

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

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(54) **SPINAL STABILIZATION SYSTEM WITH ADJUSTABLE INTERLAMINAR DEVICES**

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/164,785**

(22) Filed: **Oct. 18, 2018**

(65) **Prior Publication Data**

US 2019/0175229 A1 Jun. 13, 2019

Related U.S. Application Data

(63) Continuation-in-part of application No. 14/498,333, filed on Sep. 26, 2014, now Pat. No. 10,154,861, which is a continuation-in-part of application No. 14/209,138, filed on Mar. 13, 2014, now Pat. No. 9,510,872.

(60) Provisional application No. 61/794,543, filed on Mar. 15, 2013, provisional application No. 62/670,800, filed on May 13, 2018, provisional application No. 62/631,631, filed on Feb. 17, 2018, provisional application No. 62/574,101, filed on Oct. 18, 2017,
(Continued)

(51) **Int. Cl.**
A61B 17/70 (2006.01)

(52) **U.S. Cl.**
CPC **A61B 17/7067** (2013.01); **A61B 17/7043** (2013.01); **A61B 17/7052** (2013.01); **A61B 17/7071** (2013.01); **A61B 17/7079** (2013.01); **A61B 17/7086** (2013.01); **A61B 17/7091** (2013.01); **A61B 17/7026** (2013.01); **A61B 17/7077** (2013.01)

(58) **Field of Classification Search**
CPC A61B 17/7049–7059; A61B 17/7062–707; A61B 17/70
See application file for complete search history.

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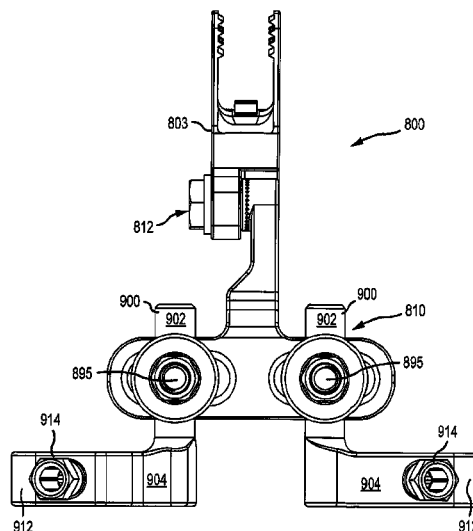
(Continued)

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Elevated IP, LLC

(57) **ABSTRACT**

An adjustable spinal stabilization system for maintaining preselected spacing and movement between adjacent vertebrae in a spinal column and for providing overall stability thereto. The system includes at least one interlaminar member positioned in the spaces intermediate a first vertebra and the vertebrae positioned immediately above or immediately below and adjacent to the first vertebra. The interlaminar member is operatively connected to an adjustable support structure and cooperates therewith to maintain the preselected spacing between adjacent vertebrae and to provide overall stability to the spinal column.

5 Claims, 59 Drawing Sheets



Related U.S. Application Data

provisional application No. 61/949,254, filed on Mar. 7, 2014, provisional application No. 61/939,484, filed on Feb. 13, 2014, provisional application No. 61/962,011, filed on Oct. 29, 2013, provisional application No. 61/883,398, filed on Sep. 27, 2013, provisional application No. 61/883,018, filed on Sep. 26, 2013.

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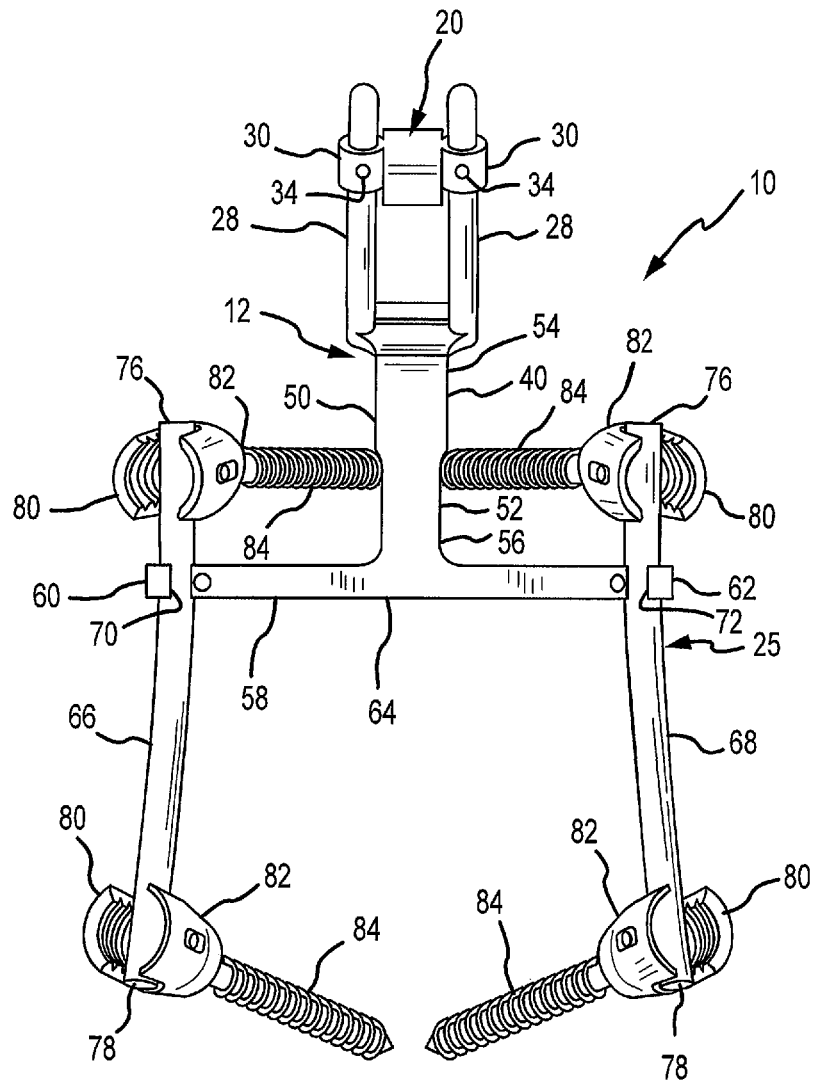


