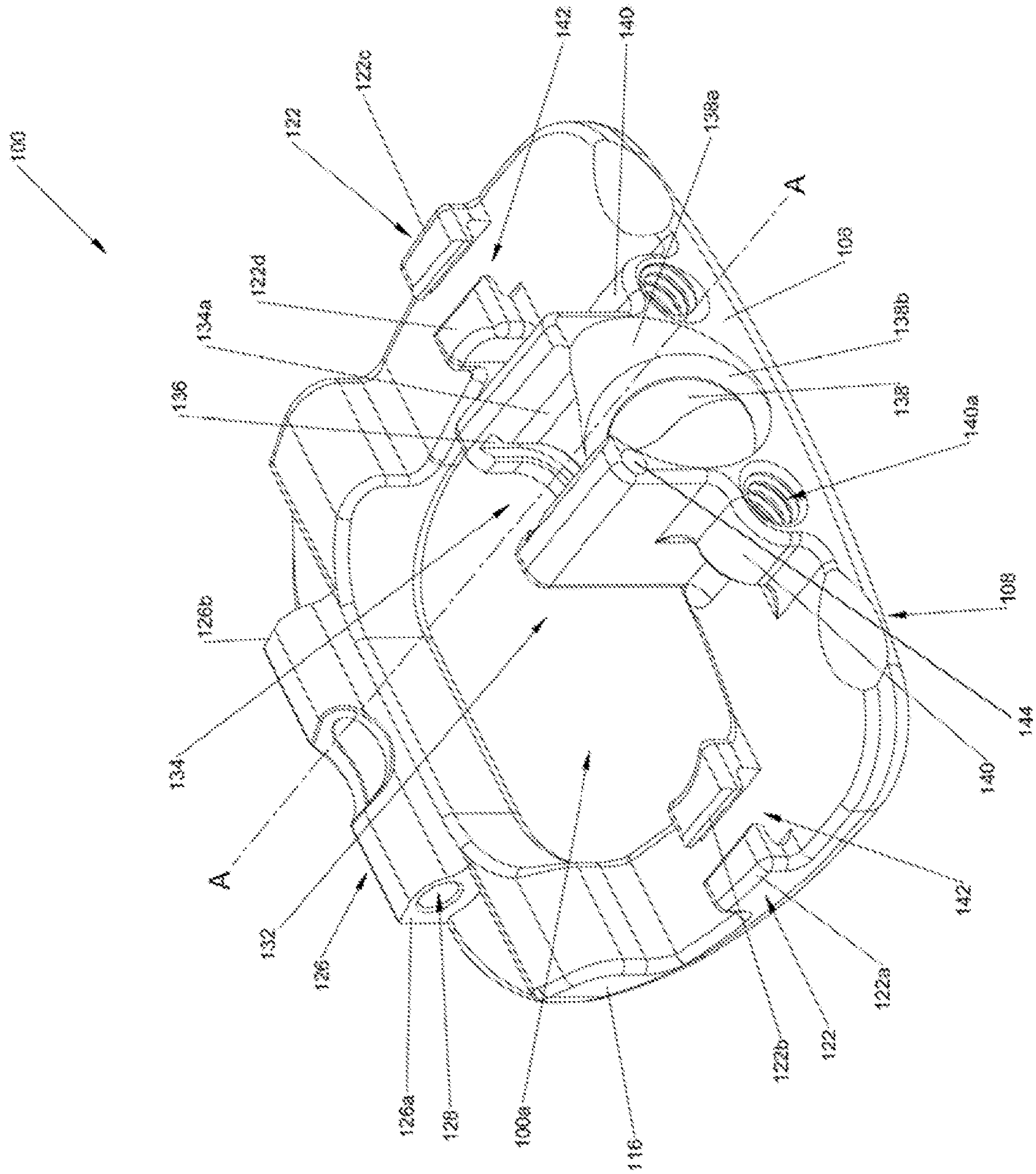

FIG. 2A

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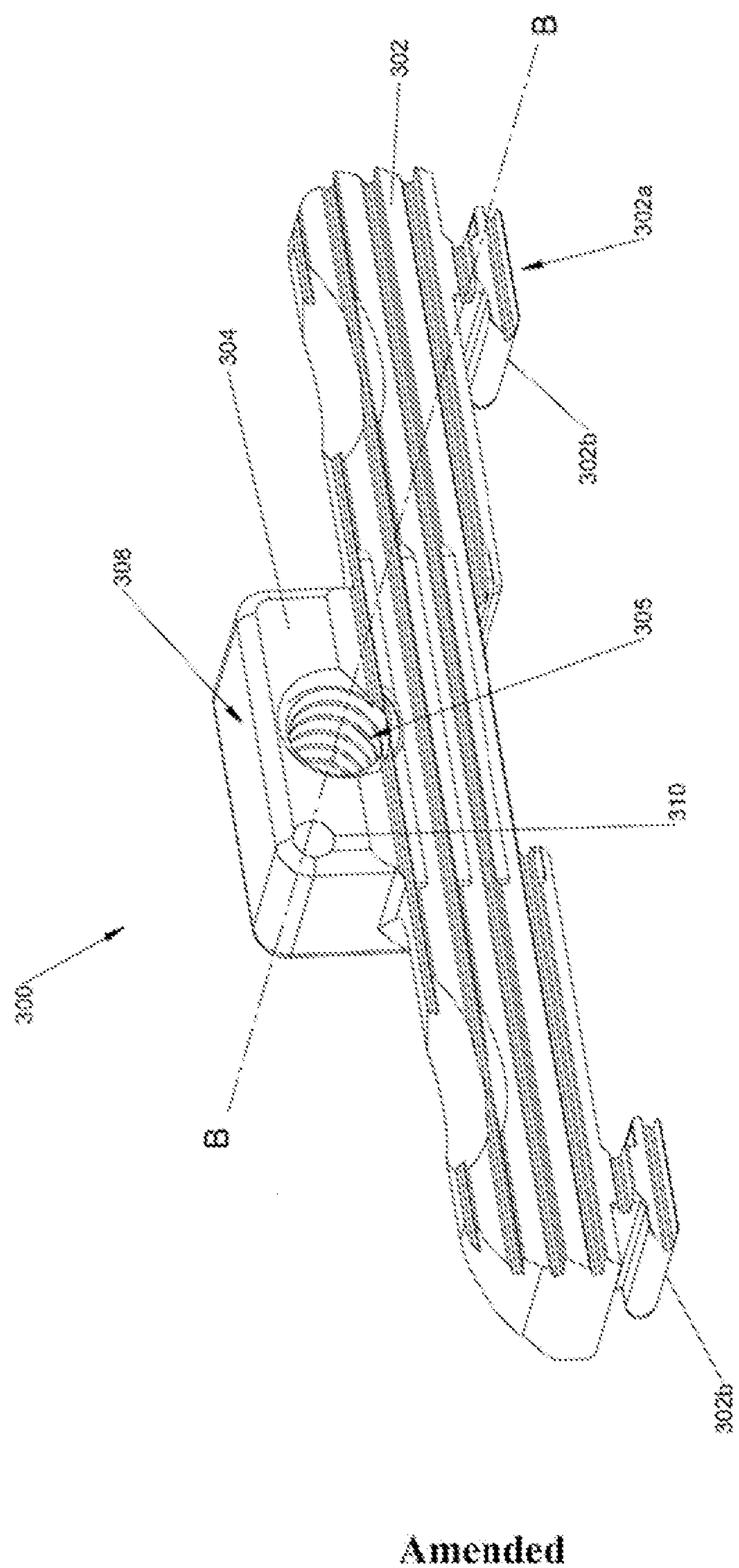

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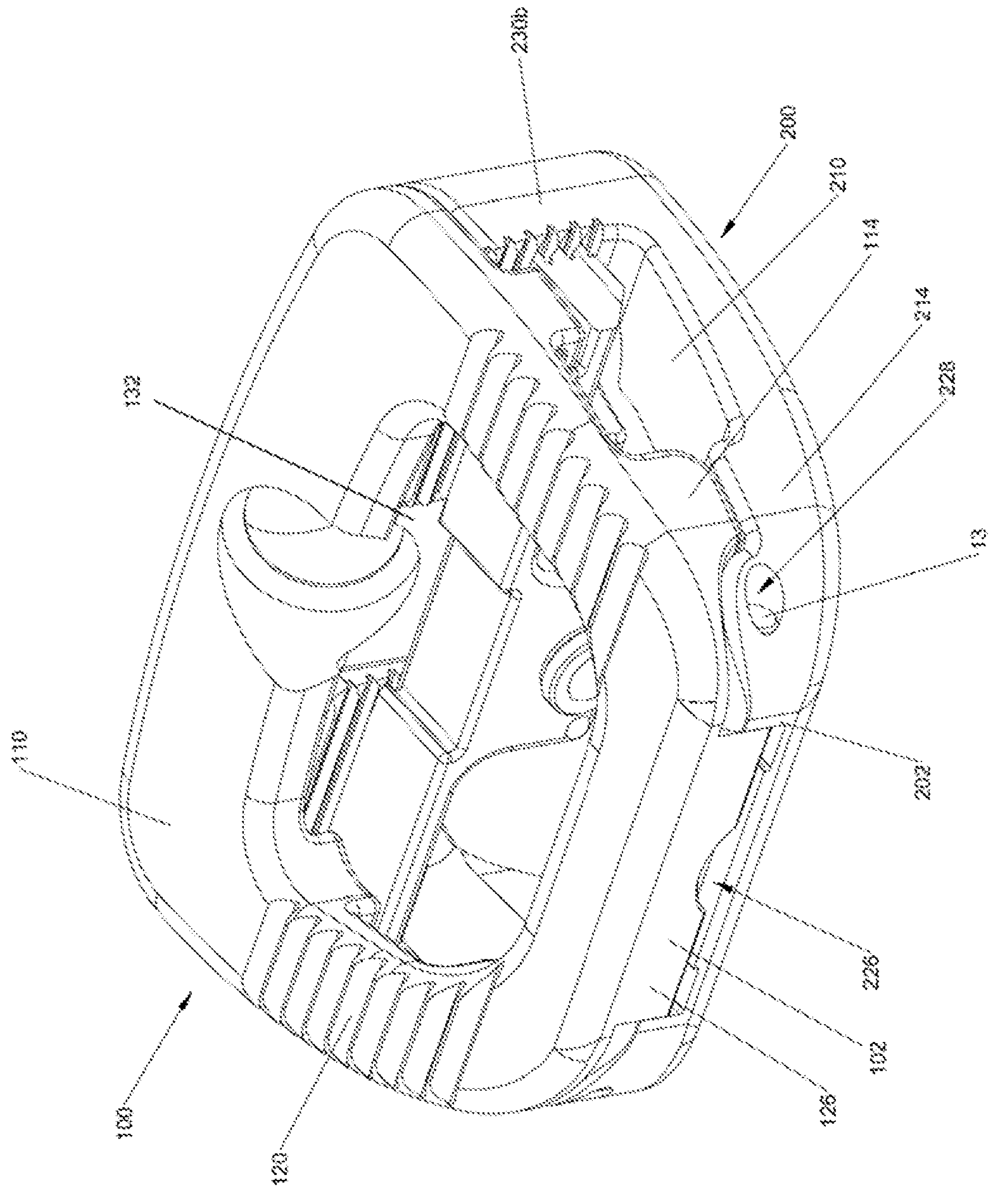

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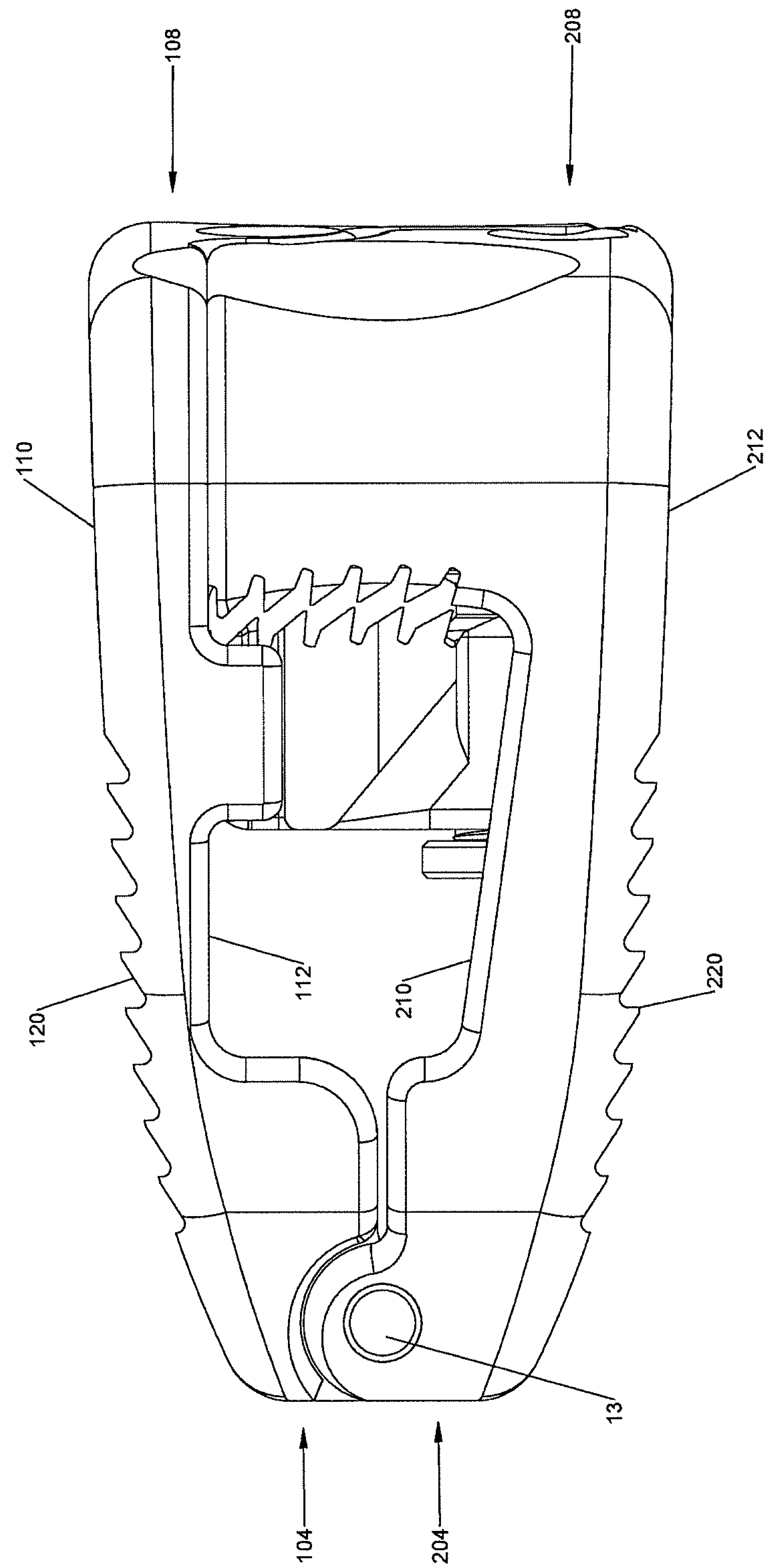