FIG. 1

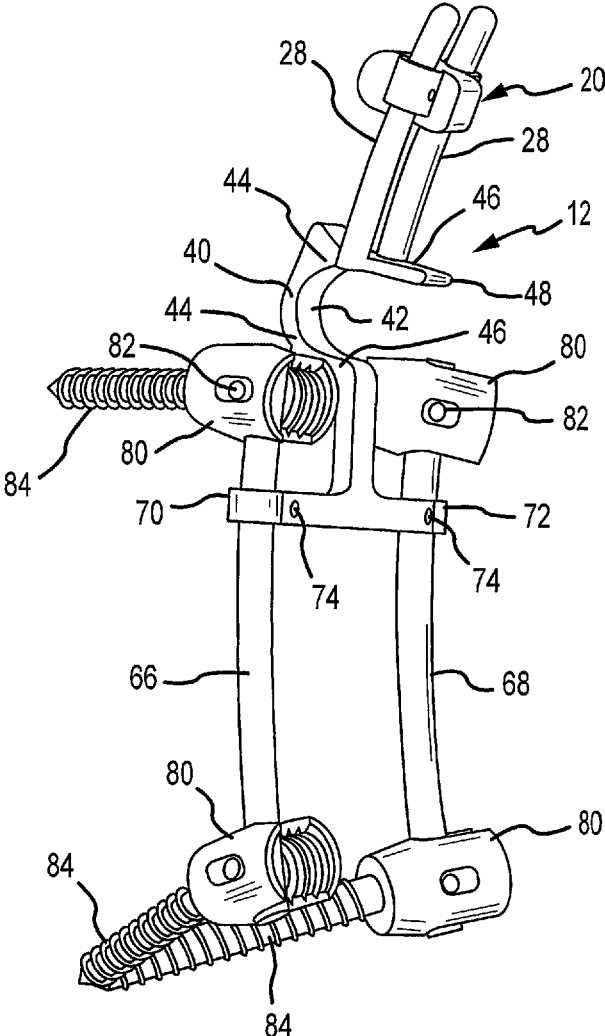


FIG.2

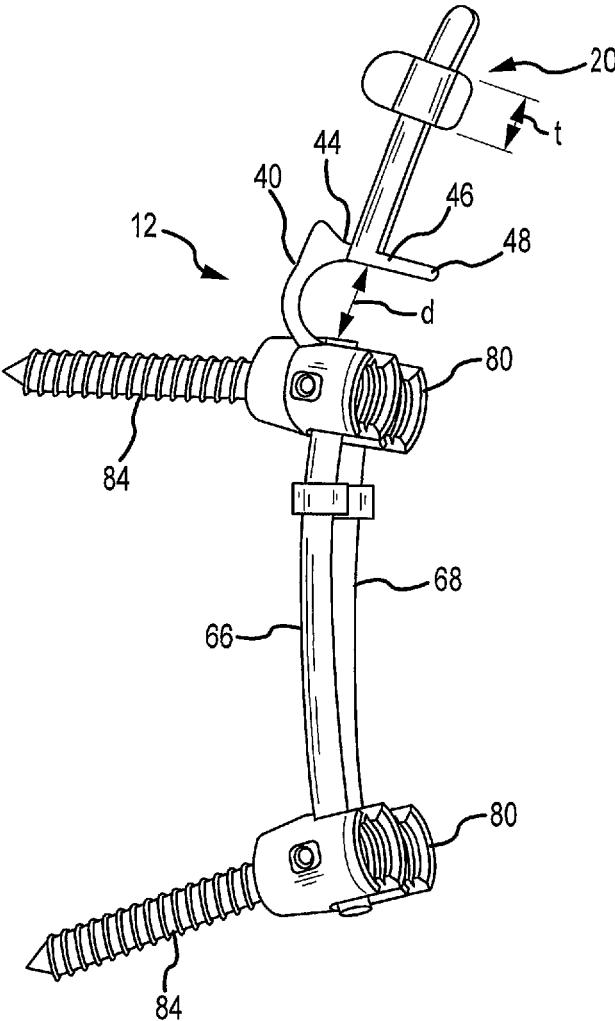


FIG.3

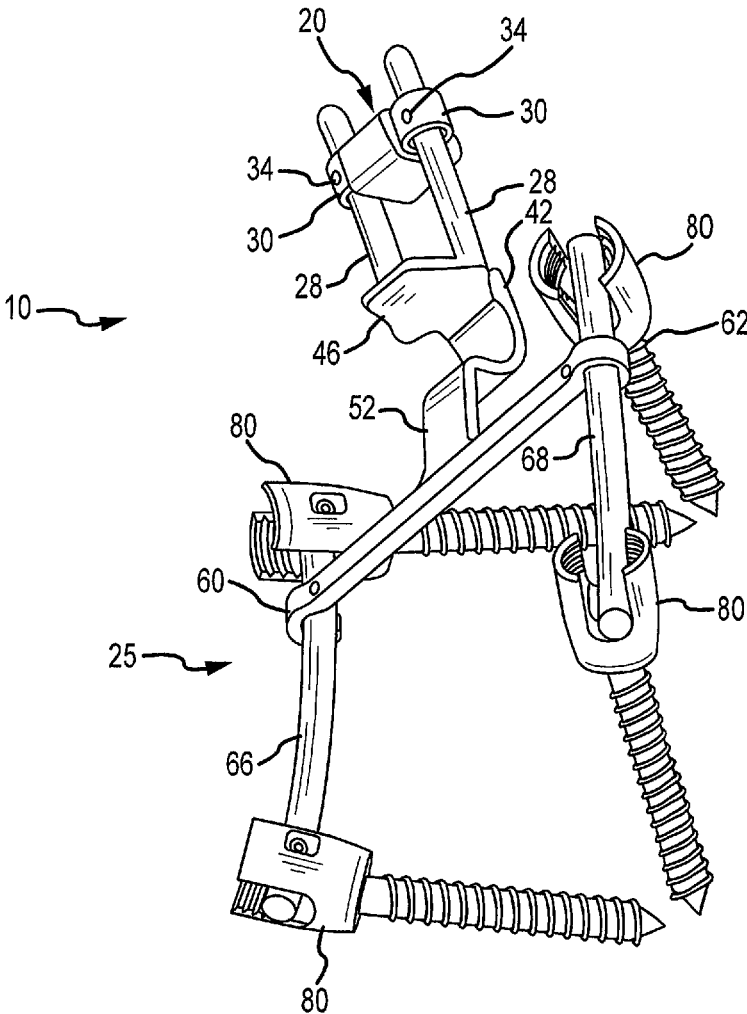


FIG.4

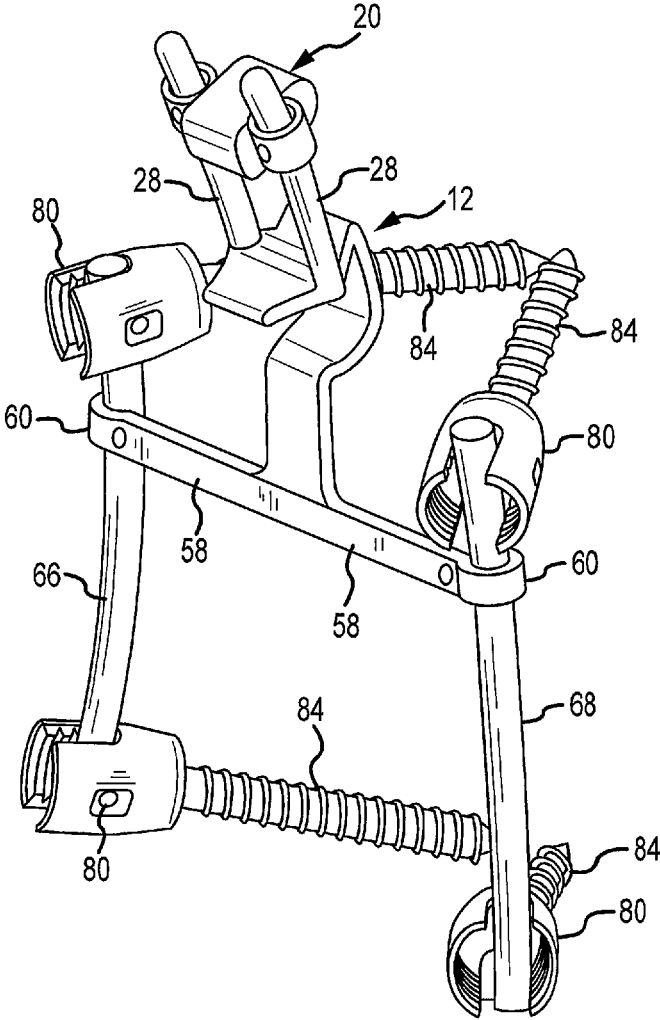


FIG.5

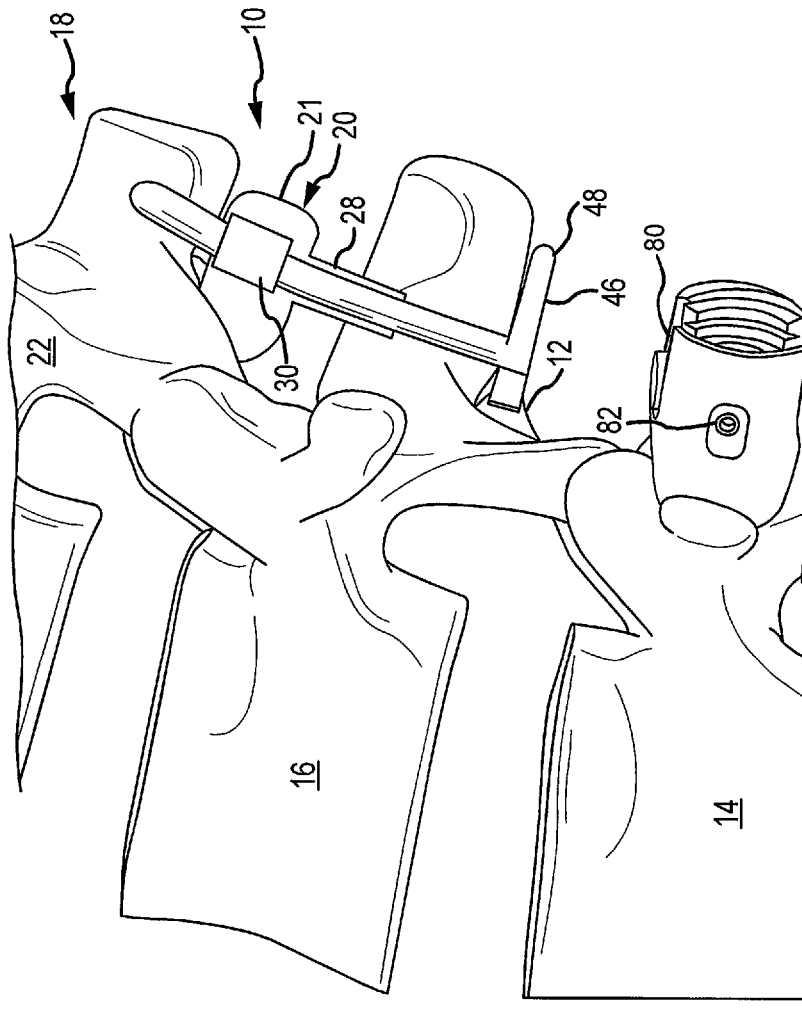


FIG. 6

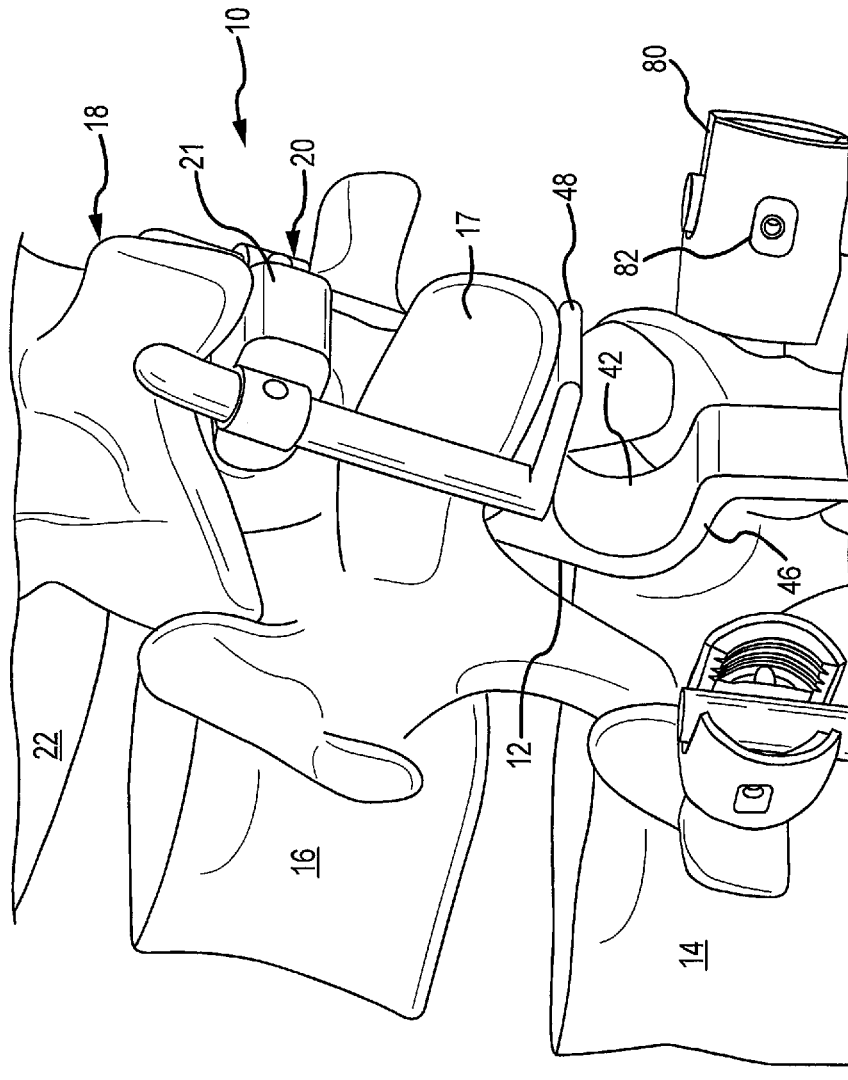


FIG.7

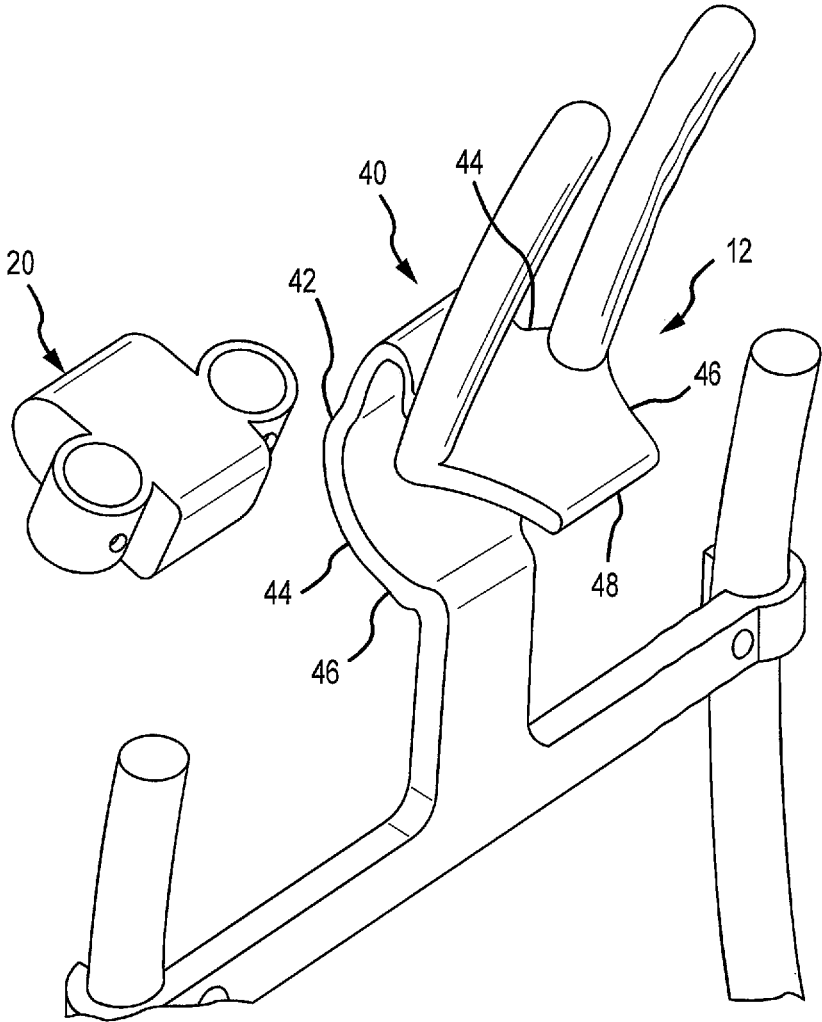


FIG. 8

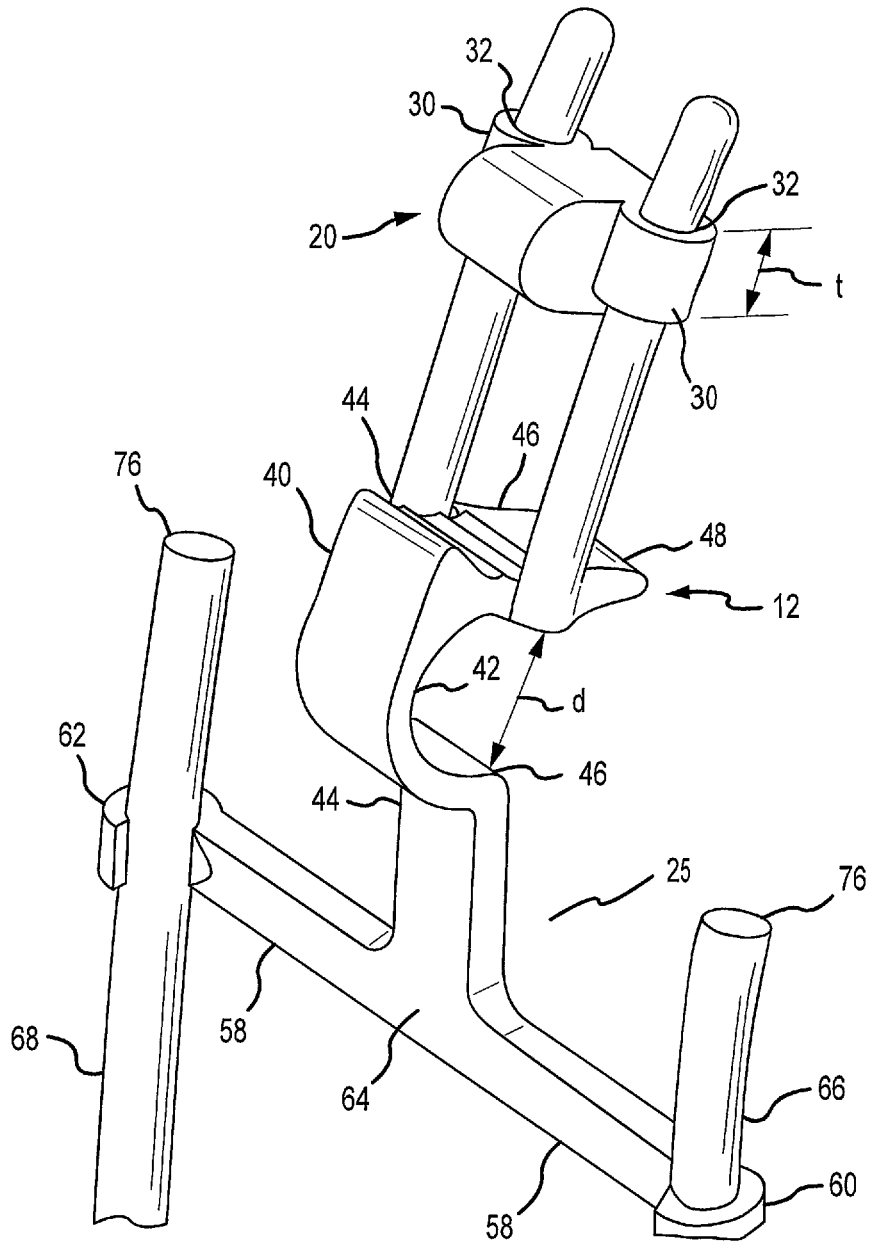


FIG.9

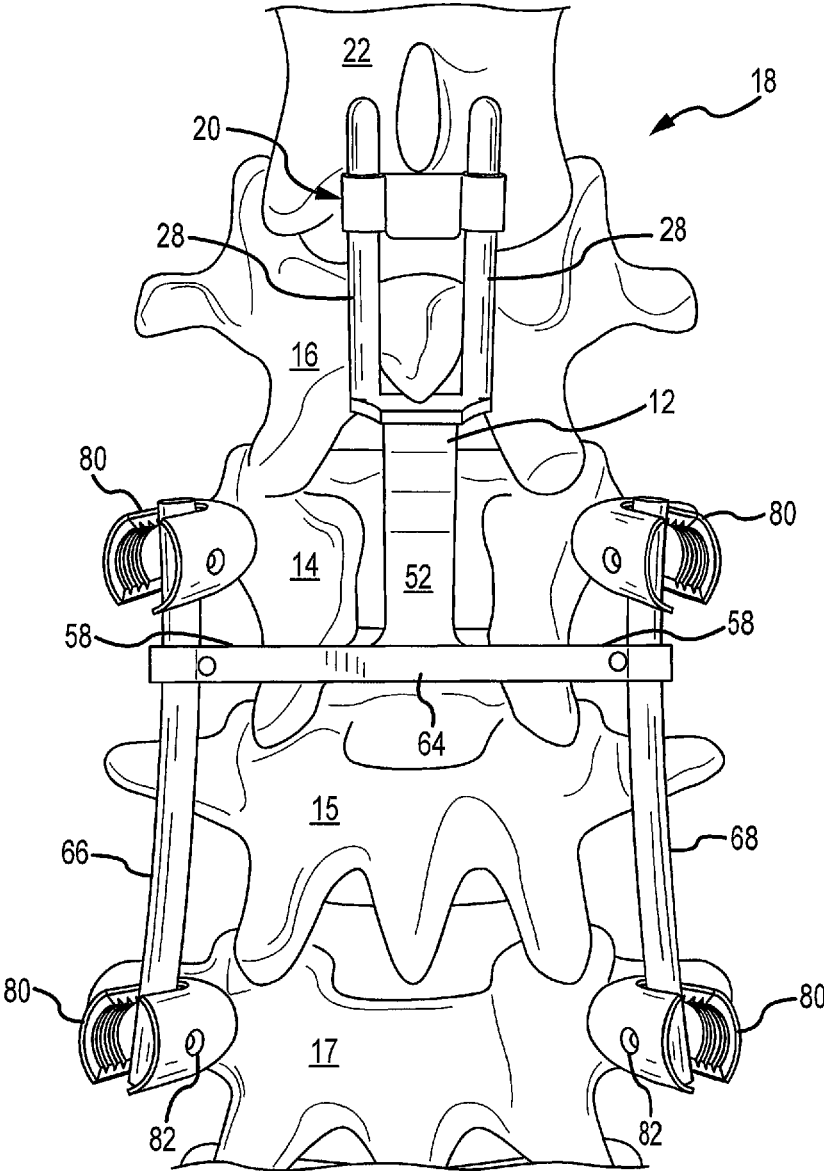


FIG.10

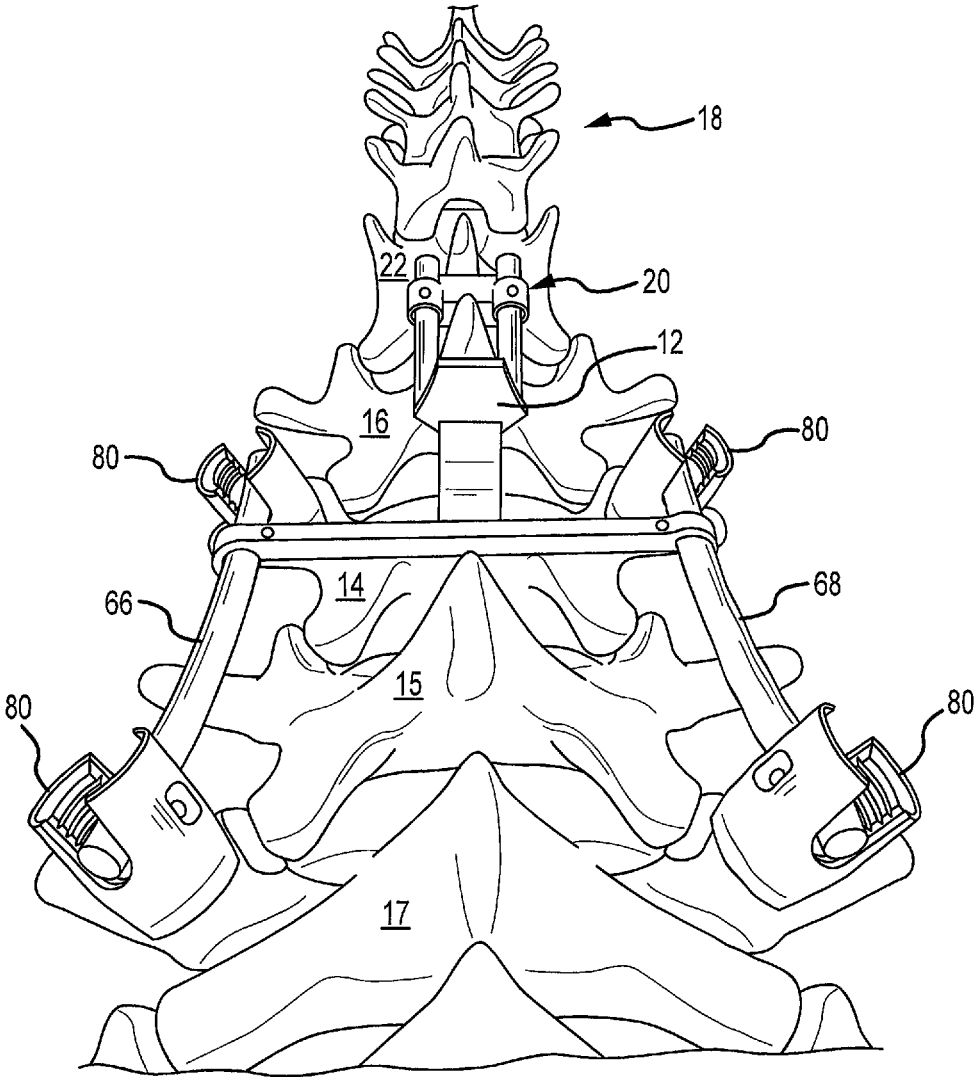


FIG.11

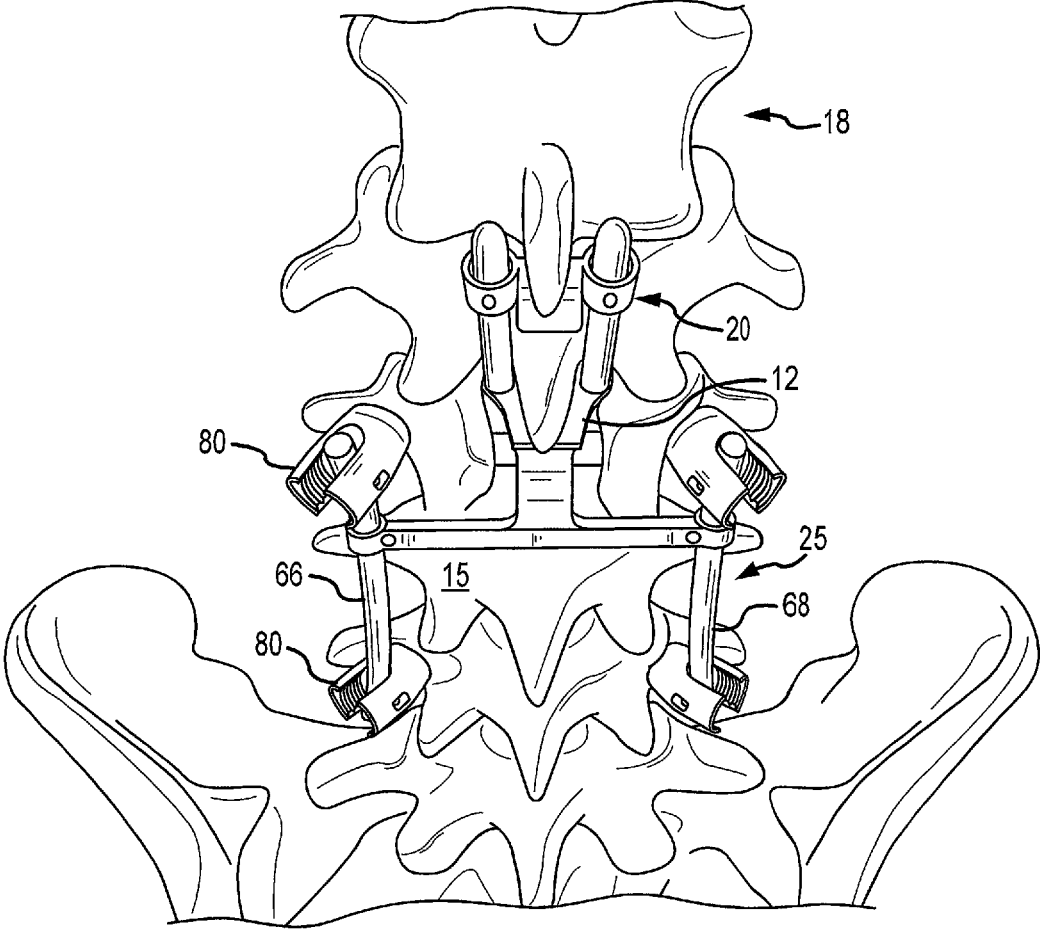