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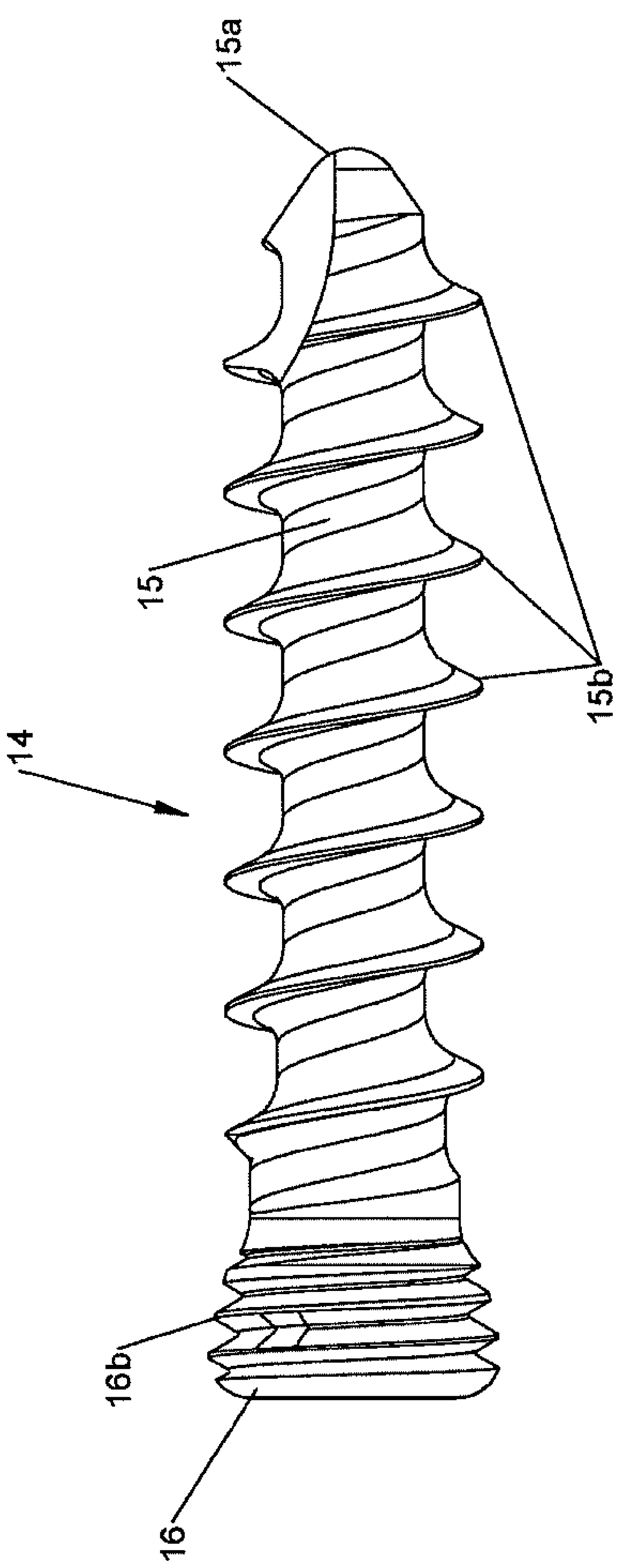


FIG. 6B

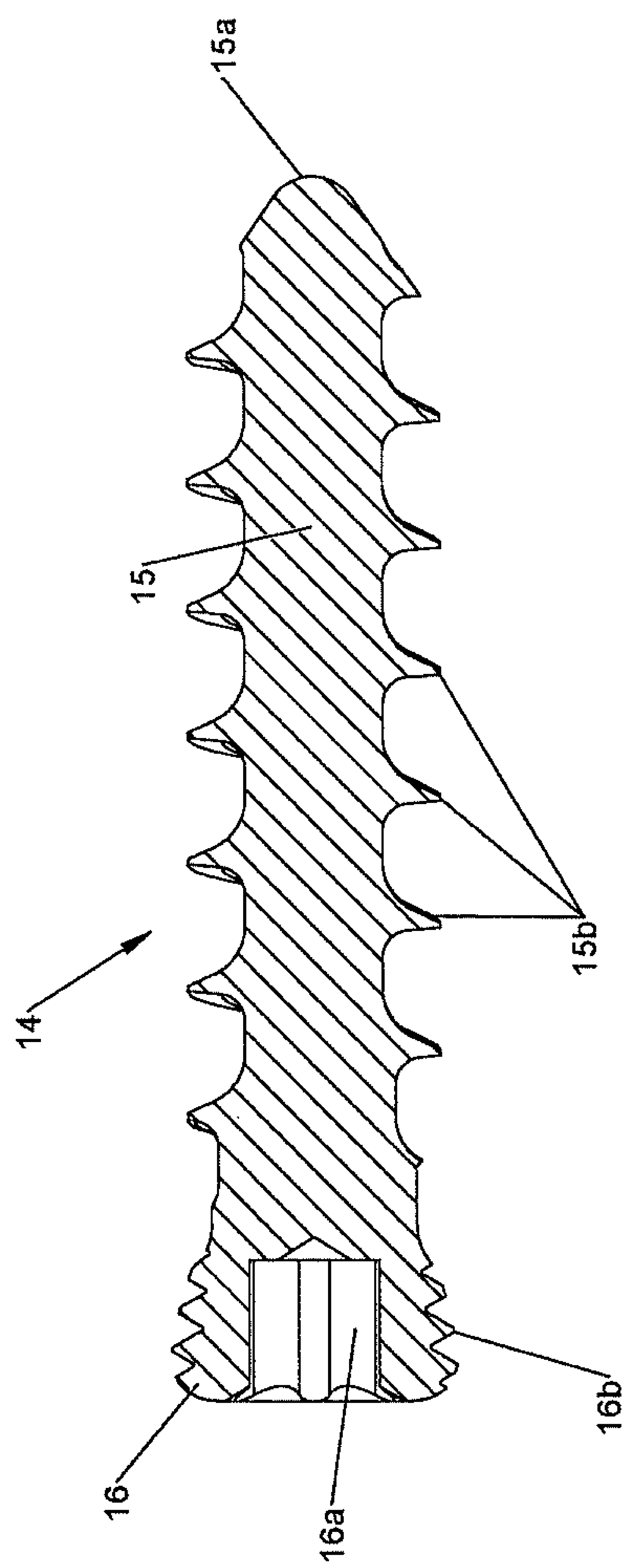


FIG. 6C

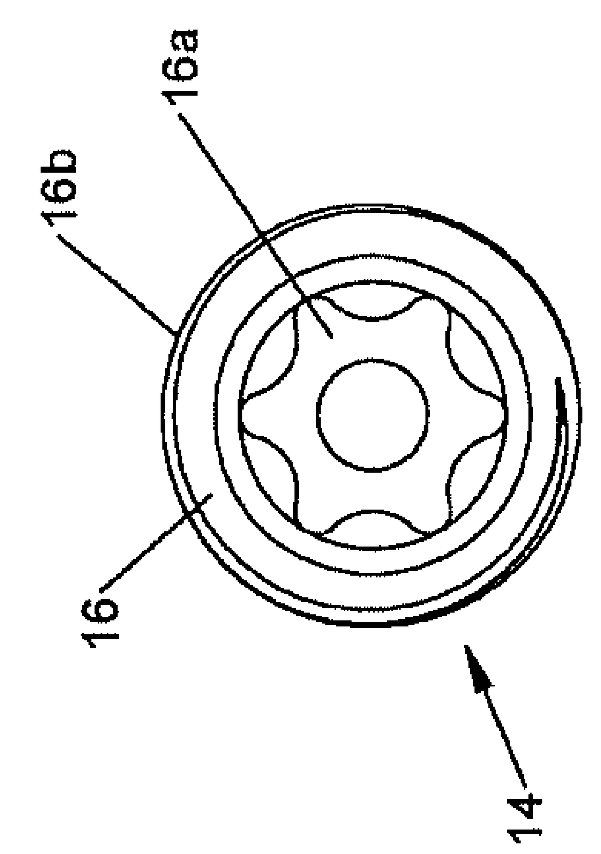
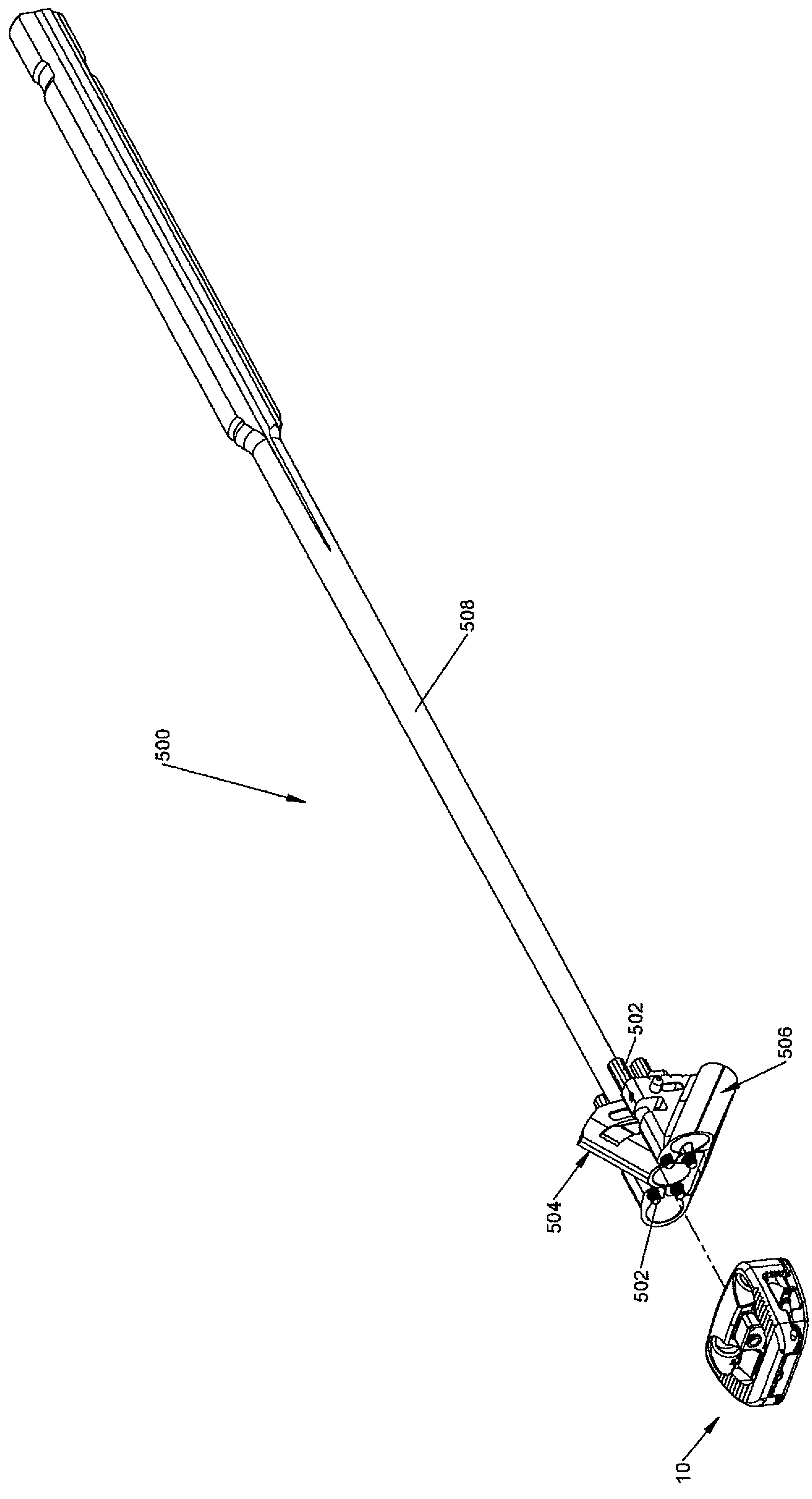


FIG. 6A



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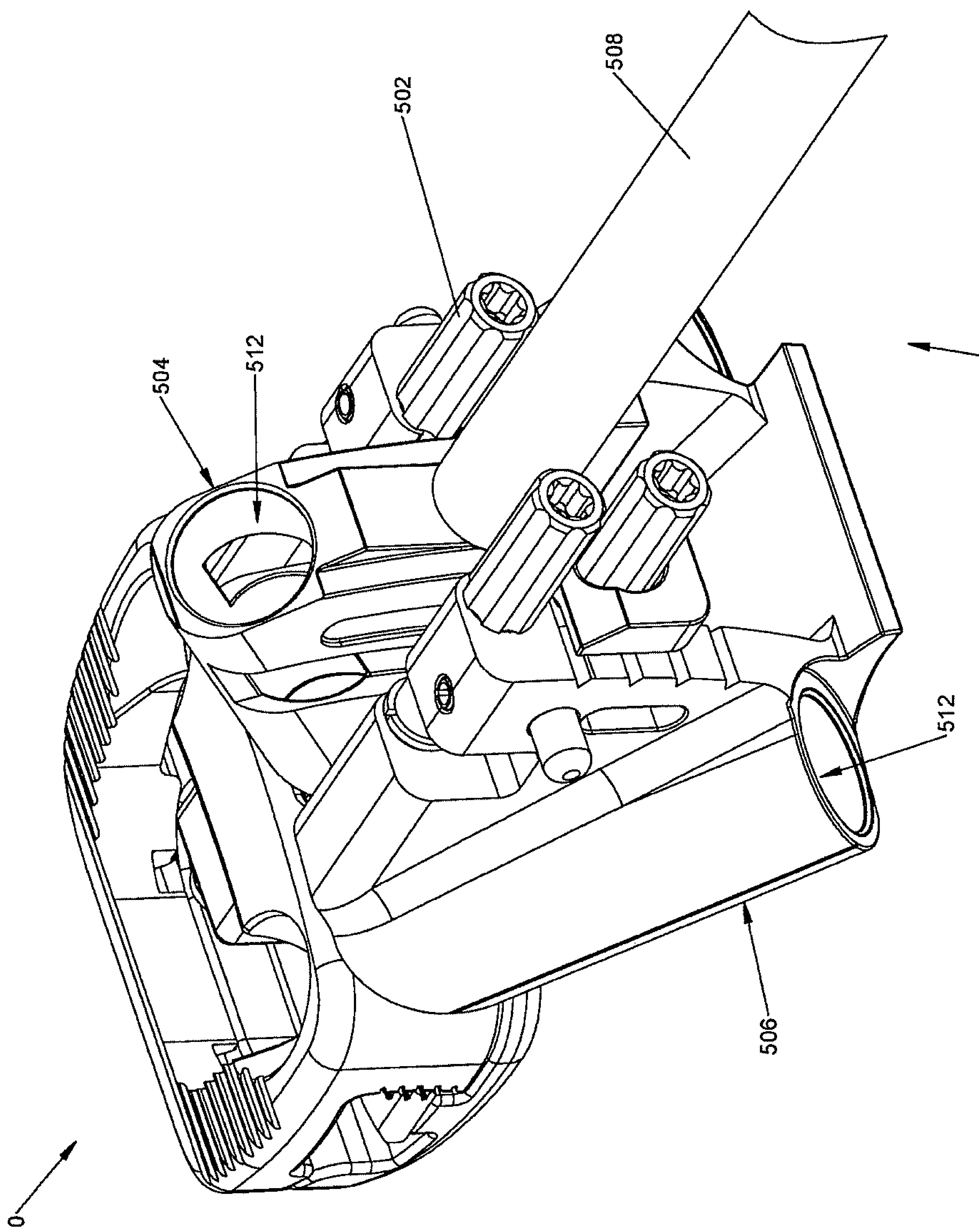

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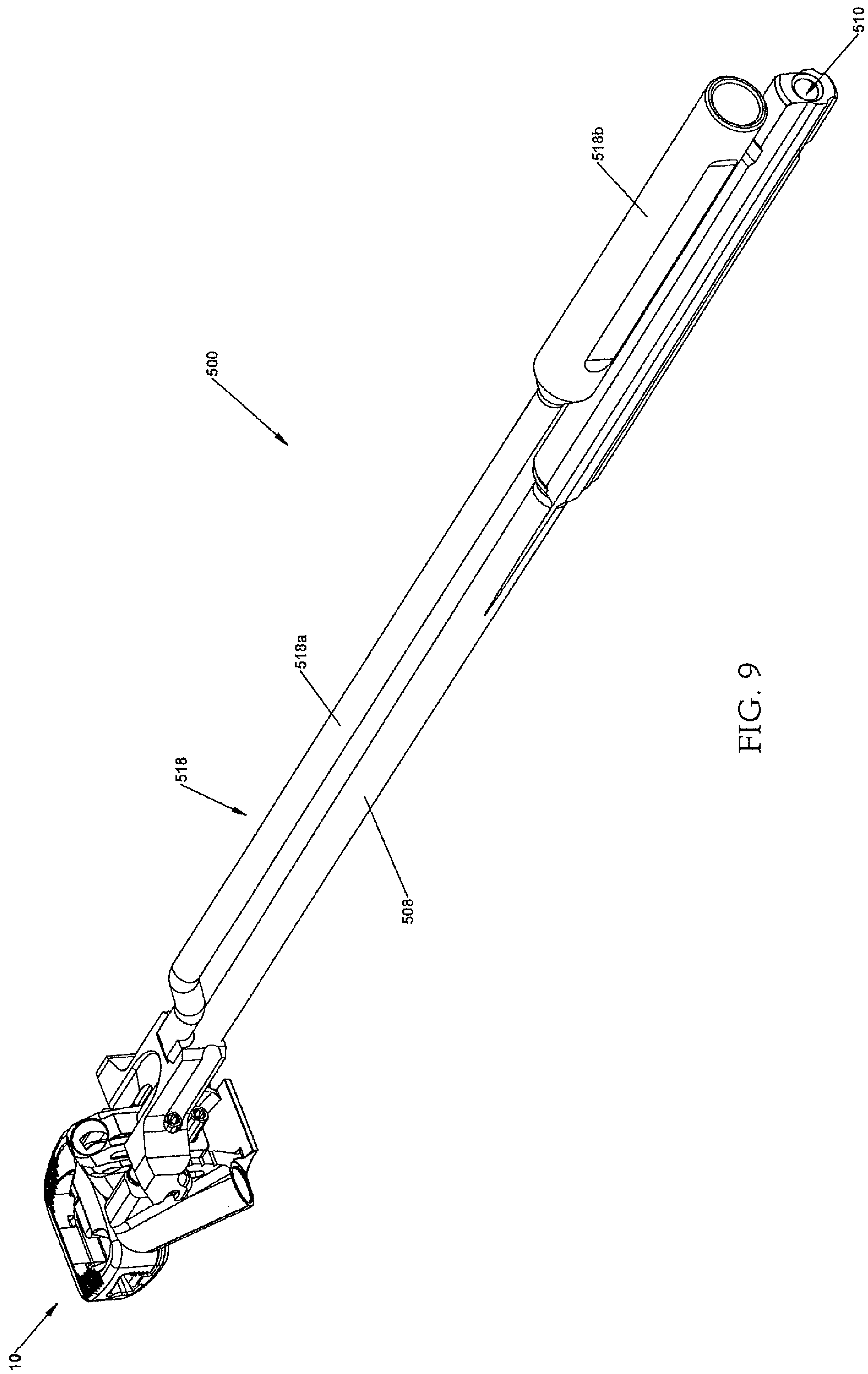
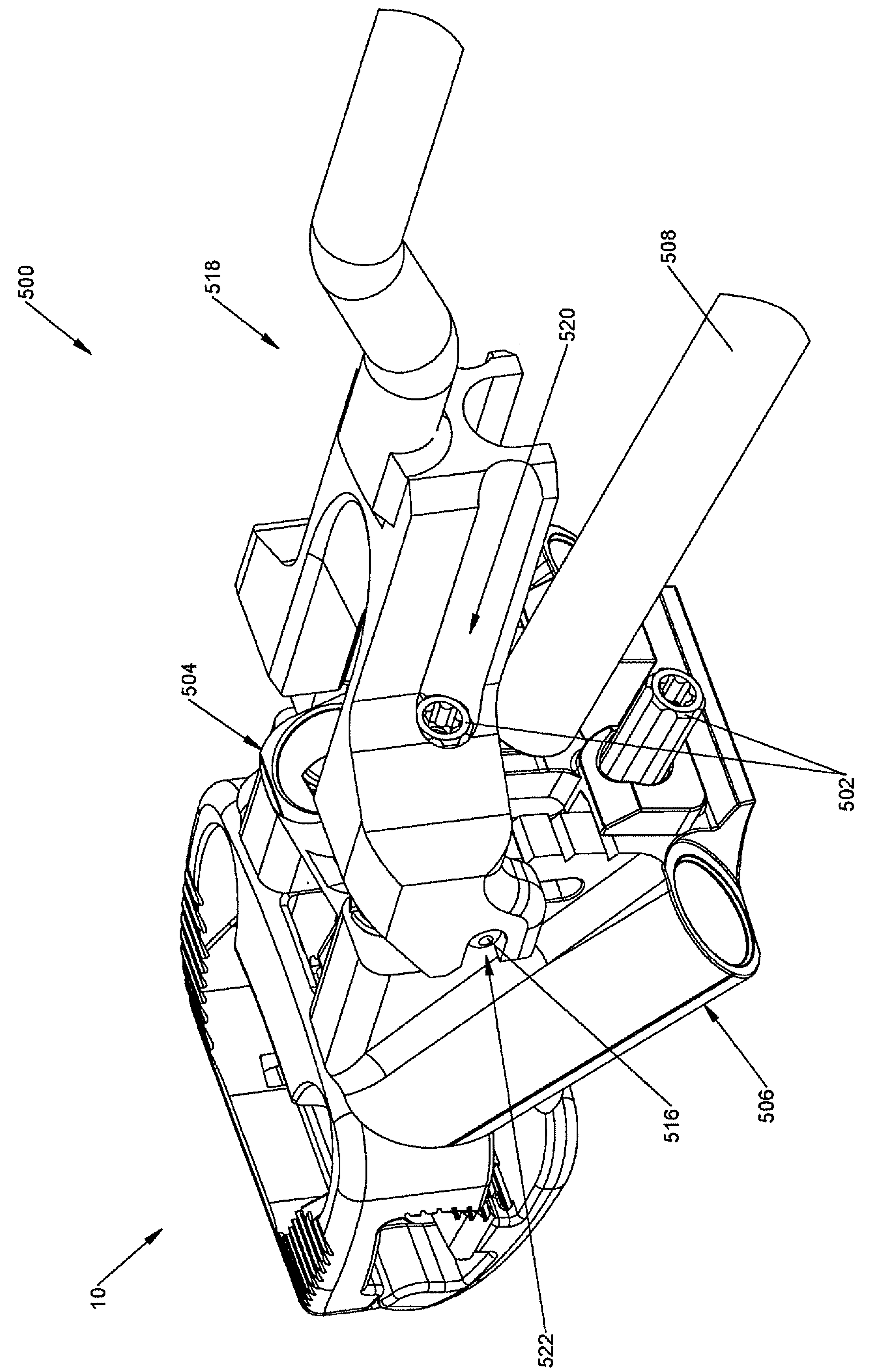