FIG.12

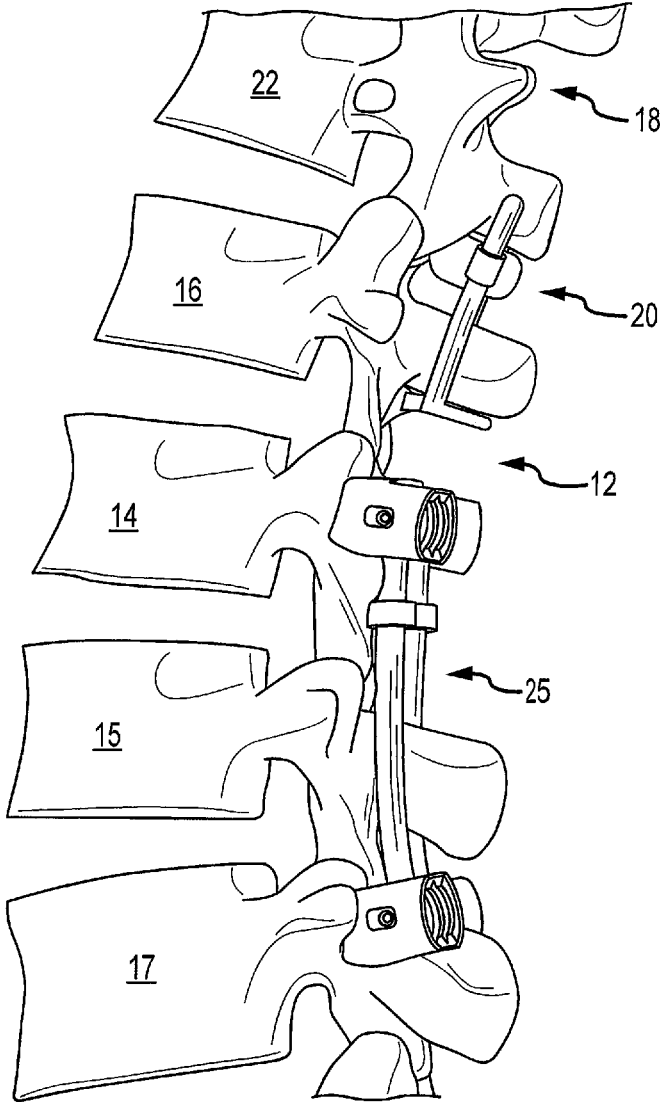


FIG.13

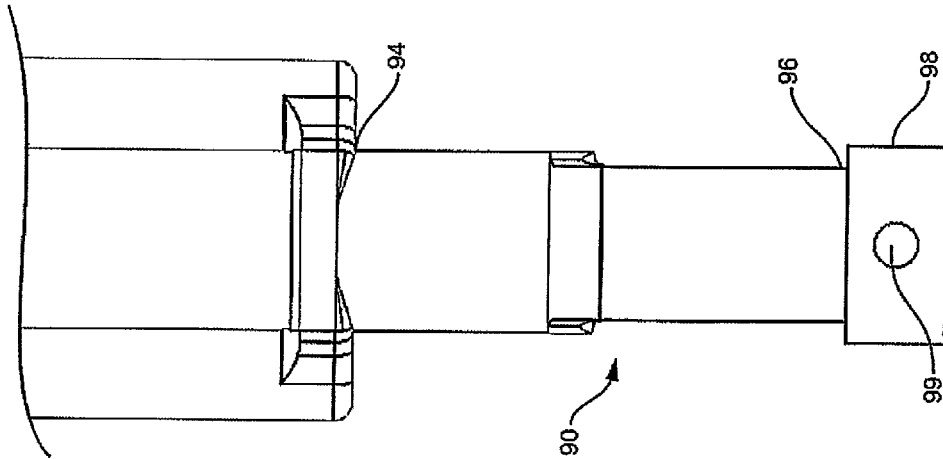


FIG. 14C

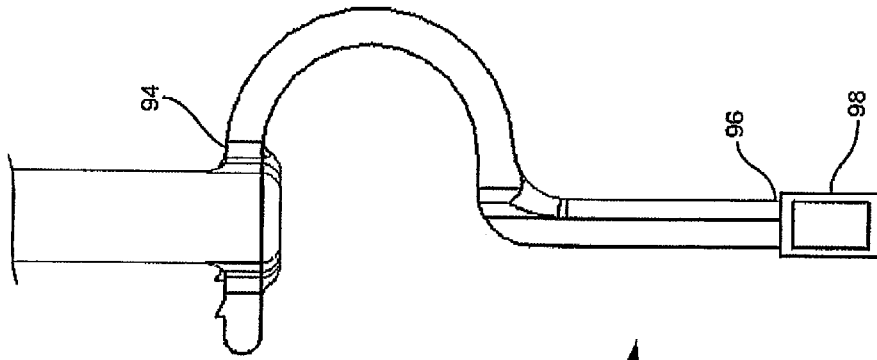


FIG. 14B

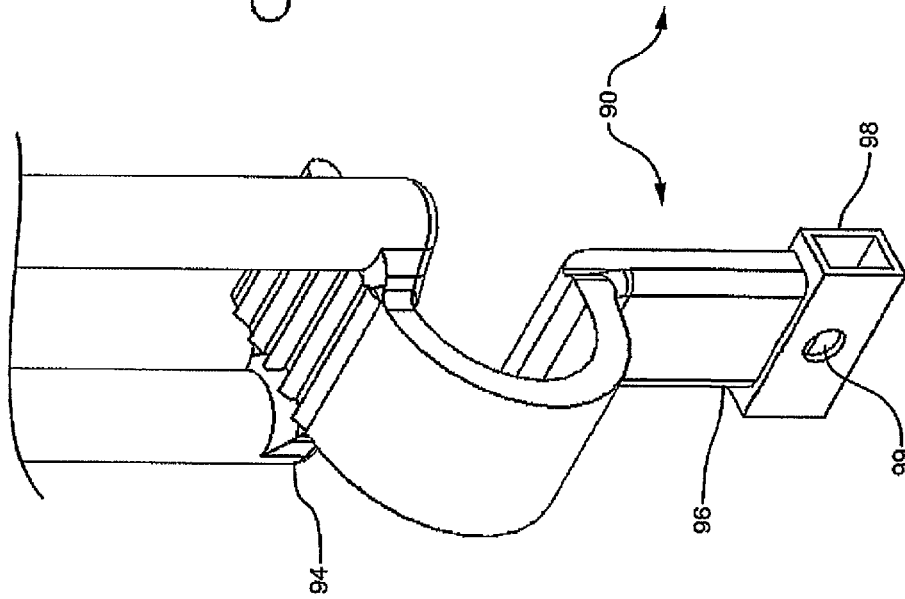


FIG. 14A

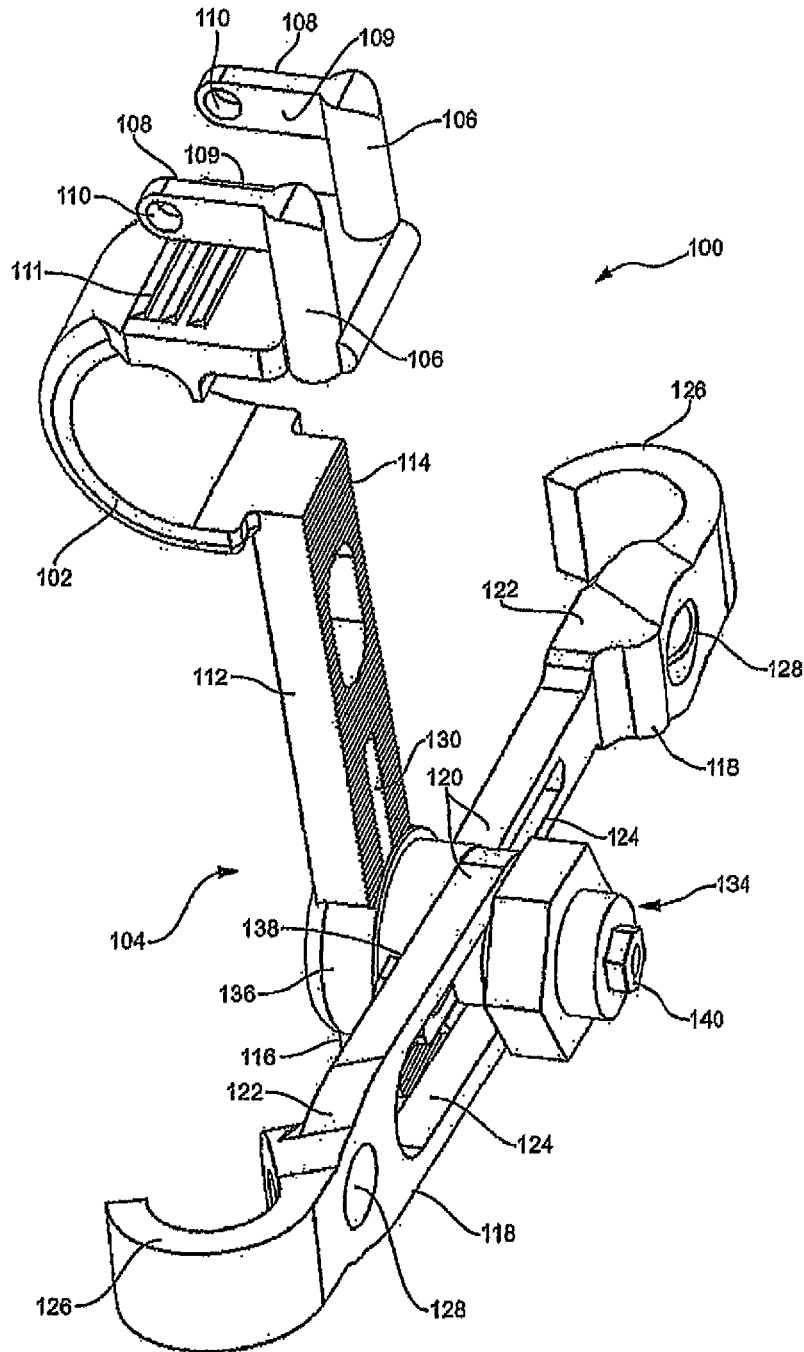


FIG. 15

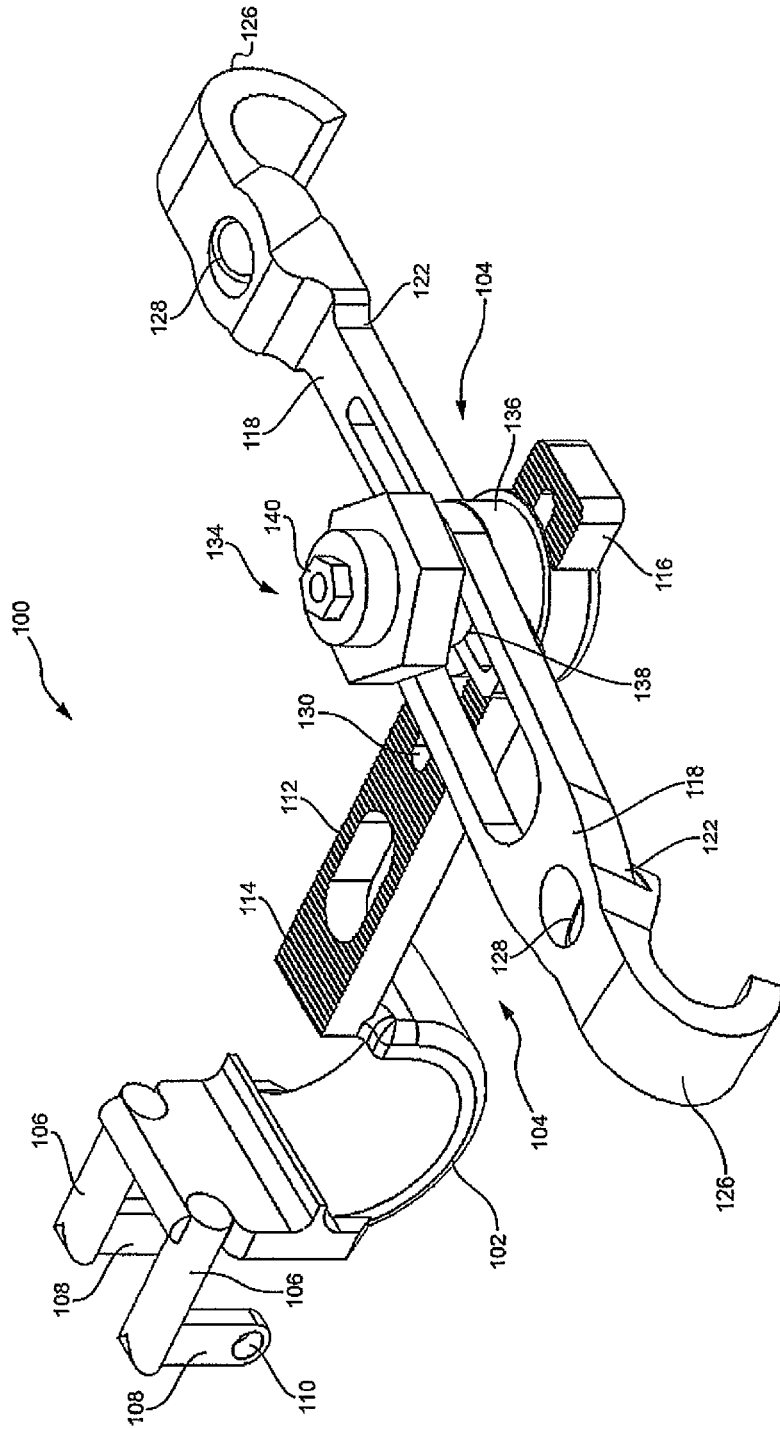


FIG. 16

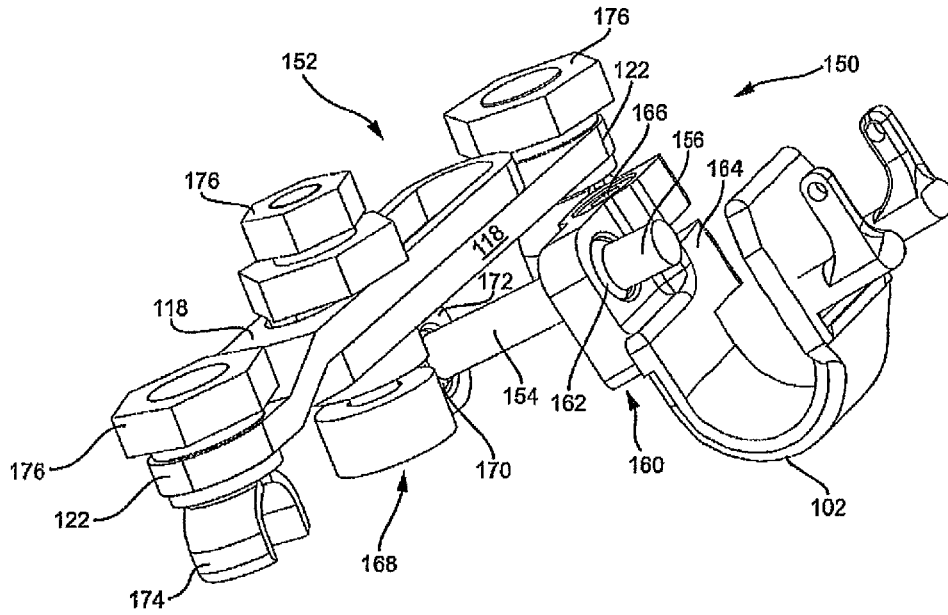


FIG. 17A

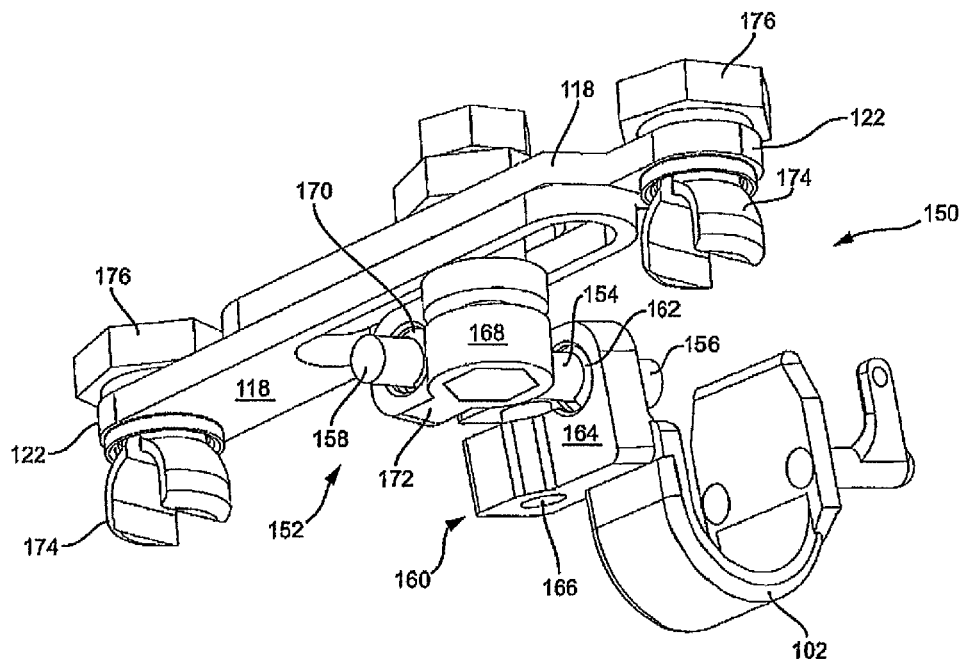


FIG. 17B

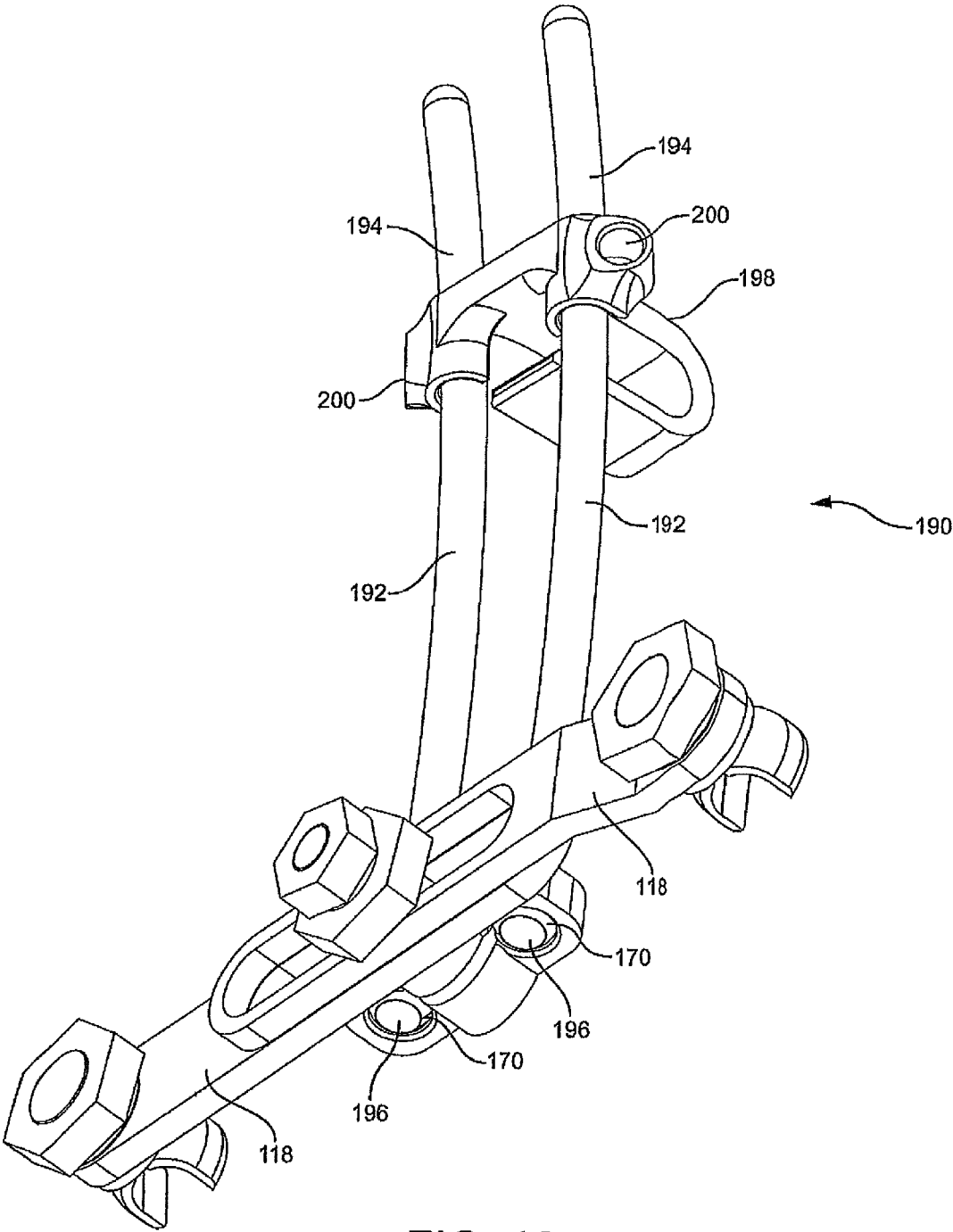


FIG. 18

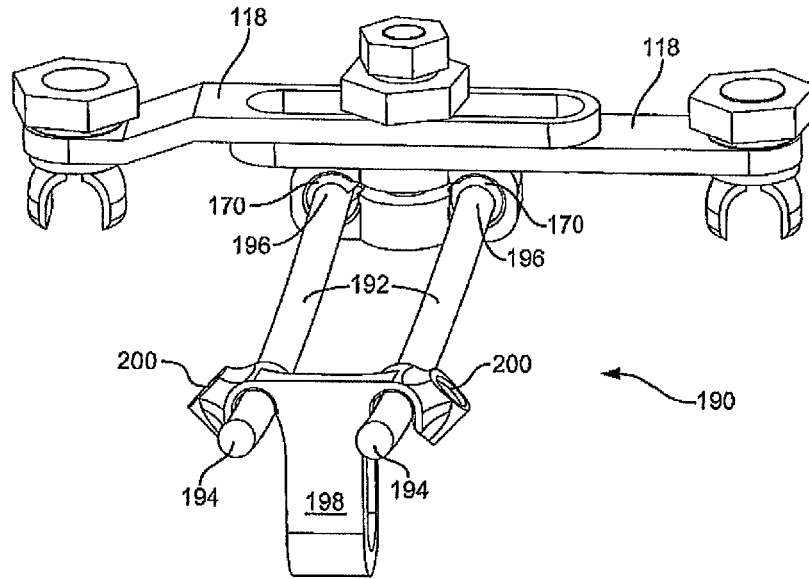


FIG. 19A