FIG. 9



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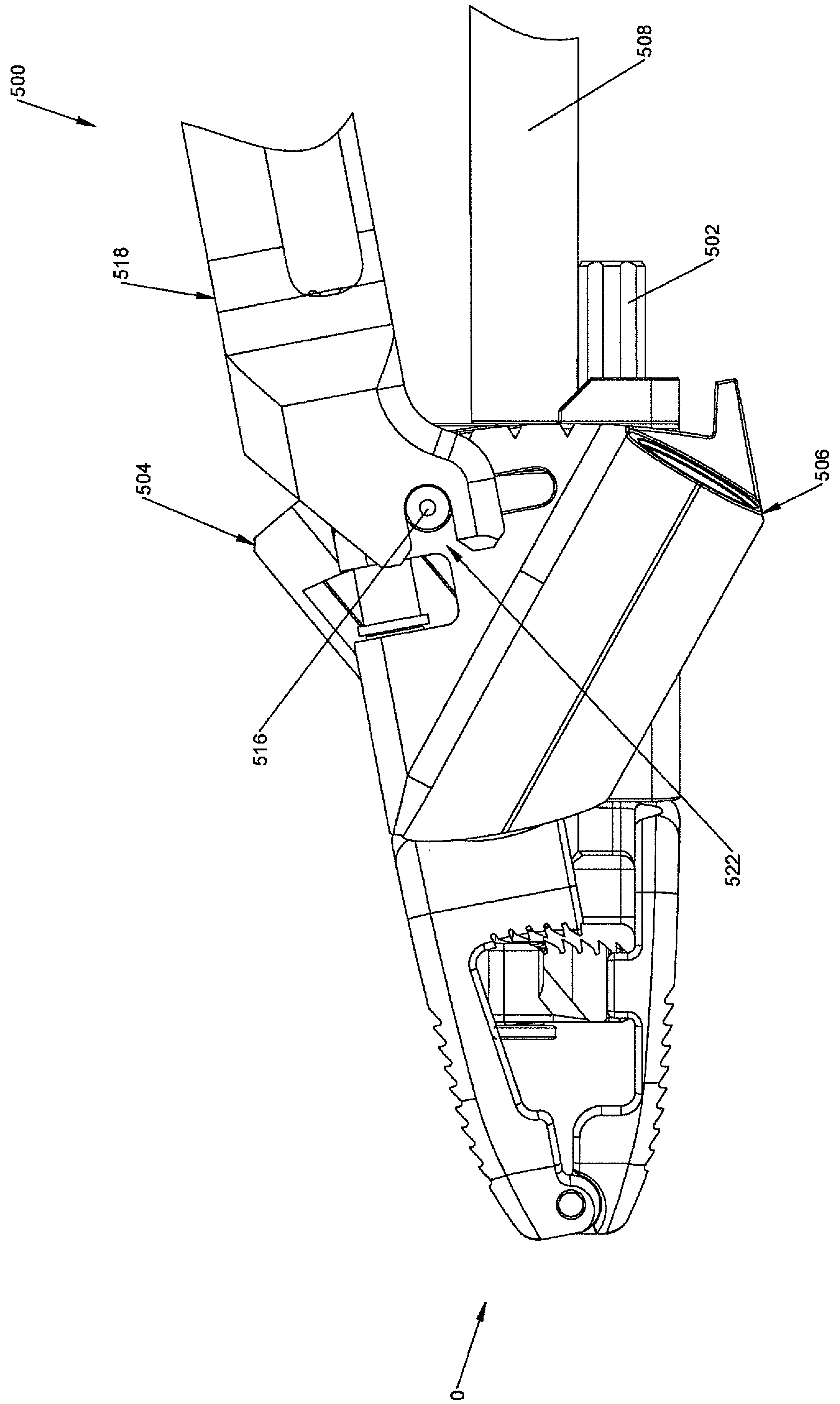
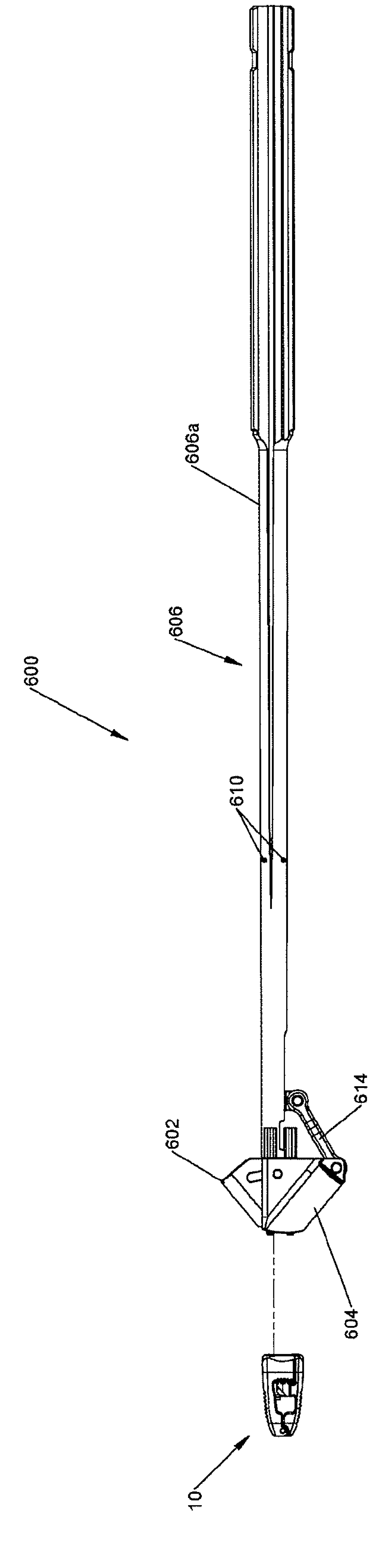


FIG. 11



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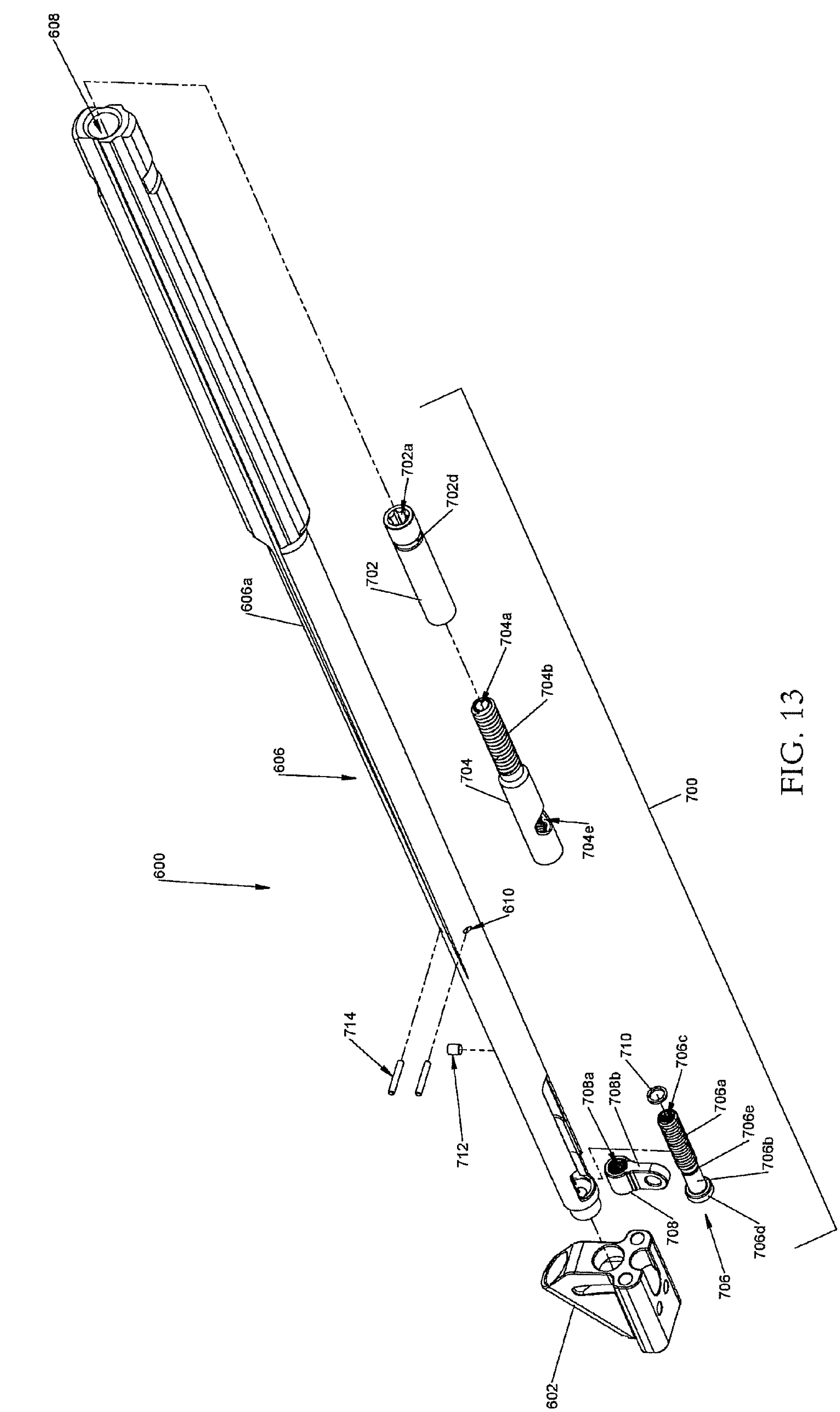
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FIG. 13

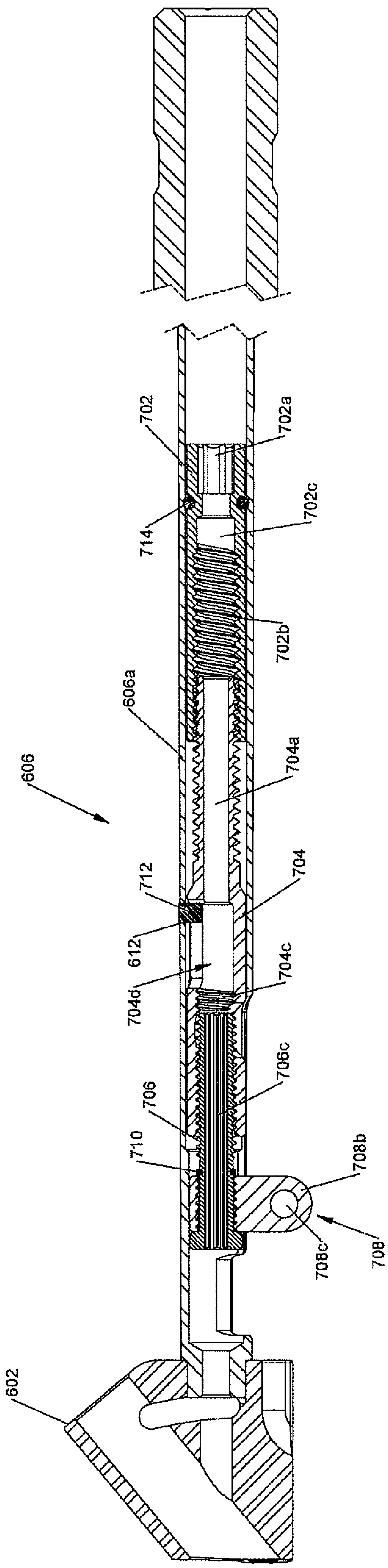
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FIG. 14

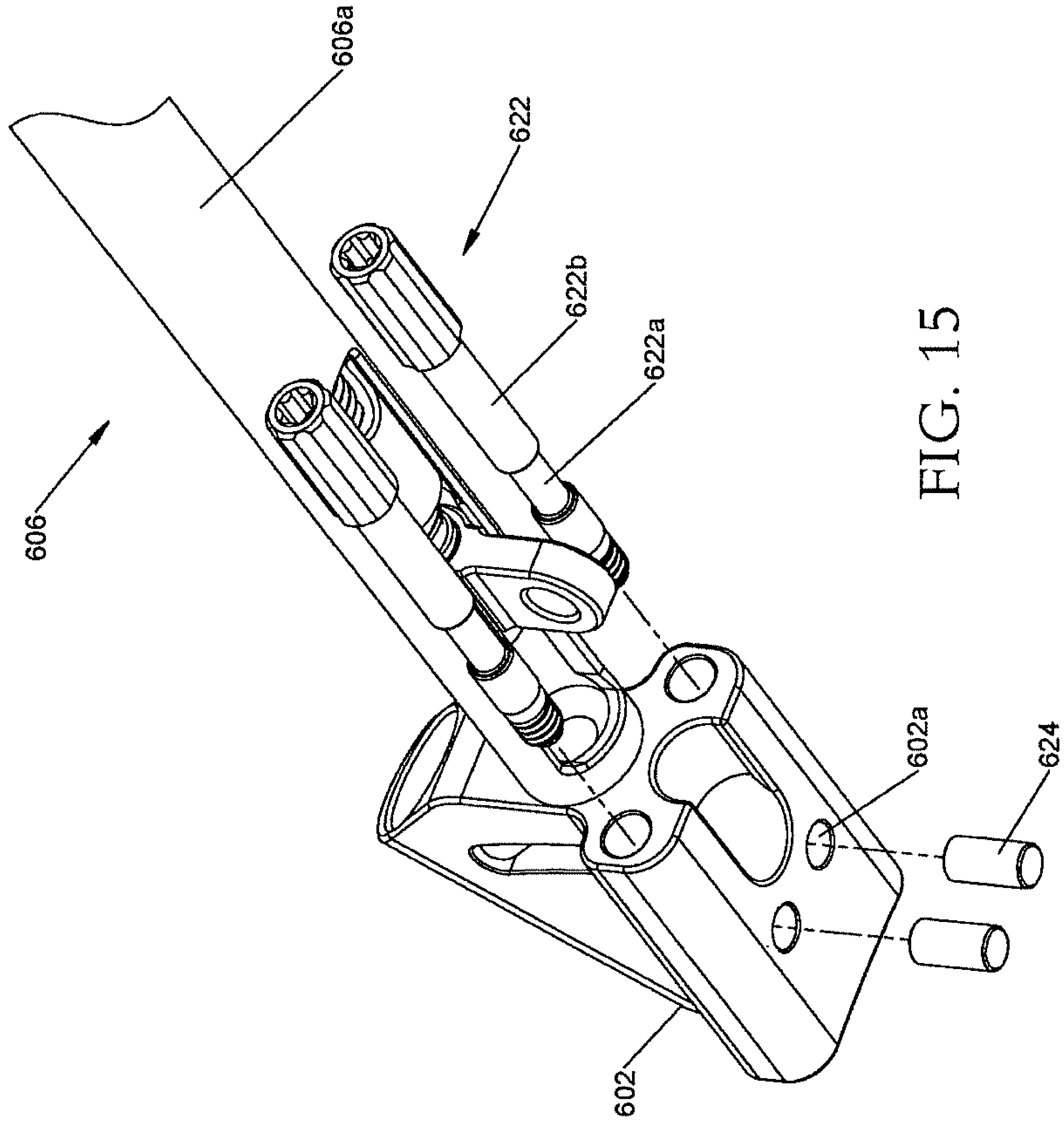

FIG. 15

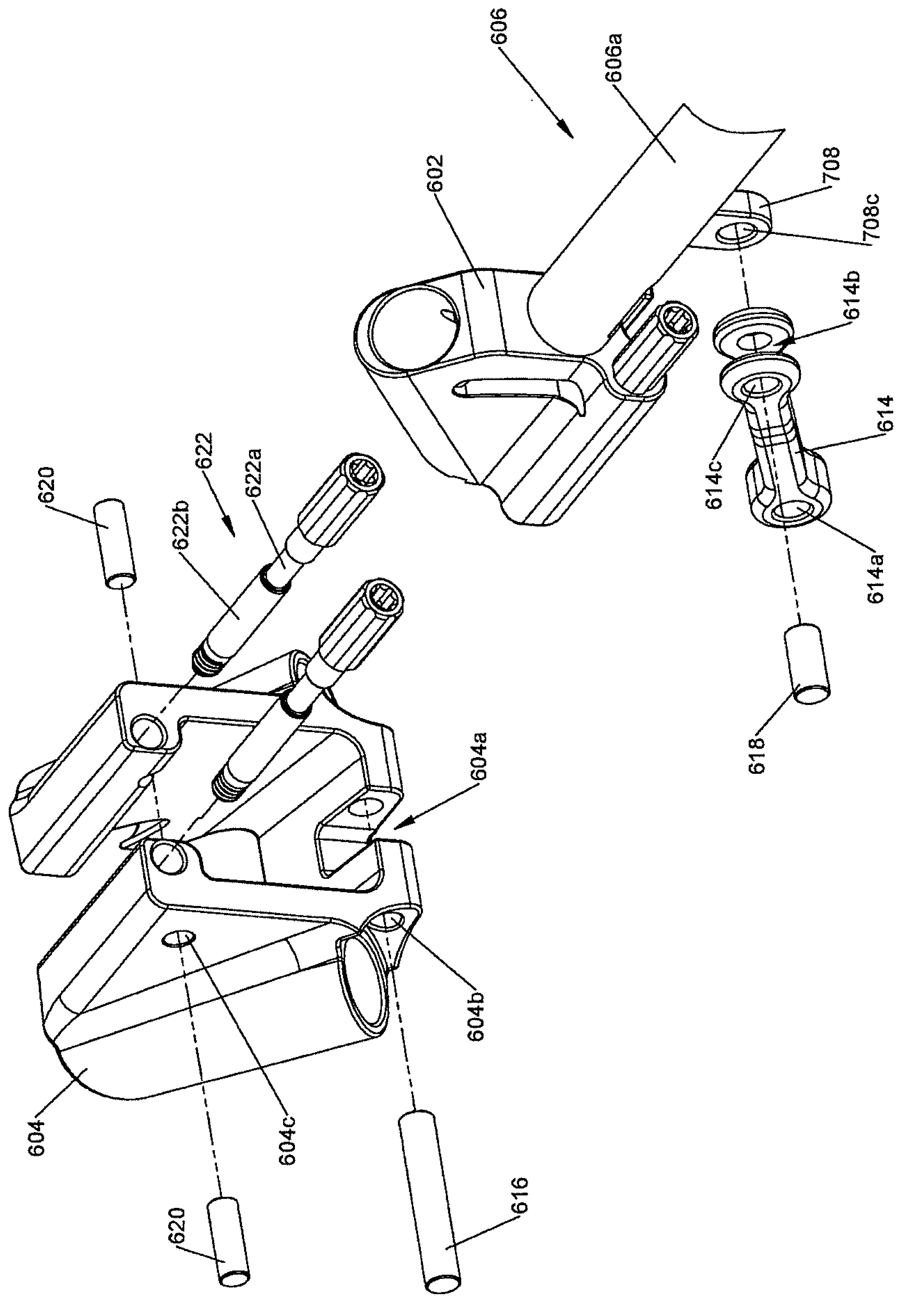

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FIG. 16

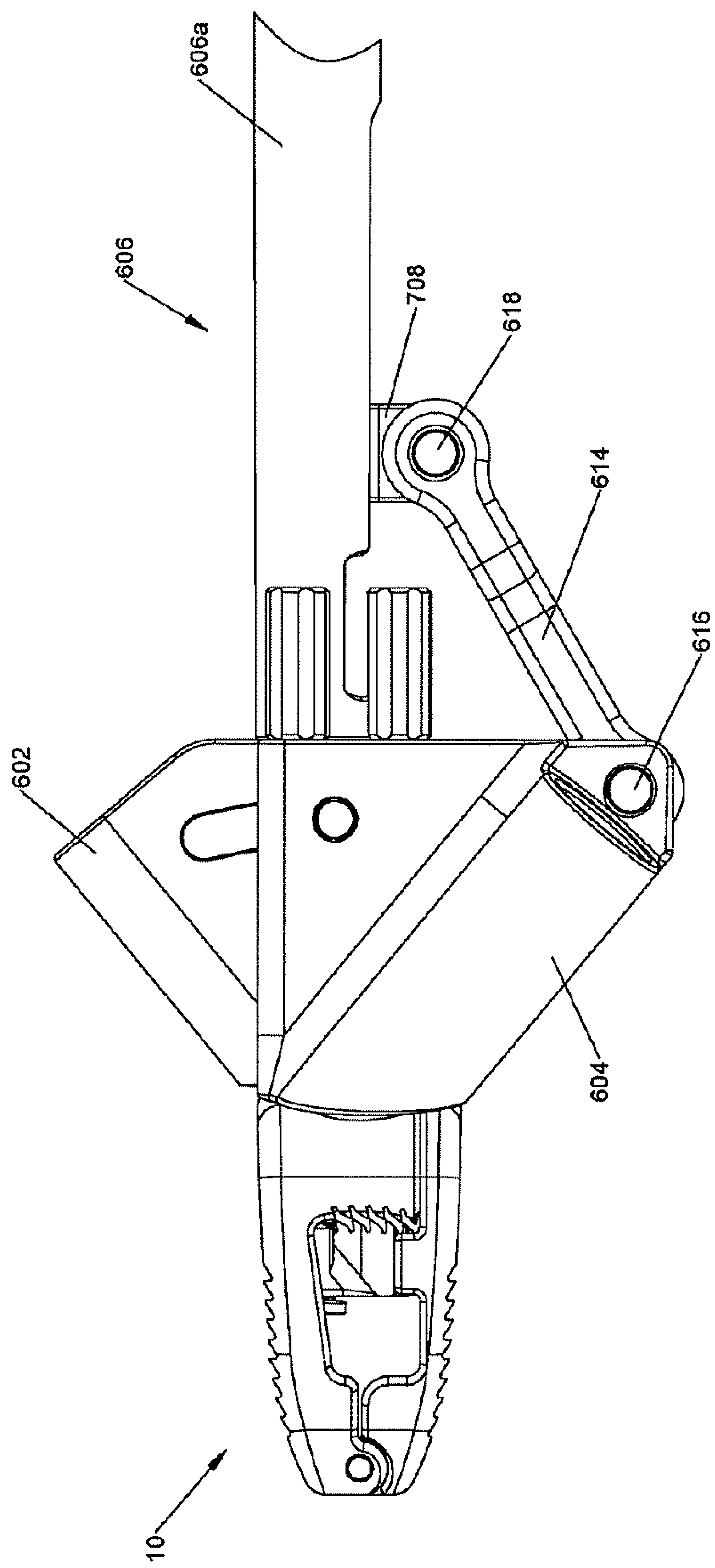
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FIG. 17

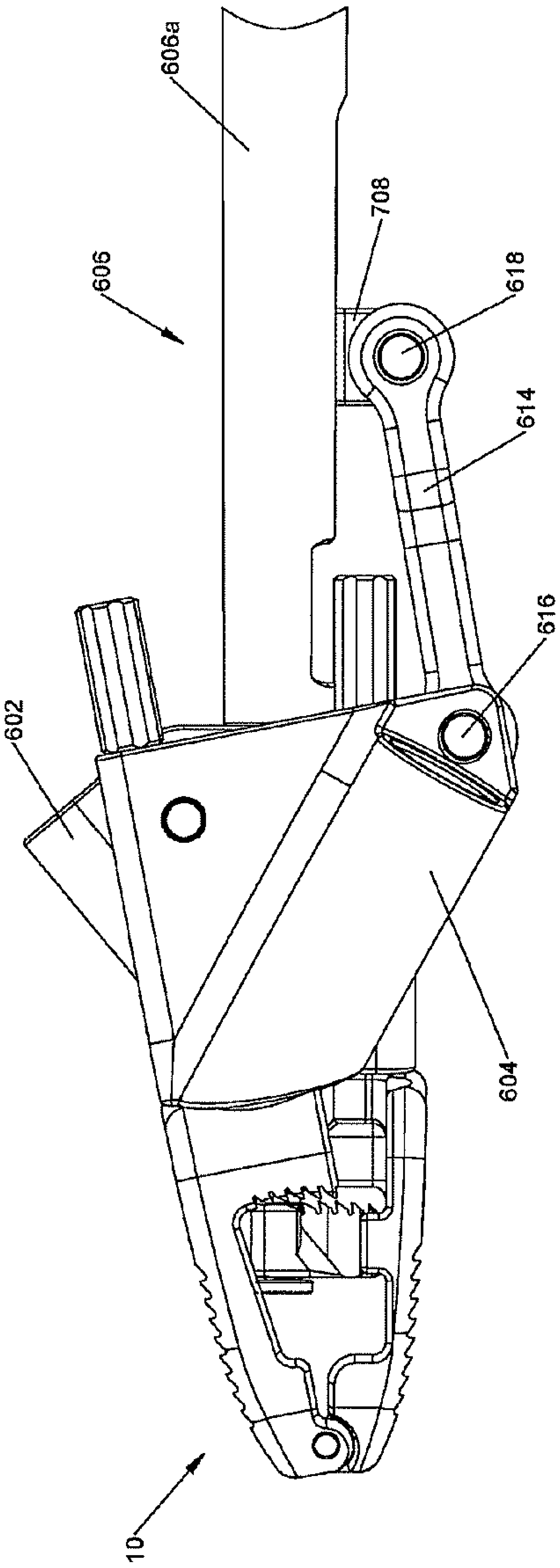
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FIG. 18

EXPANDABLE SPINAL INTERBODY SPACER AND METHOD OF USE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATION

This application is *an application for the reissue of U.S. Pat. No. 9,808,352, which is* a division of U.S. patent application Ser. No. 14/510,598, filed on Oct. 9, 2014, the entire contents of which are incorporated by reference herein.

BACKGROUND

Technical Field

The present disclosure relates generally to devices and methods for treating spinal conditions, and in particular, to expandable spinal implants configured for positioning within an intervertebral space.

Background of the Disclosure

After a partial or complete discectomy, the normally occupied space between adjacent vertebral bodies may collapse and/or become misaligned due to the absence of all or a part of the intervertebral disc. In these situations, a physician may insert one or more prosthetic spacers between the affected vertebrae to maintain normal disc spacing and/or the normal amount of lordosis in the affected region.

Typically, a prosthetic implant is inserted between the adjacent vertebrae and may include pathways that permit bone growth between the adjacent vertebrae until they are fused together. However, there exists a possibility that conventional prosthetic implants may be dislodged or moved from their desired implantation location due to movement by the patient before sufficient bone growth has occurred.

Additionally, achieving the desired lordosis can be difficult given the limitations of typical prosthetic implants once they are implanted.

Therefore, a need exists for a spinal implant that provides a desired amount of lordosis, allows for bone growth between adjacent vertebrae, maintains the space between adjacent vertebrae during bone ingrowth, and resists dislocation from its implantation site.

SUMMARY

In accordance with the present disclosure, a spinal implant including an upper body, a lower body, a ratchet mechanism, and a plurality of bone screws is provided. The upper body and the lower body are pivotably affixed at a first end and are capable of movement relative to each other. Each of the upper body and the lower body is dimensioned to be installed between two vertebral bodies. The outer surfaces of each of the upper body and the lower body are adapted to engage a corresponding end plate of the two vertebral bodies. Screw holes are defined through the outer surface and an adjacent side surface of the upper body and the outer surface and an adjacent side surface of the lower body. The screw holes are oriented towards a respective

adjacent one of the two vertebral bodies at an oblique angle. The ratchet mechanism is slidably disposed on one of the upper and lower bodies. The ratchet mechanism is capable of engaging the opposite one of the upper and lower bodies thereby permitting movement of the upper and lower bodies relative to each other in a first direction, but not in a second direction. The bone screws are insertable through corresponding screw holes of the upper body and the lower body and are attachable to bone.

In aspects, the spinal implant further includes a first lumen defined through the upper body and a second lumen defined through the lower body.

In aspects, the spinal implant further includes a plurality of ridges disposed on an outer surface of each of the upper body and the lower body. The plurality of ridges is adapted to engage a respective one of the two vertebral bodies.

In aspects, the spinal implant further includes a pair of screw holes disposed on the lower body and a single screw hole disposed on the upper body.

In aspects, the spinal implant further includes a ratchet screw rotatably supported within an annular groove defined within the lower body. The ratchet screw includes a head and threaded shank extending therefrom and is threadably engaged within a threaded through-hole defined through the ratchet mechanism. Rotation of the ratchet screw in a first direction effectuates movement of the ratchet mechanism in a first direction, and rotation of the ratchet screw in a second, opposite, direction effectuates movement of the ratchet mechanism in a second, opposite, direction.

In aspects, the spinal implant further includes a plurality of threaded bores defined through an end surface of each of the upper body and lower body. The plurality of threaded bores is configured to engage an insertion instrument capable of inserting the spinal implant between the two vertebral bodies.

In aspects, the spinal implant further includes a locating pin disposed within a through-bore defined through a side face of the lower body and a locating bore defined through the ratchet mechanism. The through-bore and locating bore are in coaxial alignment. The locating pin is in frictional engagement with the through-bore thereby retaining the locating pin therein and the ratchet mechanism is translatably supported on the locating pin.

In aspects, the spinal implant further includes a pair of legs extending from an underside of the ratchet mechanism. The pair of legs is configured to engage a corresponding pair of channels disposed on the interior surface of the upper body thereby translatably supporting the ratchet mechanism therein.

In aspects, the upper body and lower body are pivotably coupled via a hinge pin disposed within an aperture defined on the first end of the lower body and a through-hole defined on the first end of the upper body. The hinge pin is frictionally engaged with one of a first or second end of the aperture thereby retaining the hinge pin therein.

In aspects, the ratchet mechanism is slidably disposed on an interior surface of the upper body. The ratchet mechanism further includes a first plurality of teeth disposed thereon.

In aspects, the lower body includes a second plurality of teeth disposed on an interior surface thereon opposite the ratchet mechanism of the upper body. The second plurality of teeth is configured to engage the first plurality of teeth of the ratcheting mechanism.

In aspects, the first and second pluralities of teeth are oriented such that the first and second pluralities of teeth are slidably engaged in a first direction, and are prohibited from movement relative to each other in a second direction, thereby locking the position of the upper body and the lower body relative to each other.