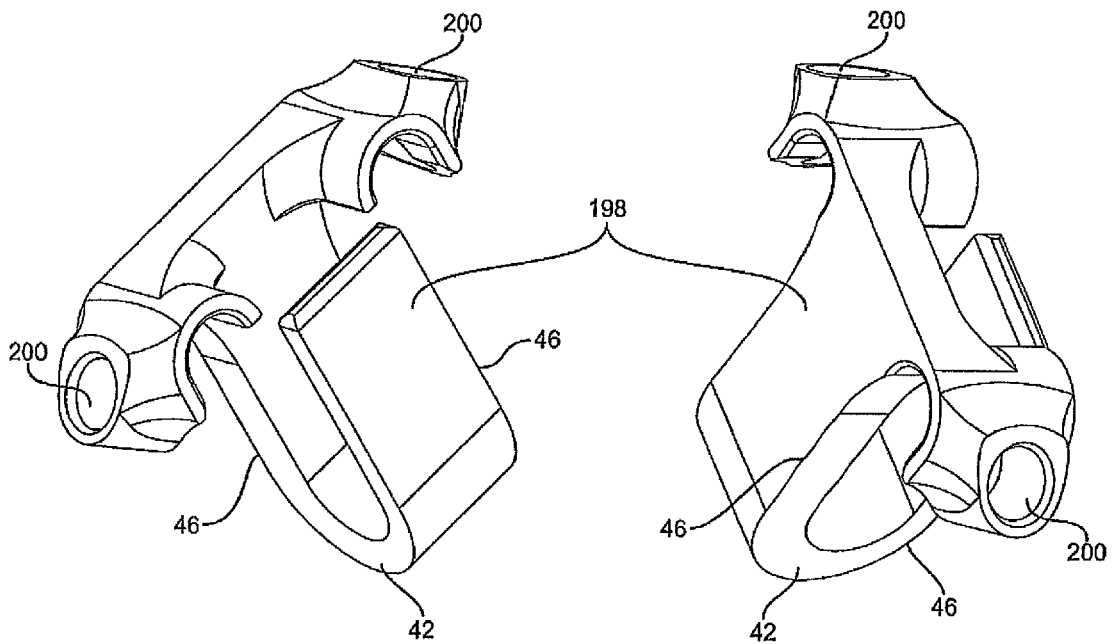


FIG. 19B

FIG. 19C

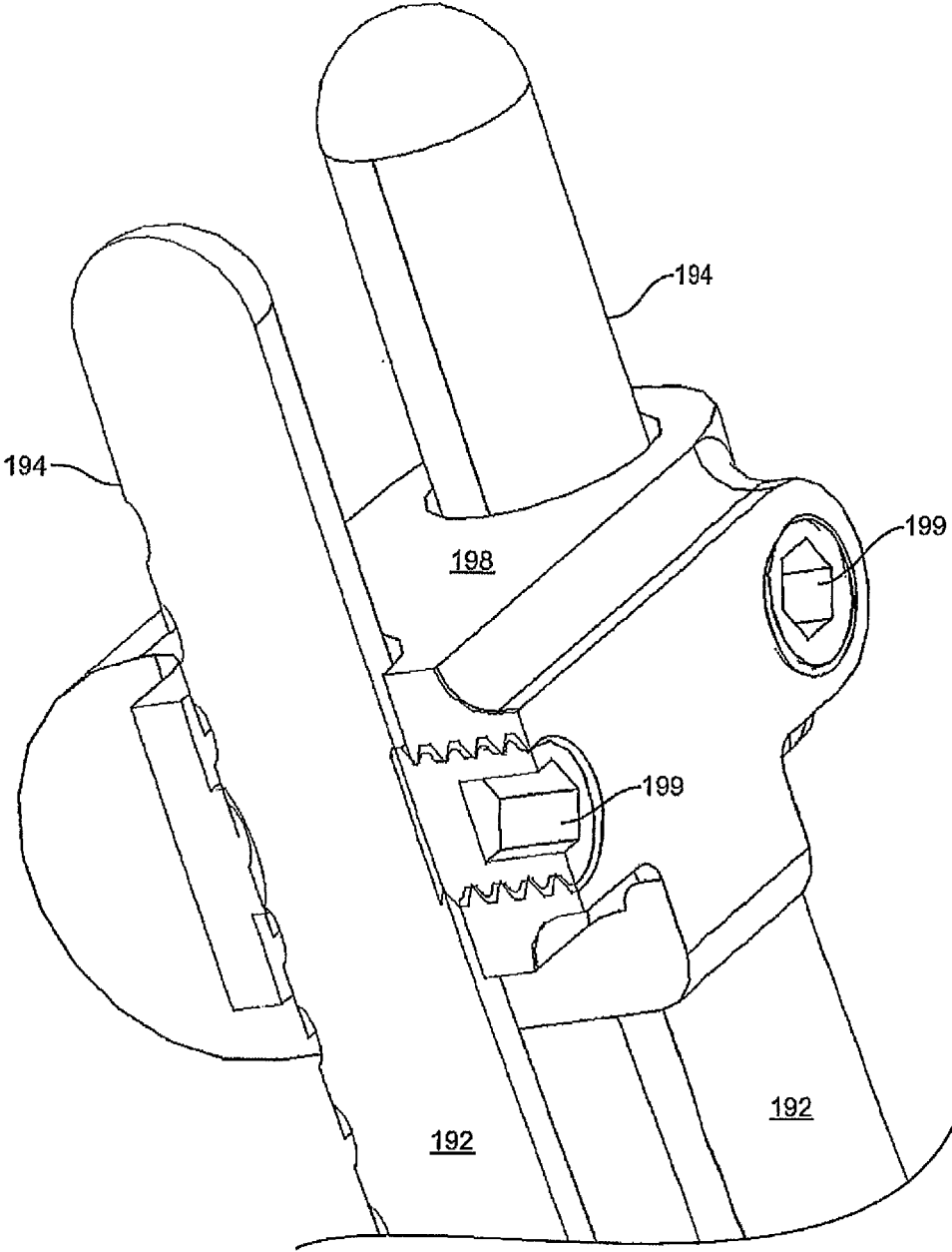


FIG. 20

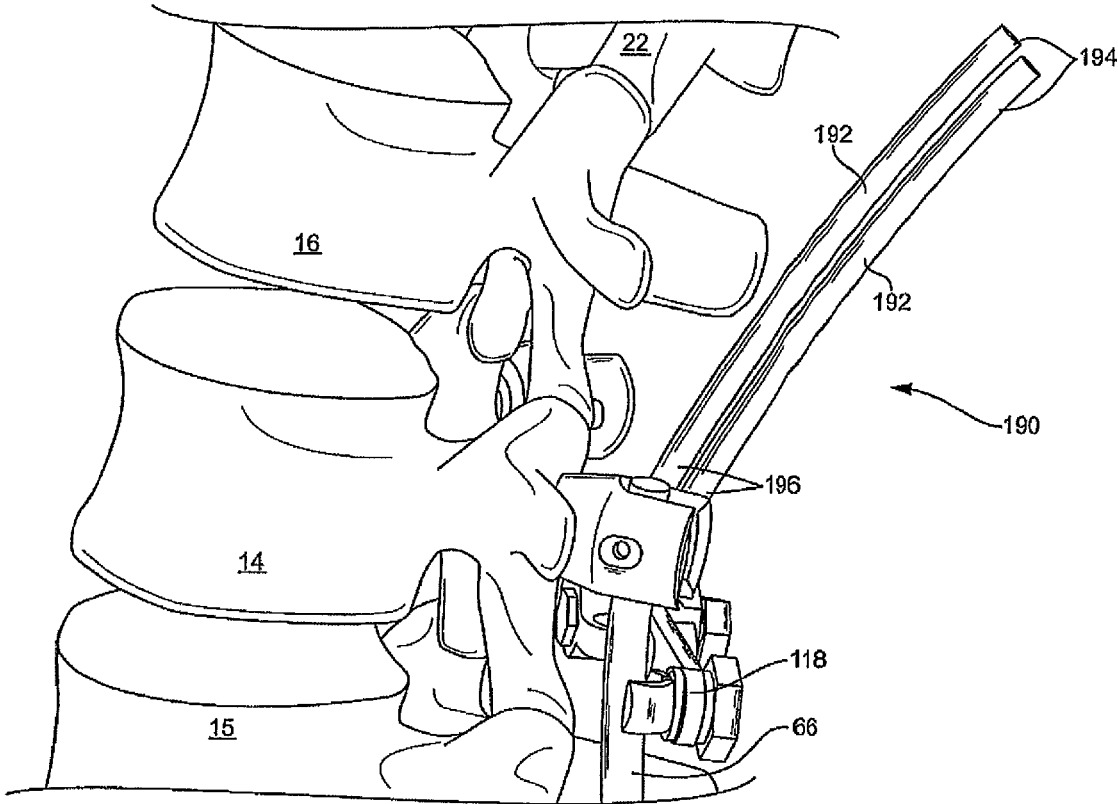


FIG. 21

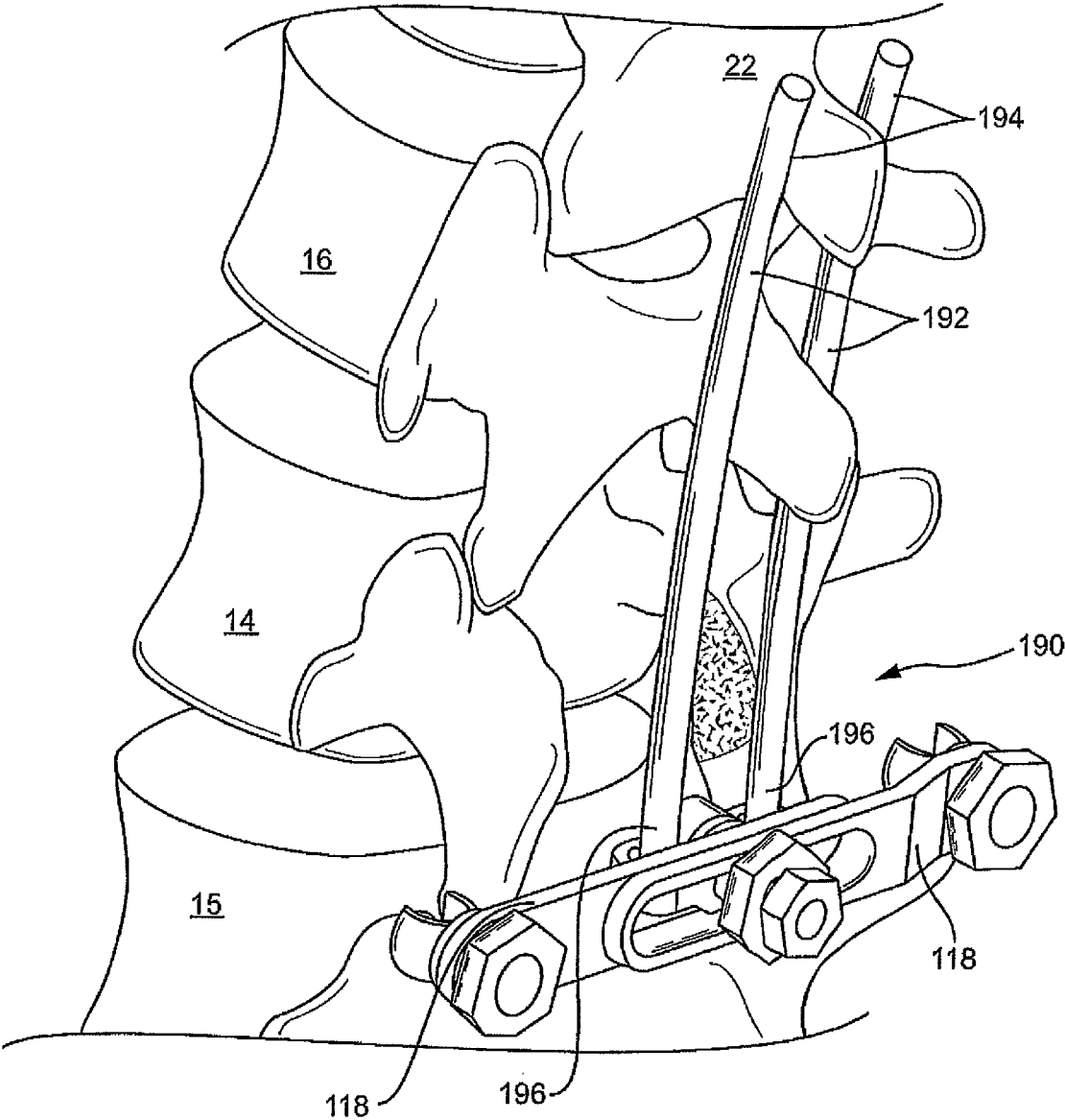


FIG. 22

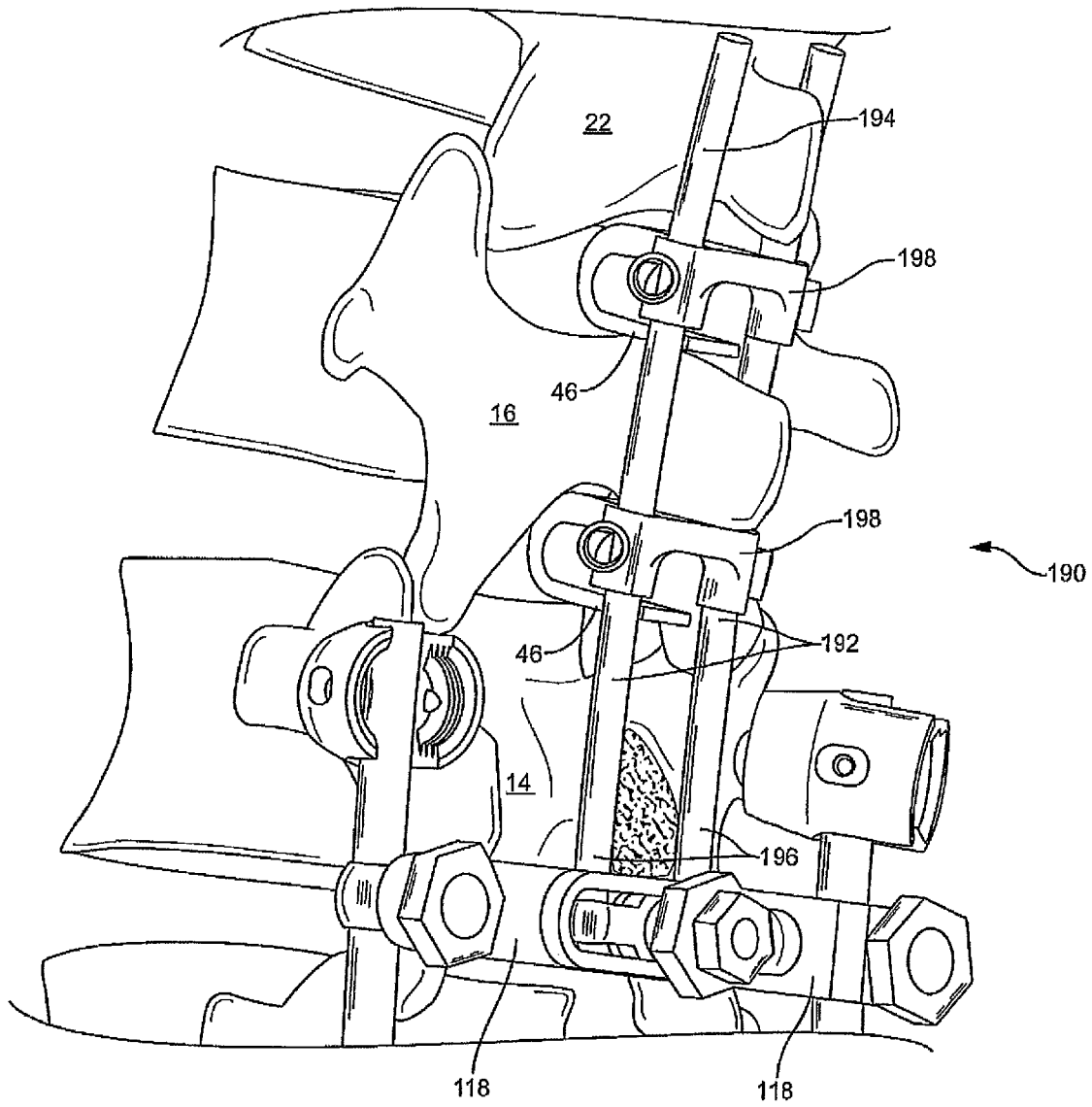


FIG. 23A

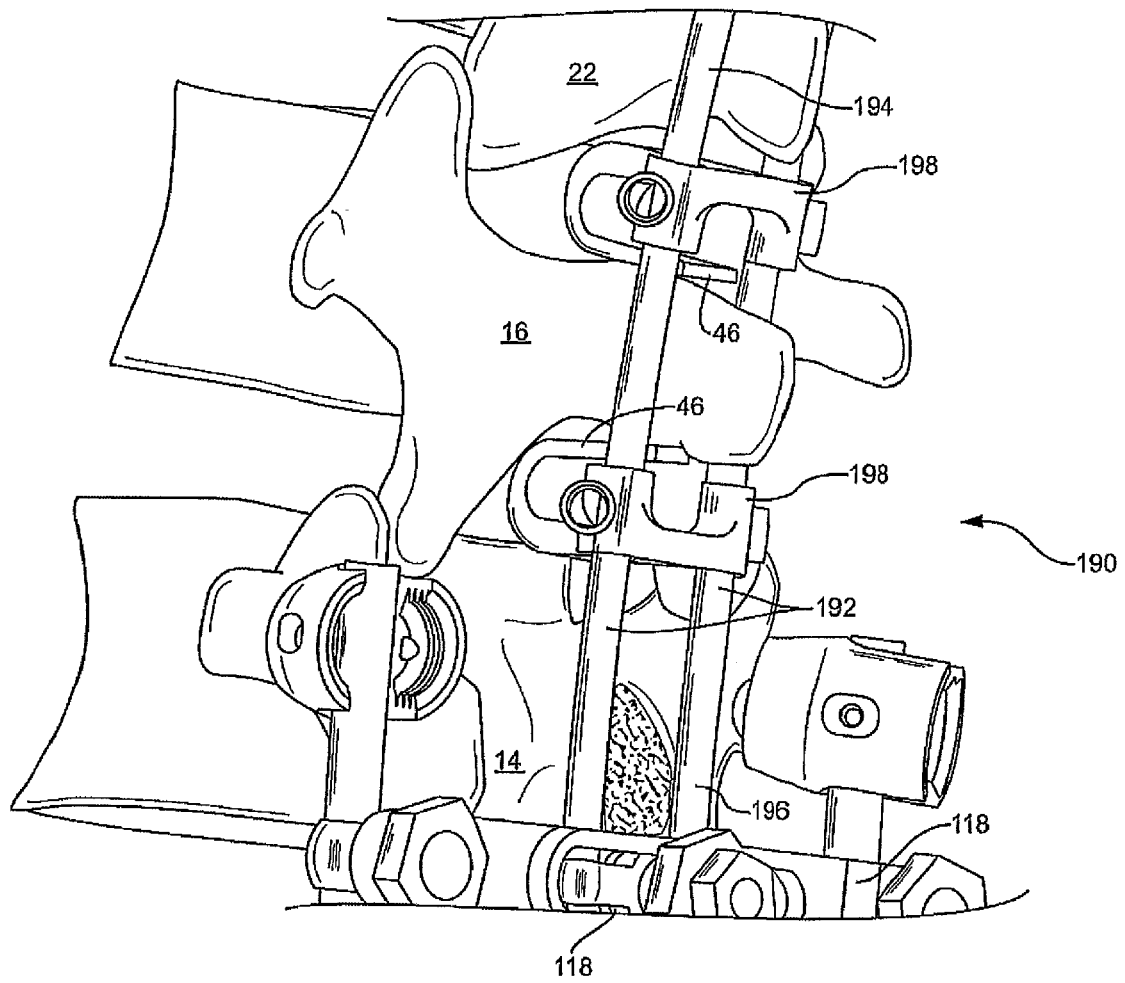