A method of performing surgery provided in accordance with the present disclosure includes providing a spinal implant comprising an upper body, a lower body, a ratchet mechanism, and a plurality of bone screws is provided. The upper body and the lower body are pivotably affixed at a first end and are capable of movement relative to each other. Each of the upper body and the lower body is dimensioned to be installed between two vertebral bodies. The outer surfaces of each of the upper body and the lower body are adapted to engage a corresponding end plate of the two vertebral bodies. Screw holes are defined through the outer surface and an adjacent side surface of the upper and the outer surface and an adjacent side surface of the lower body. The screw holes are oriented towards a respective adjacent one of the two vertebral bodies at an oblique angle. The ratchet mechanism is slidably disposed on one of the upper and lower bodies. The ratchet mechanism is capable of engaging the opposite one of the upper and lower bodies thereby permitting movement of the upper and lower bodies relative to each other in a first direction, but not in a second direction. The bone screws are insertable through corresponding screw holes of the upper body and lower body and are attachable to bone. The method further includes positioning the upper body and lower body in a first, approximated position relative each other, preparing an intervertebral space between first and second vertebral bodies to receive the spinal implant, inserting the spinal implant into the prepared intervertebral space, articulating the upper body and lower body relative to each other to effectuate a desired lordosis of a spine of the patient, inserting a plurality of bone screws through the plurality of screw holes of the upper body and lower body and into each of the respective two vertebral bodies, and locking the ratchet mechanism to lock the position of the upper body and lower body relative to each other.

In aspects, inserting the spinal implant includes first securing the spinal implant to an insertion device.

In aspects, locking the ratchet mechanism includes rotating a ratchet screw disposed within an annular groove defined within the upper body in a first direction, wherein the ratchet screw includes a head and a threaded shank extending therefrom. The ratchet screw is threadably engaged within a threaded through-hole defined through the ratchet mechanism. Rotating the ratchet screw effectuates movement of the ratchet mechanism in a first direction thereby causing the ratchet mechanism to engage the lower body and lock the position of the lower body relative to the upper body.

In aspects, positioning the upper body and lower body in a first, approximated, position includes engaging a first plurality of teeth defined on a surface of the ratchet mechanism with a second plurality of teeth defined on an opposing surface of the lower body, thereby permitting articulation of the upper body relative to the lower body in a first direction, but not in a second direction.

In aspects, locking the ratchet mechanism further includes further rotating the ratchet screw the first direction, causing the first and second pluralities of teeth to further engage, thereby locking the position of the upper body and the lower body relative to each other.

In aspects, the method further includes packing a lumen defined in each of the upper body and lower body with bone in-growth material.

In aspects, the method further includes packing a lumen defined in each of the upper body and lower body with drugs.

In aspects, positioning the upper body and lower body includes positioning the upper body and lower body in a desired articulated position relative to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features, and advantages of the present disclosure will become more apparent in light of the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. **1** is a rear, perspective view of an expandable spinal implant provided in accordance with the present disclosure;

FIG. **2** is an exploded view, with parts separated, of the expandable spinal implant of FIG. **1**;

FIG. **2**A is a perspective view of an upper body of the expandable spinal implant of FIG. **1**;

FIG. **3** is a perspective view of a ratchet mechanism of the expandable spinal implant of FIG. **1**;

FIG. **4** is a front, perspective view of the expandable spinal implant of FIG. **1**;

FIG. **5** is a side view of the expandable spinal implant of FIG. **1**;

FIG. **6**A is a top view of a bone screw usable with the expandable spinal implant of FIG. **1**;

FIG. **6**B is a side view of the bone screw of FIG. **6**A;

FIG. **6**C is a side, cross-sectional view of the bone screw of FIG. **6**A;

FIG. **7** is a perspective view of an insertion instrument and the expandable spinal implant of FIG. **1** in accordance with the present disclosure;

FIG. **8** is a rear, perspective view, of the distal end of the insertion instrument of FIG. **7** coupled to the expandable spinal implant of FIG. **1**;

FIG. **9** is a rear, perspective view, of the insertion instrument of FIG. **7**, including an articulating bar, coupled to the expandable spinal implant of FIG. **1**;

FIG. **10** is a rear, perspective view, of the distal end of the insertion instrument of FIG. **9** coupled to the expandable spinal implant of FIG. **1**;

FIG. **11** is a side view of the distal end of the insertion instrument of FIG. **10** coupled to the expandable spinal implant of FIG. **1**;

FIG. **12** is a side view of an alternate embodiment of the insertion instrument of FIG. **7** and the expandable spinal implant of FIG. **1** in accordance with the present disclosure;

FIG. **13** is a rear, perspective view, of the insertion instrument of FIG. **12**, with parts separated;

FIG. **14** is a side, cross-sectional view, of the insertion instrument of FIG. **12**;

FIG. **15** is a bottom, perspective view, of the distal end of the insertion instrument of FIG. **12**, with parts separated;

FIG. **16** is a rear, perspective view, of the distal end of the insertion instrument of FIG. **12**, with parts separated;

FIG. **17** is a side view of the distal end of the insertion instrument of FIG. **12** and the expandable spinal implant of FIG. **1**, shown in an approximated state; and

FIG. **18** is a side view of the distal end of the insertion instrument of FIG. **12** and the expandable spinal implant of FIG. **1**, shown in an articulated state.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Embodiments of the present disclosure are now described in detail with reference to the drawings in which like reference numerals designate identical or corresponding elements in each of the several views. As used herein, the term “clinician” refers to a doctor, a nurse or any other care provider and may include support personnel. Throughout this description, the term “proximal” will refer to the portion of the device or component thereof that is closer to the clinician and the term “distal” will refer to the portion of the device or component thereof that is farther from the clinician. Additionally, in the drawings and in the description that follows, terms such as front, rear, upper, lower, top, bottom, and similar directional terms are used simply for convenience of description and are not intended to limit the disclosure. In the following description, well-known functions or constructions are not described in detail to avoid obscuring the present disclosure in unnecessary detail.

Referring now to the drawings, FIG. **1** illustrates an embodiment of expandable spinal implant **10** provided in accordance with the present disclosure. Expandable spinal implant **10** includes an upper body **100**, a lower body **200**, and a ratchet **300**. Now, referring additionally to FIG. **2**, a ratchet screw **400**, an insertion instrument **500** (FIG. **7**), a washer **11**, a locating pin **12**, and a hinge pin **13** are illustrated. Upper and lower bodies **100**, **200** cooperate to define a two part expandable spinal implant configured for positioning between adjacent vertebral bodies. Bone screws **14** (FIGS. **6**A-C) are configured for securing each of upper and lower bodies **100**, **200** to the adjacent vertebral bodies, thereby substantially retaining expandable spinal implant **10** in position relative to the adjacent vertebral bodies. Ratchet **300** and ratchet screw **400** cooperate to provide a locking mechanism to lock upper and lower bodies **100**, **200** in an articulated position relative to each other, thereby effectuating adjustment of lordosis of the spine. Each of these components along with the assembly and insertion of expandable spinal implant **10** into the intervertebral space between adjacent vertebral bodies will be described in turn hereinbelow.

The various components of expandable spinal implant **10**, or portions thereof, may be formed from various similar or different materials, depending on a particular purpose. In particular, upper and lower bodies **100**, **200** may be formed from a metallic material (e.g., titanium, titanium alloy, or cobalt chrome (CoCr)) or a non-metallic material (e.g., polymeric materials such as polyetheretherketone (PEEK), nylon absorbable polymers such as polyglycolides, polylactides, polycaprolactone, etc., or organic materials such as bone). Bone screw **14** may be formed from titanium, titanium alloy, CoCr or other suitable metal that is compatible with expandable spinal implant **10**.

With reference to FIGS. **1**, **2**, and **2**A, upper body **100** is illustrated as having generally a D-shape; however, it is contemplated that upper body **100** may include other shapes, such as square, rectangular, circular, or the like. Upper body **100** includes a substantially contoured first end surface **102** (FIG. **4**) at a distal or leading end **104** and a second end surface **106** opposite thereto at a proximal or trailing end **108**. Upper body **100** extends between the first and second end surfaces **102**, **106** to define respective top and bottom surfaces **110**, **112**, as well as opposed side surfaces **114**, **116**. As illustrated in FIGS. **1** and **2**, top and bottom surfaces **110**, **112**, engage side surfaces **114**, **116**, respectively, to provide a substantially quadrilateral cross-section with rounded corners **118** on an upper end thereof. Although upper body **100** is illustrated as having rounded corners **118** extending around the entire perimeter thereof, it is contemplated that only the intersection of the proximal and distal end surfaces **102**, **106** and top surface **110** includes rounded corners **118**.

Top surface **110** is generally shown as approximating bottom surface **112** in a direction from trailing end **108** to leading end **104**; however, it is contemplated that top surface **110** may be parallel to bottom surface **112**. First lumen **100**a is defined through top and bottom surface **110**, **112**. Although shown as generally having a complimentary shape to that of body **100**, it is contemplated that first lumen **100**a may have any suitable shape, such as square, oval, circular, or the like.

With reference to FIG. **1**, upper surface **110** defines a plurality of ridges **120** arranged thereon. Ridges **120** are configured to frictionally engage an adjacent surface of a vertebral body (i.e., a vertebral endplate) to maintain expandable spinal implant **10** in a position relative to the adjacent vertebral body and to inhibit expandable spinal implant **10** from backing out of the intervertebral space since the ridges **120** will bite into the adjacent vertebral endplate.

Referring now to FIGS. **2** and **2**A, an illustration of the underside of upper body **100** is shown. Bottom surface **112** is generally planar and includes a plurality of retainers **122** extending normally therefrom. Retainers **122** include tabs **122**a, **122**b, **122**c, and **122**d, having a generally L-shaped profile (i.e., a vertical member intersecting a horizontal member) and are configured and/or adapted to retain feet **302**b (FIG. **3**) of ratchet **300** therein. Retainers **122** are arranged in opposed pairs such that tabs **122**a and **122**b are disposed adjacent to side surface **116** and tabs **122**c and **122**d are disposed adjacent to side surface **114** (FIG. **1**), thereby forming a T-shaped channel **142** configured to engage feet **302**b ratchet **300** such that ratchet **300** is translatably supported therein. Although generally shown as being co-planar with side surfaces **114**, **116**, it is contemplated that tabs [**112**a] *122a*, **122**c may be recessed from each of side surfaces **114**, **116** or protruding therefrom.

Hinge **126** extends normal from bottom surface **112** of upper body **100** adjacent to leading end **104** (FIG. **1**). Hinge **126** is centrally located between each of side surfaces **114** (FIG. **1**), **116** and includes end surfaces **126**a and **126**b. Through-hole **128** is defined through each of end surfaces **126**a and **126**b and is configured and/or adapted to receive hinge pin **13** such that hinge pin is rotatably supported therein. Although generally shown as extending partially towards each of side surfaces **114**, **116**, it is contemplated that end surfaces **126**a, **126**b may be co-planar with side surfaces **114**, **116** and a recess may be defined within a center region of hinge **126**.

Lug **130** extends normal from bottom surface **112** of upper body **100** and is adjacent to trailing end **108**. Lug **130** is centrally located between each of side surfaces **114**, **116** and includes leading face **132**. Opening **134** is defined through each of leading face **132** and second end surface **106** and defines an inner surface **134**a and longitudinal axis A-A. Annular groove **136** is defined in the leading end of inner surface **134**a and is configured to receive flange **402** of ratchet screw **400** thereby rotatably supporting ratchet screw **400** and preventing ratchet screw **400** from advancing axially along longitudinal axis A-A. Screw hole **138** extends through lug **130**. Screw hole **138** is obliquely angled relative to second end surface **106** (e.g., screw hole **138** extends in a non-perpendicular orientation relative to second end surface **106**) thereby directing bone screw **14** (FIGS. **6**A-**6**C) therethrough at a similar oblique angle towards one of the vertebral bodies for engagement of bone screw **14** within the vertebral body despite upper body **100** being vertically displaced (e.g., vertically offset, relative to the vertebral body into which the bone screw **14** extending through screw hole **138** is to engage). Screw hole **138** further defines counterbore **138**a disposed therein terminating in lip **138**b.

Lip **138**b is configured and/or adapted to engage thread **16**b of head **16** of bone screw **14** thereby retaining bone screw **14** within screw hole **138** and preventing bone screw **14** from backing out of screw hole **138**. In particular, bone screw **14** may be formed from a titanium alloy (e.g., Ti-6Al-4V) and the lip **138**b is formed of a softer compatible material, such as unalloyed titanium. As bone screw **14** is advanced through screw hole **138**, the thread **16**b engages the lip **138**b. As the lip **138**b is formed from a softer material than the bone screw **14**, advancement of the bone screw **14** through the screw hole **138** results in the thread **16**b deforming the lip **138**b such that the bone screw **14** resists backing out of the screw hole **138**.

Disposed on either side of lug **130** is a plurality of bosses **140**. Each boss **140** includes a threaded bore **140**a defined therethrough configured and/or adapted to engage guide screws **502** of insertion instrument **500** (FIG. **7**).

Through-bore **144** (FIG. **2**A) is defined through second end surface **106** and leading face **132** on an upper end of lug **130** and is configured and or adapted to receive locating pin **12** such that locating pin **12** is frictionally engaged therein. Through-bore **144**, locating pin **12**, and locating bore **310** (FIG. **3**) cooperate to translatably support ratchet **300** on locating pin **12**.

With reference to FIG. **2**, lower body **200** is illustrated as having a shape complimentary to that of upper body **100**. Lower body **200** includes a substantially contoured first end surface **202** at a distal or leading end **204** (FIG. **5**) and a second end surface **206** opposite thereto at a proximal or trailing end **208**. Lower body **200** extends between the first and second end surfaces **202**, **206** to define respective top and bottom surfaces **210** (FIG. **4**), **212**, as well as opposed side surfaces **214** (FIG. **4**), **216**. As illustrated in FIG. **2**, the top and bottom surfaces **210**, **212**, engage side surfaces **214**, **216**, respectively, to provide a substantially quadrilateral cross-section with rounded corners **218** on an upper end thereof. Although lower body **200** is illustrated as having rounded corners **218** extending around the entire perimeter thereof, it is contemplated that only the intersection of the proximal and distal end surfaces **202**, **206** and bottom surface **212** includes rounded corners **218**. Bottom surface **212** is generally shown as approximating top surface **210** in a direction from trailing end **208** to leading end **204** (FIG. **5**); however, it is contemplated that bottom surface **212** may be parallel to top surface **210**. Second lumen **200**a is defined through top and bottom surfaces **210**, **212**. Although shown as generally having a complimentary shape to that of first lumen **100**a of upper body **100**, it is contemplated that second lumen **200**a may have any suitable shape different than that of first lumen **100**a, such as square, oval, circular, or the like.

Continuing with FIG. **2**, bottom surface **212** defines a plurality of ridges **220** arranged thereon. Ridges **220** are configured to frictionally engage an adjacent surface of a vertebral body (i.e., a vertebral endplate) to maintain expandable spinal implant **10** in a position relative to the adjacent vertebral body and to inhibit expandable spinal implant **10** from backing out of the intervertebral space since the ridges **220** will bite into the adjacent vertebral endplate.

As illustrated in FIG. **4**, slot **226** is defined within top surface **210** adjacent to proximal end surface **202**. Slot **226** is centrally located between side surfaces **214**, **216** (FIG. **2**) and extends normal from proximal end surface **202** such that hinge **126** may be disposed therein. Aperture **228** is defined through each of side surfaces **214**, **216** adjacent to leading end **204** and is configured and/or adapted to receive hinge pin **13**. One end of aperture **228** is dimensioned to rotatably support hinge pin **13** while the opposing end of aperture **228** is dimensioned to frictionally engage hinge pin **13**, thereby capturing hinge pin **13** therein and permitting upper body **100** and lower body **200** to be articulated relative to each other about hinge pin **13** from a closed, approximated position, to a plurality of open (articulated) positions.

Opposing lugs **230**a, **230**b are disposed on top surface **210** adjacent to each of side surfaces **214**, **216** respectively and extend normal therefrom. Opposing lugs **230**a, **230**b are separated such that lug **130** may be disposed therein when upper body and lower body are in an approximated configuration. A plurality of teeth **232** is disposed on a leading face of opposing lugs **230**a, **230**b and is configured to engage teeth **302** of ratchet **300**.

A plurality of screw holes **238** extend through each of opposing lugs **230**a, **230**b and have a similar configuration to that of screw hole **138** with lips **238**b. The interaction between the bone screw **14** and the lip **238**b is substantially similar to the interaction between the bone screw **14** and the lip **138**b that was discussed hereinabove. Therefore, in the interest of brevity, screw holes **238** will not be described in detail herein. It is contemplated that the plurality of screw holes **138**, **238** may include a locking device (not shown) to retain bone screw **14** therein. The locking device may be any suitable locking device, such as a locking clip, locking plate, an additional screw, or the like. For a detailed discussion of the construction of exemplary locking devices, reference may be made to U.S. patent application Ser. No. 13/750,496 and U.S. Pat. No. 8,137,405, the entire contents of each which are incorporated herein by reference.

A plurality of threaded bores **240** (FIG. **2**) is defined through second end surface **206** on each of opposing lugs **230**a, **230**b respectively. Threaded bores **240** are configured and/or adapted to engage guide screws **502** of insertion instrument **500** (FIG. **9**).

With reference to FIGS. **2** and **3**, an illustration of ratchet **300** is shown having a generally T-shaped configuration. Threaded through-hole **305** extends through leg **308** and defines longitudinal axis B-B. Ratchet **300** is oriented relative to upper body **100** such that longitudinal axis B-B is coaxial with longitudinal axis A-A. Threaded through-hole **305** is configured to threadably engage threaded shank **400**b of ratchet screw **400** such that ratchet **300** may be translated axially along axis B-B as ratchet screw **400** is rotated. Teeth **302** are disposed on a trailing edge **304** of ratchet **300** and are configured and/or adapted to engage teeth **232** of lower body **200** as ratchet **300** is advanced axially along axis A-A toward the leading face of opposing lugs **230**a, **230**b. Once engaged, teeth **302** and **232** maintain lower body **200** and upper body **100** in a selected position relative to each other.

Locating bore **310** extends through leg **308** and is configured to receive locating pin **12** such that ratchet **300** is translatably supported thereon. Locating bore **310**, in conjunction with locating pin **12** and channel **142** (FIG. **2**A) of upper body **100**, serves to locate ratchet **300** relative to upper body **100** to maintain the coaxial alignment of axes A-A and B-B.

A pair of legs **302**a is disposed on opposing sides of the underside of ratchet **300**. Legs **302**a extend normal from the underside of ratchet **300** and have a generally T-shaped configuration, complimentary to T-shaped channel **142** of upper body **100**, defining feet **302**b. Feet **302**b are configured to engage tabs **122**a, **122**b, **122**c, and **122**d of upper body **100** such that ratchet **300** is translatably supported along axis B-B. In conjunction with locating pin **12**, T-shaped channel **142** (FIG. **2**A) and feet **302**b translatably support ratchet **300** such that ratchet **300** may translate along axis B-B relative to upper body **100** and locating pin **12**. In this manner, T-shaped channel **142** and feet **302**b translatably support the lower side of ratchet **300**, while locating bore **310** and locating pin **12** translatably support the upper side of ratchet **300**, thereby maintaining coaxial alignment of axes A-A and B-B and preventing any binding that may occur during translation of ratchet **300** relative to upper body **100**.

Referring now to FIG. **2**, an illustration of ratchet screw **400** is illustrated having proximal and distal ends, includes a head **400**a on the proximal end and a threaded shank **400**b extending distally therefrom. Head **400**a of ratchet screw **400** defines a tool-engaging recess **400**c. Tool-engaging recess **400**c may have any shape and/or dimension suitable for transmitting rotational motion from a tool to ratchet screw **400** (e.g., square, hex, pozidrive, or the like). Ratchet screw **400** is configured to be threaded into threaded bore **305** of ratchet **300**. Flange **402** is disposed adjacent to head **400**a and is configured to engage annular groove **136** of lug **130** such that ratchet screw **400** is rotatably supported within annular groove **136** thereby causing ratchet **300** to translate axially in a first direction along axis B-B as ratchet screw **400** is rotated in a first direction. The distal end of ratchet screw **400** includes an unthreaded portion **404** disposed on the shank configured to engage washer **11**. Washer **11** is configured and/or dimensioned to be advanced over the unthreaded portion **404** of ratchet screw **400** and engage the leading edge of ratchet **300** such that when ratchet screw **400** is rotated in a second direction, washer **11** abuts the leading edge of ratchet **300** and advances ratchet **300** axially in a second direction along axis B-B. Washer **11** is retained on the unthreaded portion **404** of ratchet screw **400** by any means known in the art, such as bonding, welding, etc.

Referring now to FIGS. **6**A-C, an illustration of bone screw **14** configured for use with expandable spinal implant **10** is shown. As can be appreciated, a plurality of bone screws **14** is configured to secure each of upper and lower bodies **100**, **200** of expandable spinal implant **10** to adjacent vertebral bodies. However, as bone screws **14** are similar to one another, only one is described in detail herein. It is also contemplated that other suitable bone screws **14** be provided for use with expandable spinal implant **10**.

Bone screw **14** generally includes a shank **15** and a head **16**. Shank **15** defines a distal tip **15**a and pitched threading **15**b disposed about shank **15**. Distal tip **15**a and pitched threading **15**b facilitate driving bone screw **14** into bone and securement of bone screw **14** therein. Head **16** of bone screw **14** defines a tool-engaging recess **16**a. Head **16** further includes a thread **16**b for threadably engaging lip **138**b, **238**b of upper and lower bodies **100**, **200** respectively. Pitched threading **15**a has a pitch greater than that of thread **16**b. Tool-engaging recess **16**a may have any shape and/or dimension suitable for transmitting rotational motion from a tool to bone screw **14** (e.g., square, hex, pozidrive, or the like).

For a detailed discussion of the construction of exemplary bone screws, reference may be made to U.S. patent application Ser. No. 13/750,496 as referenced hereinabove.

With reference to FIGS. **7**-**11**, an insertion instrument **500** provided in accordance with the present disclosure is illustrated. Insertion instrument **500** includes first body **504** and second body **506**, which are pivotably connected at a first end such that first and second body **504**, **506** are operable to be positioned in an expanded state (FIG. **11**), or an approximated state (FIG. **7**). First body **504** includes an elongate handle **508** extending proximally therefrom, defining a tool lumen **510** therethrough (FIG. **9**). Tool lumen **510** is adapted to receive any suitable tool (not shown) capable of engaging tool engaging recess **400**c of ratchet screw **400** for transmitting rotational motion thereto.

Guide bores **512** are defined through first body **504** and second body **506**, and are arranged at corresponding angles to that of screw holes **138**, **238** such that when insertion instrument **500** is secured to expandable spinal implant **10**, bone screws **14** may be advanced through guide bores **512** and thereafter, screw holes **138**, **238**.

Guide screws **502** are insertable through corresponding through-bores (not shown) of first and second bodies **504**, **506**, and are adapted to be threadably received within corresponding threaded bores **140**a, **240** of upper and lower bodies **100**, **200** respectively. Guide pins **516** are disposed on opposing side surfaces of second body **506** and are configured to engage slots **522** of upper handle **518** (FIG. **10**). Upper handle **518** is selectably engageable with guide pins **516** and guide screws **502** of second body **506**. Apertures **520** are defined through a distal end of upper handle **518** and are configured to receive guide screws **502** of second body **506** therein. Slots **522** are disposed on opposing side surfaces of the distal end of upper handle **518** and are configured to receive guide pins **516** therein. Upper handle **518** includes an elongate body **518**a extending proximally and terminating at a proximal end **518**b, such that a clinician may grasp the proximal end **518**b of upper handle **518** and the proximal end of elongate handle **508** and manipulate upper handle **518** and elongate handle **508** relative to each other. Upper handle **518**, guide screws **502**, and slots **522** cooperate to allow a clinician to manipulate upper handle **518** and elongate handle **508** relative to each other to effectuate expansion of expandable spinal implant **10**.

With references to FIGS. **12**-**18**, an alternate embodiment of an insertion instrument is generally designated as insertion instrument **600**. In this embodiment, insertion instrument **600** includes first body **602** and second body **604**, which are operable to be positioned in an expanded state (FIG. **18**), or an approximated state (FIG. **17**). First body **602** includes an elongate handle **606** extending proximally therefrom, defining a lumen **608** therethrough (FIG. **13**). Locating bores **610** are defined through an outer surface **606**a and a portion of an inner surface of lumen **608** of elongate handle **606** in a direction normal to lumen **608**. Locating bores **610** are adapted to frictionally retain locating pins **714** such that locating pins **714** are flush with the outer surface **606**a. Locating pins **714** may be any suitable pin, such as a dowel, a roll pin, a rivet, or the like. Through-hole **612** (FIG. **14**) is defined through outer surface **606**a and is adapted to frictionally retain limiting pin **712**. Limiting pin **712** may be any suitable pin, such as a dowel, a roll pin, a rivet, or the like.

As illustrated in FIGS. **13** and **14**, adjustment assembly **700** is disposed within lumen **608** and generally includes an adjustment nut **702**, a coupler **704**, a threaded barrel **706**, a shuttle **708**, a retaining clip **710**, limiting pin **712**, and locating pins **714**. Adjustment nut **702** is adapted to be received within lumen **608** and includes a tool receiving portion **702**a defined within a proximal end thereof. Internal threads **702**b are disposed on an interior surface of the distal end of a throughbore **702**c defined through adjustment nut **702**. An outer surface of adjustment nut **702** includes an annular groove **702**d defined thereon adapted to receive a portion of locating pins **714**. When locating pins **714** are advanced within locating bores **610** and annular groove **702**d, adjustment nut **702** is rotatably retained within lumen **608** (i.e., adjustment nut **702** is free to rotate while being fixed longitudinally).

Coupler **704** includes a through-hole **704**a defined through proximal and distal ends. The proximal end of coupler **704** includes a threaded outer surface **704**b adapted to threadably engage internal threads **702**b of adjustment nut **702**. The distal end of coupler **704** includes threads **704**c disposed on an inner surface of through-hole **704**a. A first slot **704**d is defined through an outer surface of coupler **704** and extends longitudinally along through-hole **704**a. A second slot **704**e is defined through an opposing side of the outer surface of coupler **704** and extends longitudinally along through-hole **704**a. First slot **704**d is adapted to slidably receive limiting pin **712** such that when coupler **704** is translated along lumen **608** by rotation of adjustment nut **702**, limiting pin **702** abuts the proximal or distal end of first slot **704**d, thereby limiting the longitudinal motion of coupler **704**.