FIG. 23B

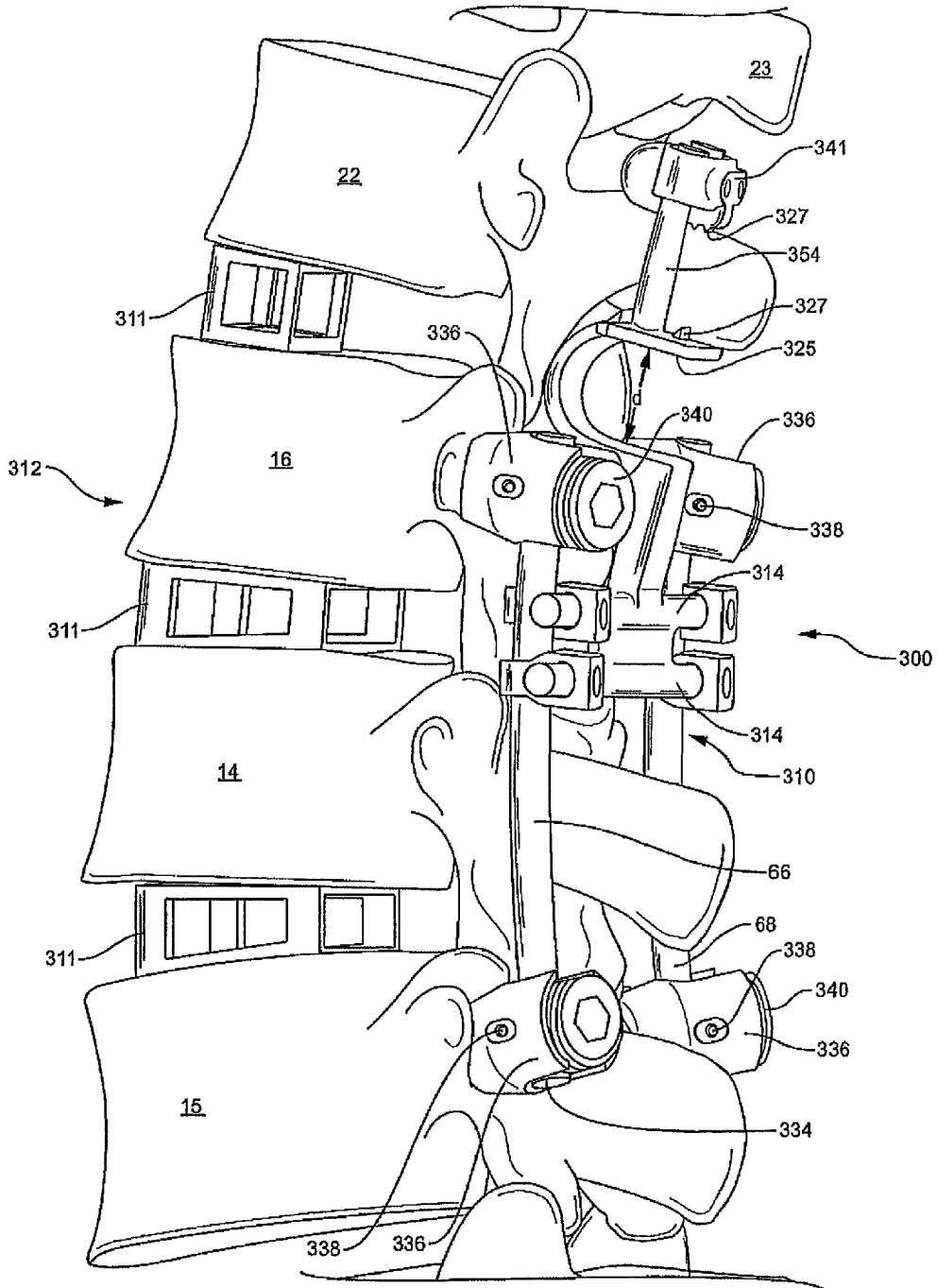


FIG. 24

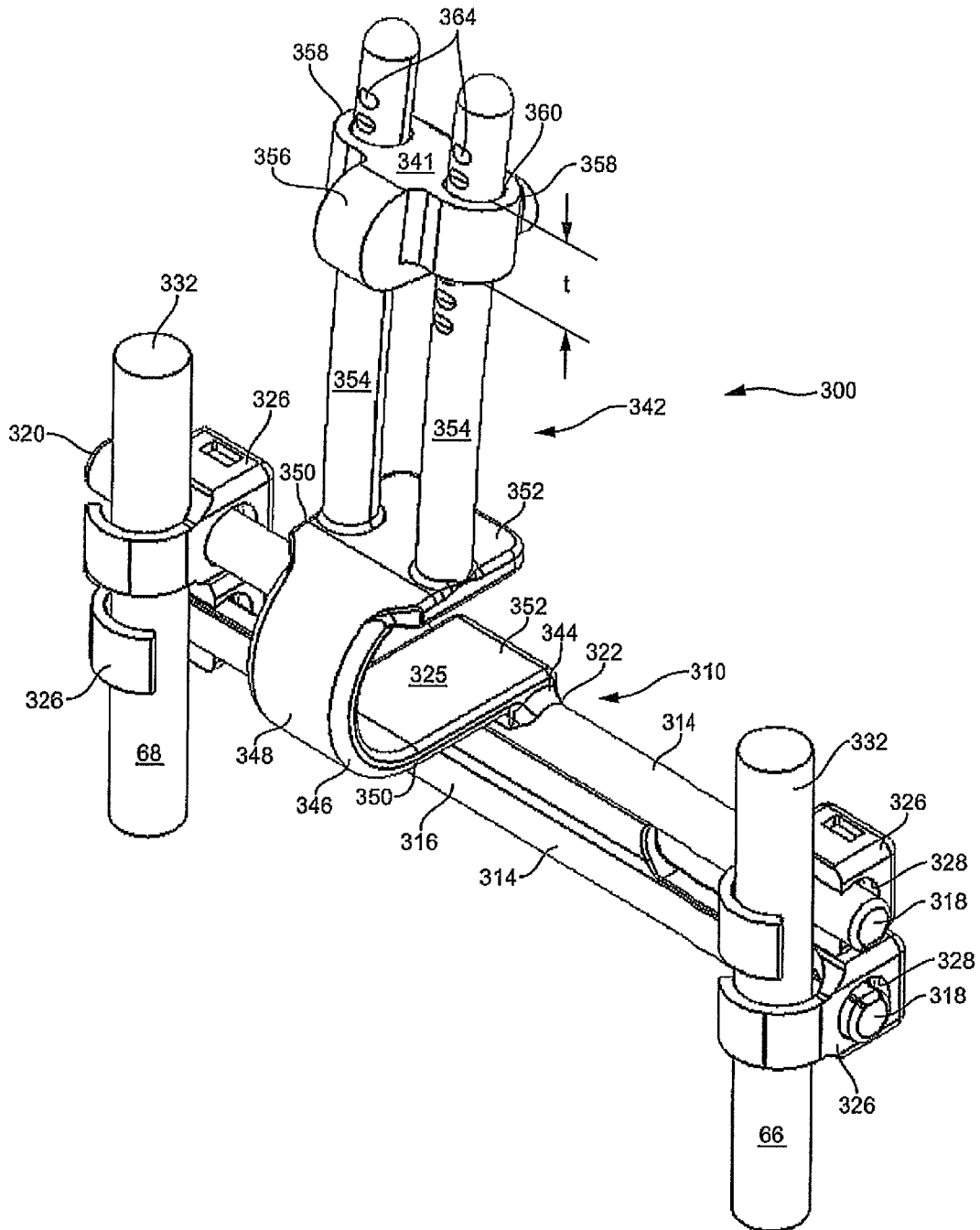


FIG. 25

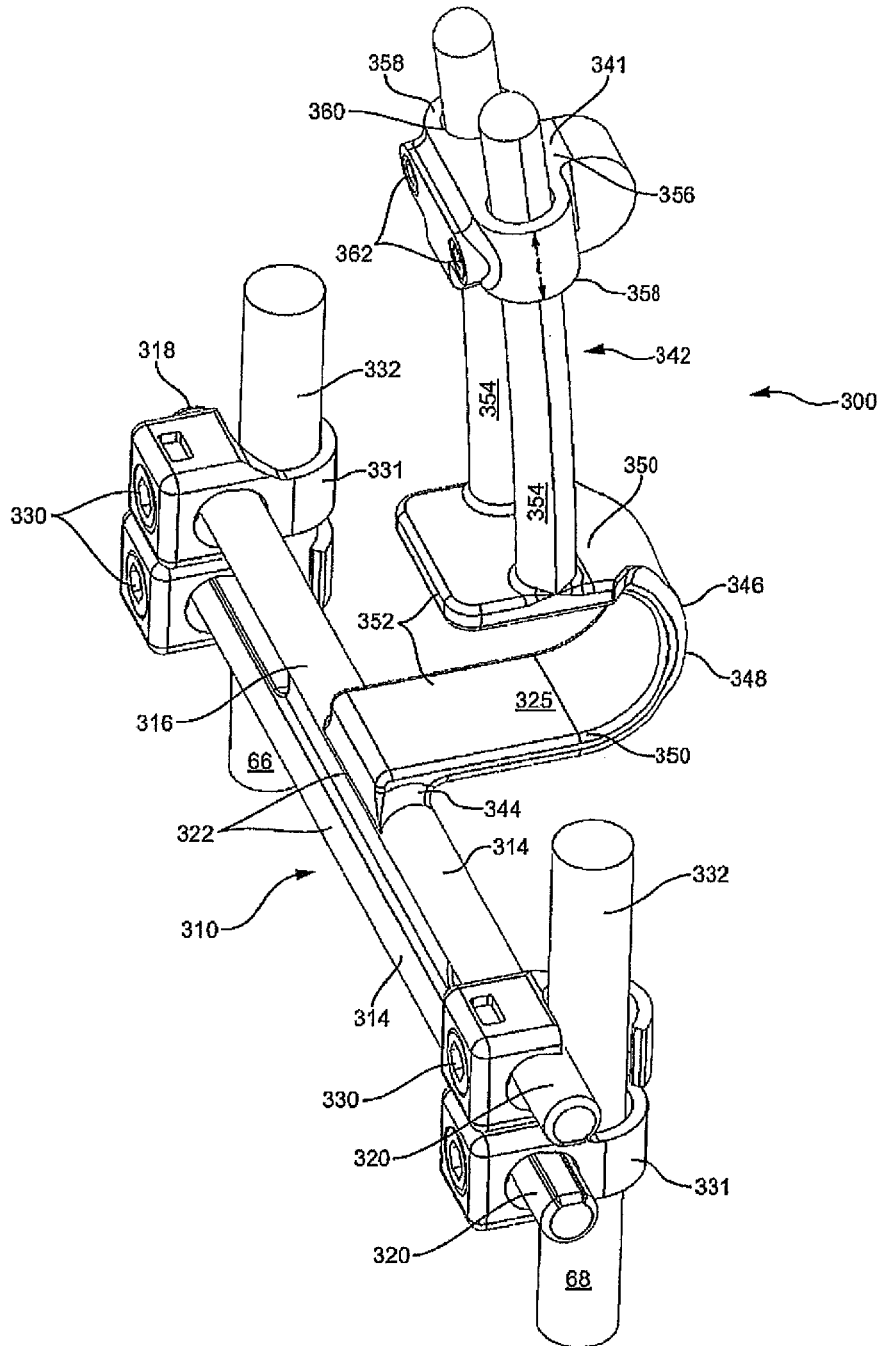


FIG. 26

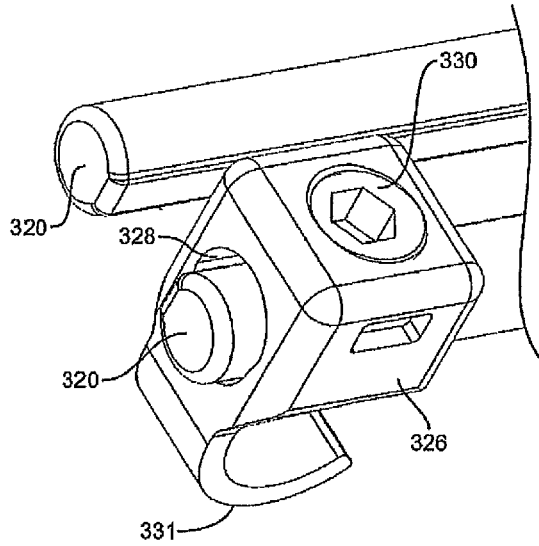


FIG. 27A

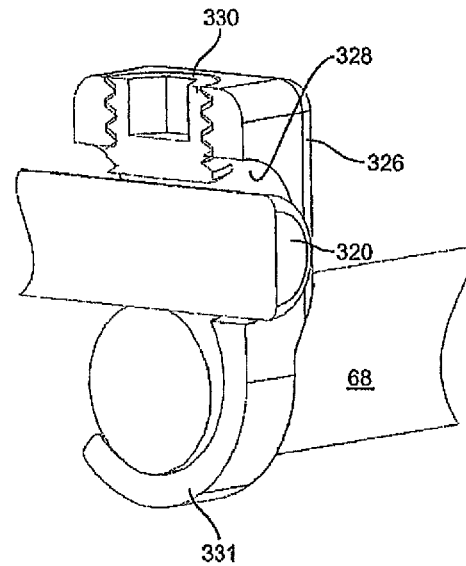