Shuttle **708** includes a threaded bore **708**a defined therethrough and a flange **708**b extending normally therefrom. Threaded bore **708**a is adapted to be rotatably supported on shank **706**b of threaded barrel **706**. Threaded barrel **706** includes a threaded outer surface **706**a disposed on a proximal end thereof and a hexagonal through-bore **706**c defined therethrough. Hexagonal through-bore **706**c is adapted to engage a suitable tool capable of effectuating rotational motion. Threaded barrel **706**a transitions to a smooth shank **706**b located on a distal end of threaded barrel **706**. Smooth shank **706**b transitions to a flange **706**d having a diameter greater than that of smooth shank **706**b. Retaining clip **710** is disposed within an annular groove **706**e defined in an outer surface of smooth shank **706**b. Retaining clip **710** may be any suitable clip, such as a circlip, a spring clip, or the like. Shuttle **708** is longitudinally retained between flange **706**d and retaining clip **710**. Threaded outer surface **706**a is adapted to threadably engage threads **704**c of coupler **704**. Once entirely threaded therein, the proximal end of threaded outer surface **706**a is mechanically secured to threads **704**c by any suitable means, such as staking, welding, or the like.

Link **614** includes a first transverse pivot hole **614**a defined through opposing sides of a distal end thereof. A channel **614**b is defined through a proximal end of link **614** and is adapted to slidably receive flange **708**b therein. A second transverse pivot hole **614**c is defined through opposing sides of a proximal end of link **614**.

First and second bodies **602**, **604** are similar to first and second bodies **504**, **506**, respectively, and therefore, in the interest of brevity, only the differences therebetween will be described in detail herein.

As illustrated in FIG. **16**, second body **604** includes a slot **604**a defined through a proximal end thereof adapted to slidably receive a distal end of link **614**. Retaining bores **604**b are disposed through side surfaces of second body **604** and are adapted to frictionally receive a first link pin **616**. When first link pin **616** is fully advanced within retaining bores **604**b and pivot hole **614**a, link **614** is rotatably secured to second body **604**. A second link pin **618** is adapted to be received within a pivot hole **708**c defined through flange **708**b and second transverse pivot hole **614**c of link **614** such that link **614** is rotatably supported thereon. A pair of transverse through-bores **604**c is defined through opposing side surfaces of second body **604** and are adapted to frictionally receive a corresponding first pair of pins **620**. Pins **620** are adapted to partially engage a respective annular groove **622**a disposed on a shank **622**b of retaining screws **622** and may be any suitable pin, such as a dowel pin, a roll pin, a rivet, or the like. Retaining screws **622** are similar to guide screws **502** except for annular groove **622**a. When fully inserted, retaining screws **622** are longitudinally fixed by pins **620** while still permitting retaining screws **622** to rotate axially.

First body **602** includes a pair of holes **602**a disposed within a lower surface thereof. Holes **602**a are adapted to receive a corresponding second pair of pins **624**. Pins **624** are adapted to partially engage a respective annular groove **622**a disposed on a shank **622**b of retaining screws **622** and may be any suitable pin, such as a dowel pin, a roll pin, a rivet, or the like. When fully inserted, retaining screws **622** are longitudinally fixed by pins **624** while still permitting retaining screws **622** to rotate axially.

Elongate handle **606**, guide screws **502**, link **614**, and adjustment assembly **700** cooperate to allow a clinician to effectuate expansion of expandable spinal implant **10** as will be discussed in further detail herein.

With reference to FIGS. **2** and **5**, the insertion of an expandable spinal implant **10** into the intervertebral space between adjacent vertebral bodies during the course of a spinal surgical procedure is described. Initially, ratchet **300** is placed in a first, unengaged position by rotating ratchet screw **400** in a first direction using a suitable tool inserted within tool-engaging recess **400**c of ratchet screw **400**. Next, upper body **100** is manipulated relative to lower body **200** such that upper body and lower body **100**, **200** are in a first, approximated, position. At this point, ratchet screw **400** is rotated in a second, opposite direction, drawing teeth **302** of ratchet **300** into engagement with teeth **232** of lower body **200** such that the position of upper body **100** relative to lower body **200** is fixed. The intervertebral space is then prepared, e.g., damaged or diseased tissue is removed. Thereafter, the interior space of lumens **100**a, **200**a of upper and lower body **100**, **200**, respectively, may be packed with bone in-growth material, drugs, or other suitable materials or compounds. Examples of such materials are allograft material, autograft material, calcium phosphate/bone marrow aspirate (BMA), autogenous bone material, or synthetic materials comprised of a biocompatible, osteoconductive, osteoinductive, or osteogenic material such as VITOSS® Synthetic Cancellous Bone Void Filler material. Next, expandable spinal implant **10** is affixed to a insertion instrument **500** by threadably engaging guide screws **502** to threaded bores **140**a, **240** disposed on upper body **100** and lower body **200** respectively (FIGS. **7-8**). At this point, expandable spinal implant **10** may be advanced within an incision within the patient and thereafter, a previously prepared intervertebral space of the patient's spine. Bone screws **14** (FIGS. **6**A-**6**C) are then inserted through guide bores **512** of insertion instrument **500** (FIG. **8**), and thereafter, screw holes **238** of lower body **200** and are driven into one of the adjacent vertebral bodies. Due to the obliquely angled configuration of screw holes **238** relative to second end face **206** mentioned above, bone screws **14** are guided through screw holes **238** and into the vertebral body. Next, a final bone screw **14** is inserted through remaining guide bore **512** of insertion instrument **500**, and thereafter, screw hole **138** of upper body **100** and is driven into the other adjacent vertebral body. As with screw holes **238**, the obliquely angled configuration of screw hole **138** relative to second end face **106** guides bone screw **14** through screw hole **138** and into the vertebral body. Next, a suitable tool may be advanced within tool lumen **510** (FIG. **9**) of insertion tool **500** and thereafter ratchet screw **400**. Ratchet screw **400** may be rotated in the first direction to disengage teeth **302** of ratchet **300** from teeth **232** of lower body **200**. At this point, upper body **100** and lower body **200** may be articulated about hinge pin **13** to a desired location by manipulating upper handle **518** and elongate handle **508** relative to each other (FIG. **11**). Articulation of upper body **100** and lower body **200** relative to each other effectuates lordosis of the spine. Alternatively, it is contemplated that upper body **100** and lower body **200** may be articulated relative to each other to effectively fill the intervertebral space without effectuating lordosis of the spine. The desired location of upper body **100** and lower body **200** is selected based on the desired lordosis of the spine. Once a desired location has been selected, ratchet screw **400** is rotated in the second, opposite, direction to draw teeth **302** of ratchet **300** into engagement with teeth **232** of lower body **200** to lock the position of upper body **100** relative to lower body **200**. Thereafter, insertion instrument **500** is disengaged from expandable spinal implant **10** and removed from the incision.

In another embodiment, alternate insertion instrument **600** may be secured to expandable spinal implant **10** by threading retaining screws **622** into threaded bores **140**a, **240** (FIGS. **2** and **2**A) disposed on upper body **100** and lower body **200** respectively (FIG. **12**). The insertion, locking, and removal of expandable spinal implant **10** using insertion instrument **600** is similar to that using insertion instrument **500**, and therefore, in the interest of brevity, only the differences will be described herein.

Once expandable spinal implant **10** has been inserted within the intervertebral space, a first suitable tool (not shown) is inserted within lumen **608** of elongate handle **606** and is drawn into engagement with the tool receiving portion **702**a of adjustment nut **702**. Adjustment nut **702** is then rotated, which, in turn, draws coupler **704** in a proximal direction within lumen **608** of elongate handle **606**. As coupler **704** is drawn proximally, threaded barrel **706**, and therefore shuttle **708** are also drawn proximally, causing link **614** to impart a proximal force on second body **604** thereby causing second body **604** to rotate relative to first body **602**. This rotation of second body **604** effectuates expansion of expandable spinal implant **10** (see FIGS. **17** and **18**). Once a desired location of upper body **100** and lower body **200** is selected, the first tool is removed from lumen **608**. Next, a second suitable tool may be advanced within lumen **608** of insertion tool **600** and advanced through through-hole **704**a of coupler **704**, through-bore **706**c of threaded barrel **706**, and thereafter ratchet screw **400**.

In some embodiments, the position of upper body **100** relative to lower body **200** may be set prior to inserting expandable spinal implant **10** within the intervertebral space. Thereafter, the position may continue to be manipulated until the desired lordosis is achieved using the procedure previously described above.

It is further contemplated that the teeth **302** of ratchet **300** may be drawn into engagement with teeth **232** of lower body **200** such that lower body **200** may be articulated about hinge pin **13** in a first direction (i.e., ratchet open), but not in a second direction (i.e., preventing upper body **100** and lower body **200** from approximating). Once the desired lordosis is achieved, ratchet screw **400** may be rotated in the second direction to lock upper body **100** and lower body **200** in the selected position.

This process may be repeated as many times as the procedure requires, whether it be for the same expandable spinal implant **10** or for a plurality of expandable spinal implants **10** as required by the procedure being performed.

It will be understood that various modifications may be made to the embodiments of the presently disclosed expandable spinal implant. Therefore, the above description should not be construed as limiting, but merely as exemplifications of embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the present disclosure.

What is claimed is:

1. A method of performing surgery, comprising:

positioning an upper body and a lower body of a spinal implant in a first, approximated position relative to each other, the upper body and lower body pivotably coupled at a first end and capable of movement relative to each other, wherein each of the upper body and the lower body is dimensioned to be installed between first and second vertebral bodies, the outer surfaces of each of the upper body and the lower body are adapted to engage a corresponding end plate of the first and second vertebral bodies;

preparing an intervertebral space between the first and second vertebral bodies to receive the spinal implant;

inserting the spinal implant into the prepared intervertebral space;

articulating the upper body and lower body relative to each other to effectuate a desired lordosis of a spine of the patient;

inserting a plurality of bone screws that are capable of being attached to bone through a plurality of screw holes defined through the outer surface and an adjacent side surface of the upper body and through the outer surface and an adjacent side surface of the lower body, wherein the screw holes are oriented towards a respective adjacent one of the first and second vertebral bodies at an oblique angle; and

locking a ratchet mechanism slidably disposed on one of the upper and lower bodies, to lock the position of the upper body and lower body relative to each other, the ratchet mechanism capable of engaging the opposite one of the upper and lower bodies thereby permitting movement of the upper and lower bodies relative to each other in a first direction, but not in a second direction.

2. The method of claim **1**, wherein inserting the spinal implant includes first securing the spinal implant to an insertion device.

3. The method of claim **1**, wherein locking the ratchet mechanism includes rotating a ratchet screw disposed within an annular groove defined within the upper body in a first direction, wherein the ratchet screw includes a head and a threaded shank extending therefrom, the ratchet screw being threadably engaged within a threaded through-bore defined through the ratchet mechanism, wherein rotating the ratchet screw effectuates movement of the ratchet mechanism in a first direction thereby causing the ratchet mechanism to engage the lower body and lock the position of the lower body relative to the upper body.

4. The method of claim **1**, wherein positioning the upper body and lower body in a first, approximated, position includes engaging a first plurality of teeth defined on a surface of the ratchet mechanism with a second plurality of teeth defined on an opposing surface of the lower body, thereby permitting articulation of the upper body relative to the lower body in a first direction, but not in a second direction.

5. The method of claim **4**, wherein locking the ratchet mechanism further includes further rotating the ratchet screw the first direction, thereby causing the first and second pluralities of teeth to further engage, thereby locking the position of the upper body and the lower body relative to each other.

6. The method of claim **1**, further including packing a lumen defined in each of the upper body and lower body with bone in-growth material.

7. The method of claim **1**, further including packing a lumen defined in each of the upper body and lower body with drugs.

8. The method of claim **1**, wherein positioning the upper body and lower body includes positioning the upper body and lower body in a desired articulated position relative to each other.

9. A method of treatment of a spinal condition, comprising:

inserting a spinal implant into an intervertebral space between a first vertebral body and a second vertebral body;

articulating an upper body and a lower body of the spinal implant relative to each other to a desired one of a plurality of articulated arrangements, the upper and lower bodies being positioned to define a different respective angle therebetween in each of the plurality of articulated arrangements;

after the step of articulating the upper and lower bodies, and while the upper and lower bodies are positioned in the desired articulated arrangement with the respective angle therebetween, actuating a locking mechanism of the spinal implant by moving the locking mechanism from an unlocked configuration to a locked configuration, so as to lock the positions of the upper and lower bodies relative to each other in the desired articulated arrangement with the respective angle therebetween; and

anchoring the spinal implant to the first and second vertebral bodies with a plurality of screws, at least a first one of the screws extending through an outer surface of the upper body and into the adjacent first vertebral body, and at least a second one of the screws extending through an outer surface of the lower body and into the adjacent second vertebral body.

10. The method of claim 9, wherein the first and second screws extend at an oblique angle through the outer surfaces of the respective upper and lower bodies.

11. The method of claim 9, wherein actuating the locking mechanism includes rotating a screw.

12. The method of claim 9, wherein the locking mechanism is disposed in the implant during the step of inserting the spinal implant into the intervertebral space.

13. The method of claim 9, wherein actuating the locking mechanism includes moving a portion of the locking mechanism into engagement with grooves formed in the upper body or the lower body to prevent articulating movement of the upper and lower bodies relative to each other in at least one direction.

14. The method of claim 13, wherein actuating the locking mechanism includes moving a ratchet mechanism into engagement with the grooves formed in the upper body or the lower body.

15. The method of claim 9, wherein inserting the spinal implant includes securing a proximal end of the spinal implant to an insertion instrument.

16. The method of claim 15, wherein, during the step of inserting the spinal implant into the intervertebral space, the upper and lower bodies of the spinal implant are arranged in an approximated configuration, such that a projecting portion of one of the upper and lower bodies at the proximal end of the spinal implant is received within a recessed portion of the other of the upper and lower bodies at the proximal end of the spinal implant.

17. The method of claim 15, wherein securing the proximal end of the spinal implant to the insertion instrument comprises securing the insertion instrument to at least one threaded bore in the proximal end of the spinal implant.

18. The method of claim 15, wherein articulating the upper body and the lower body relative to each other comprises articulating the upper and lower bodies about a hinge axis disposed at a distal end of the spinal implant.

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