FIG. 27B

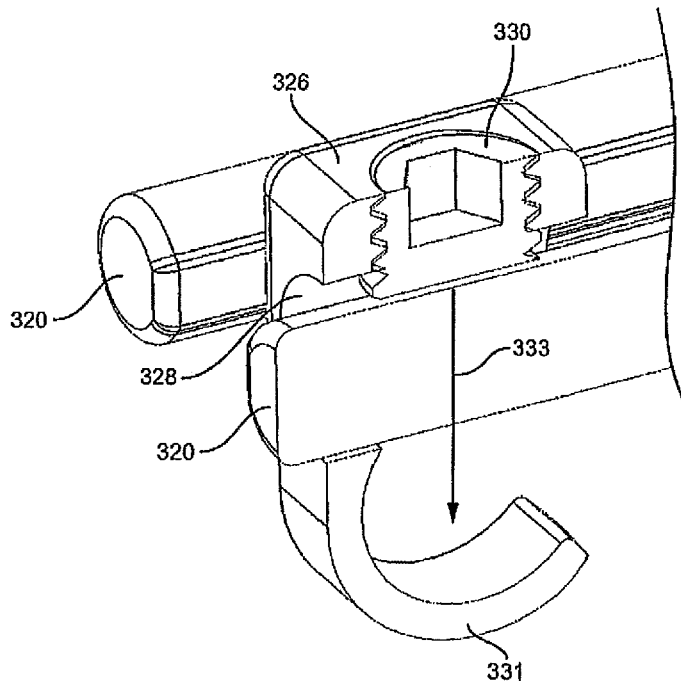


FIG. 27C

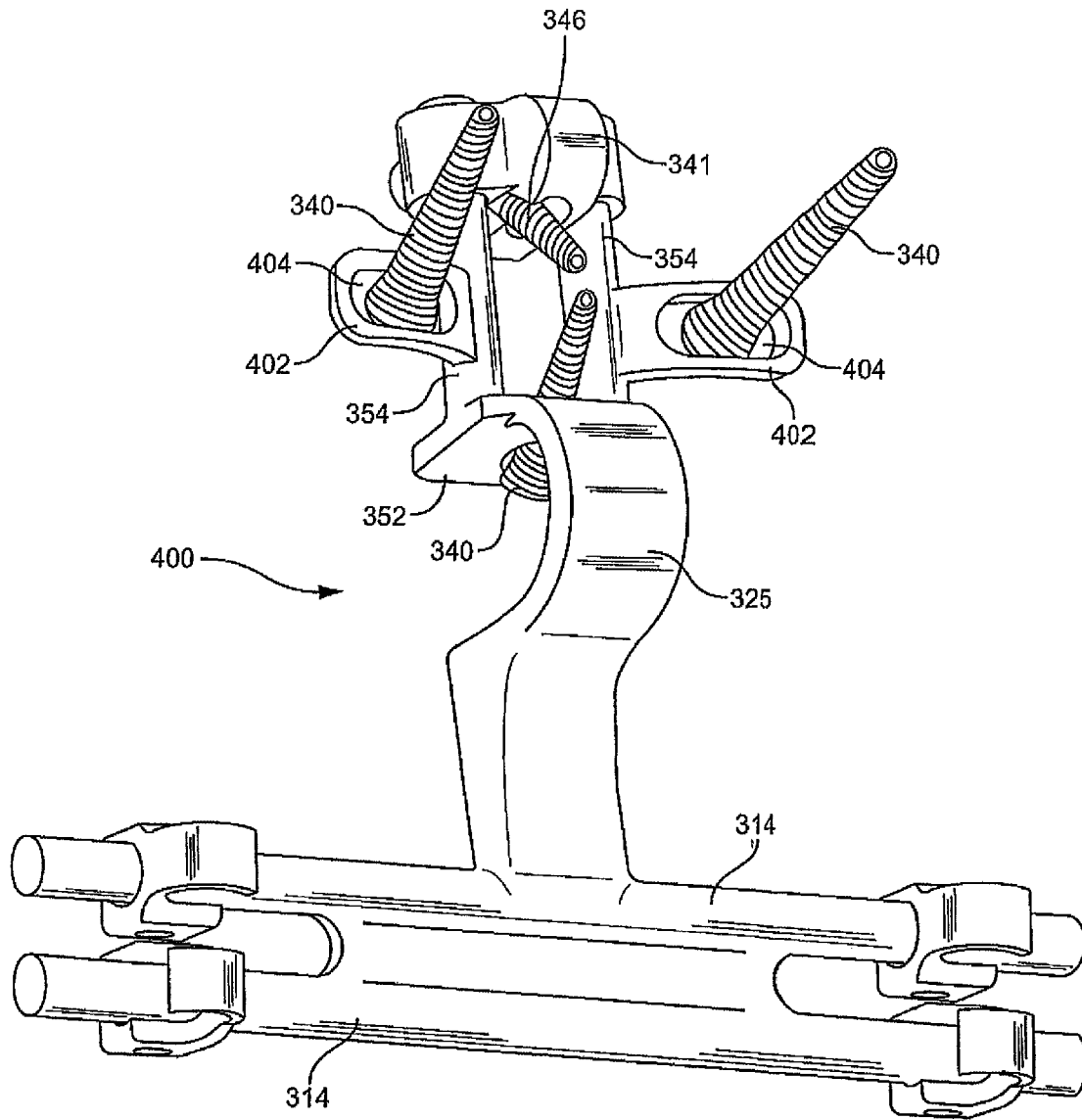


FIG. 28

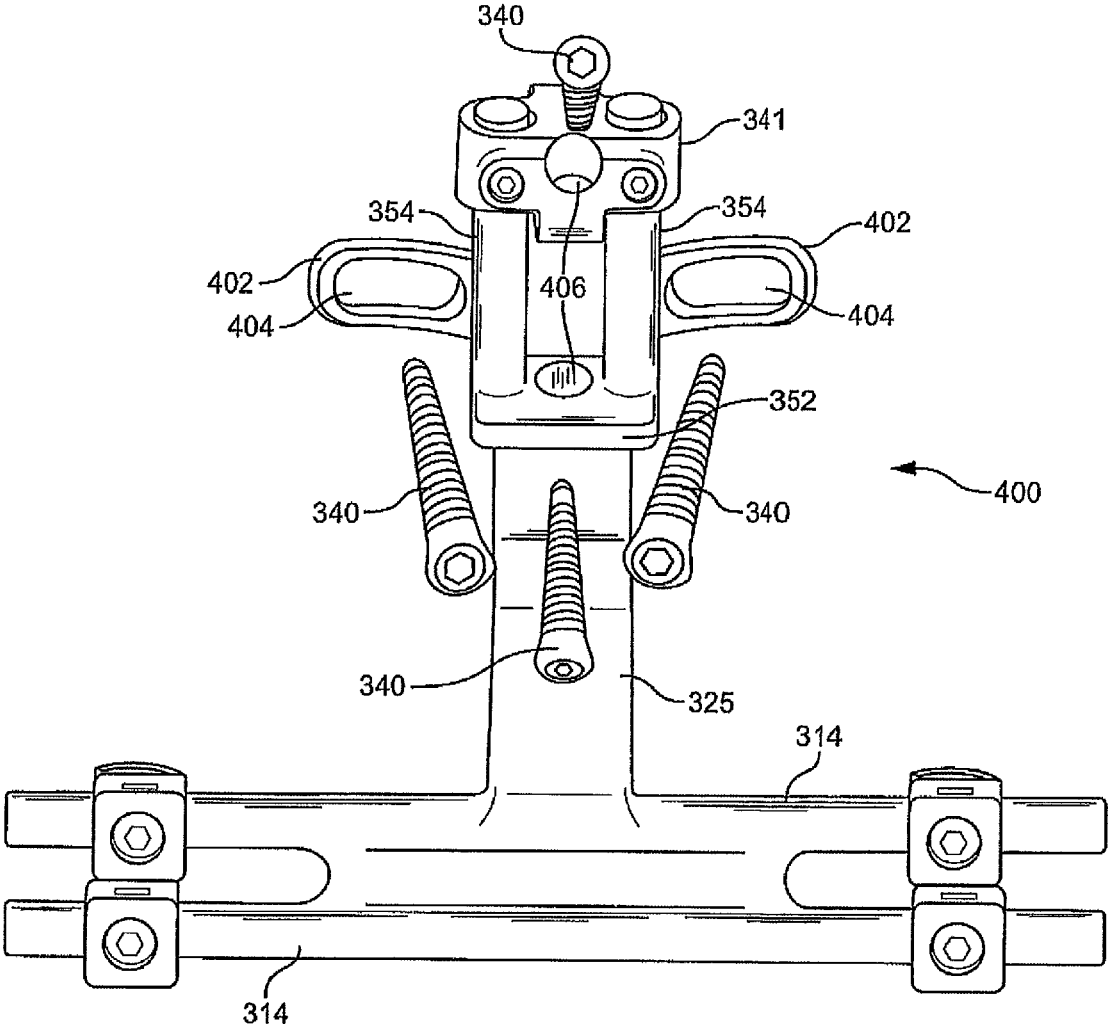


FIG. 29

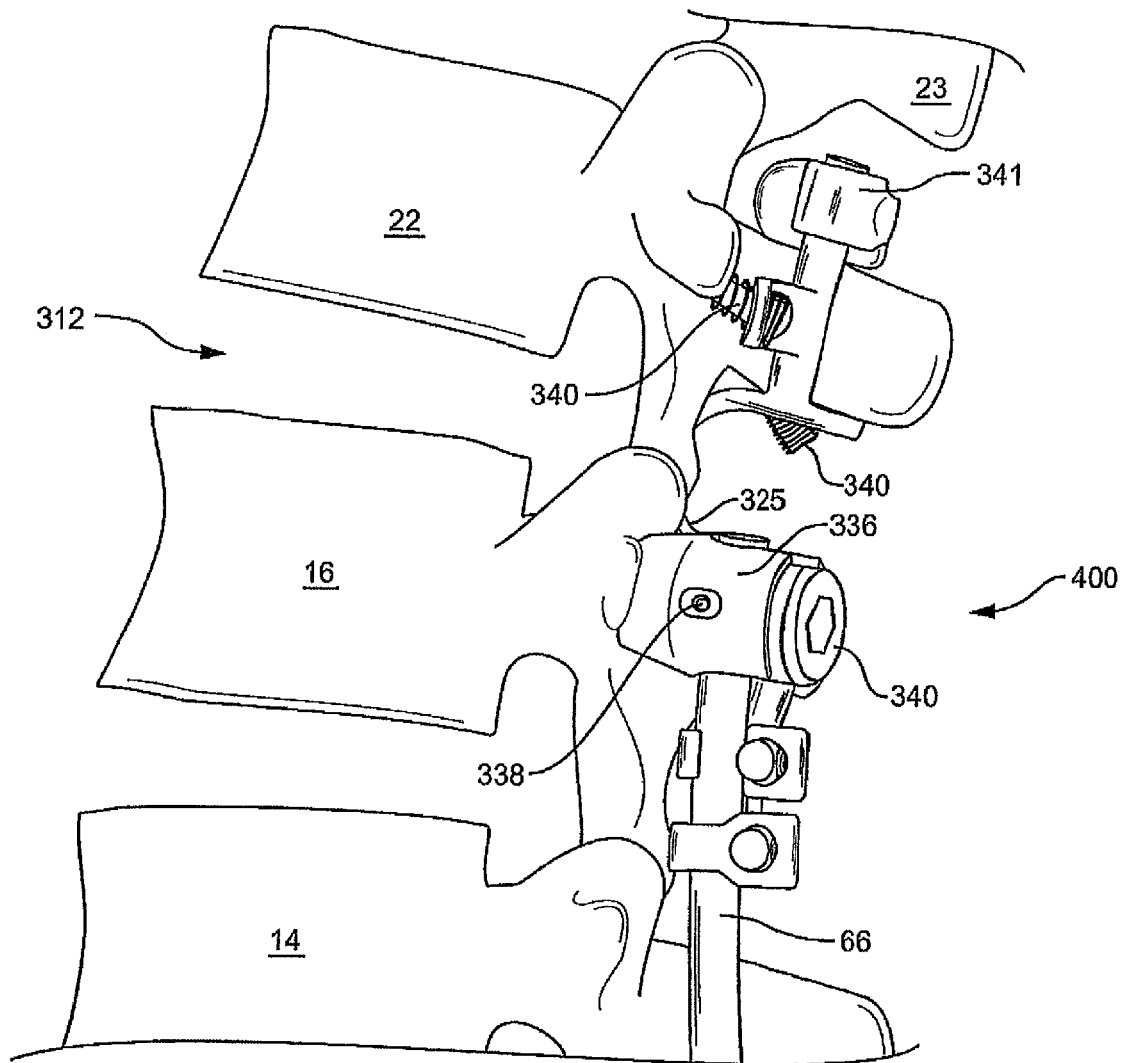


FIG. 30

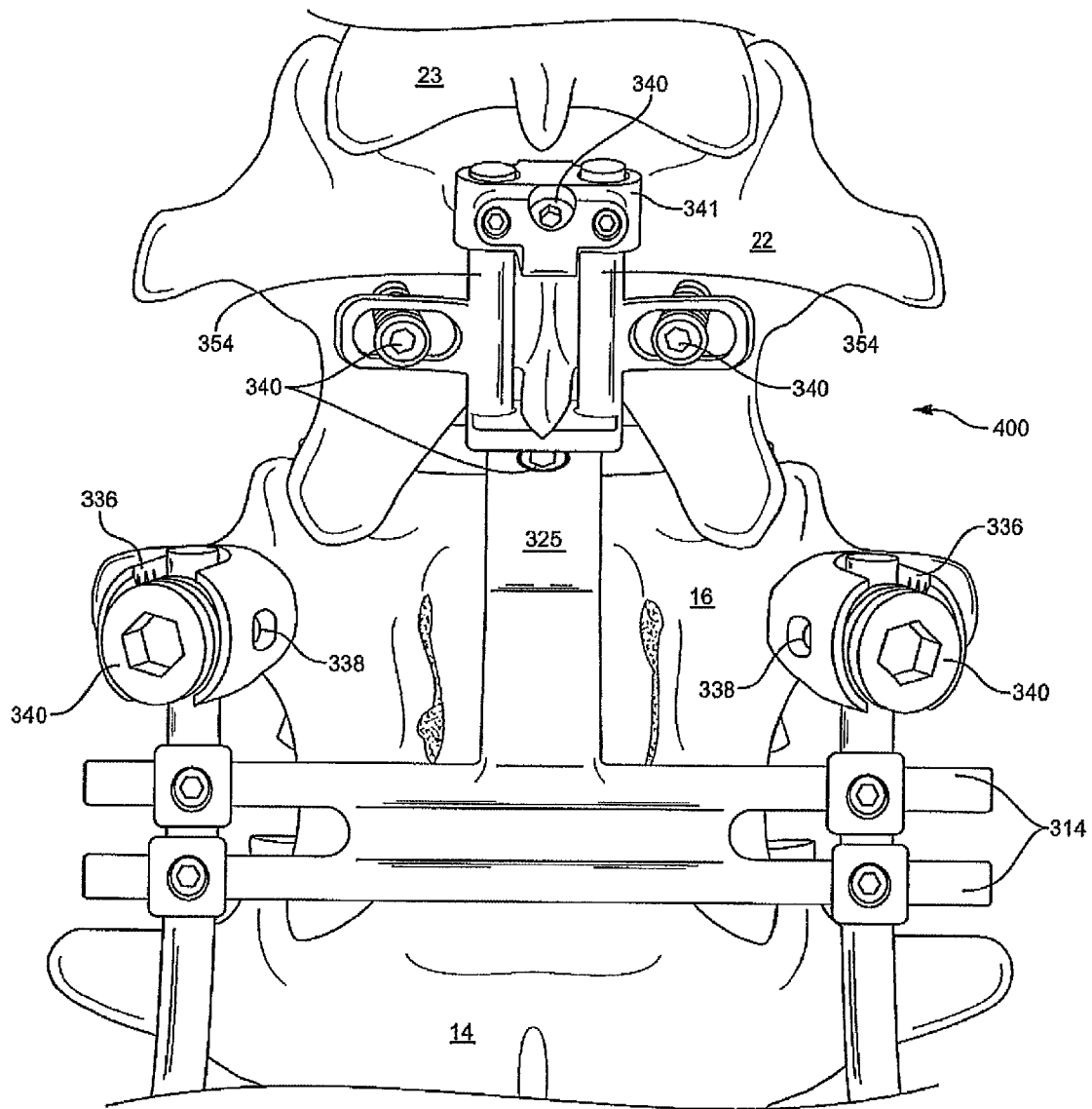


FIG. 31

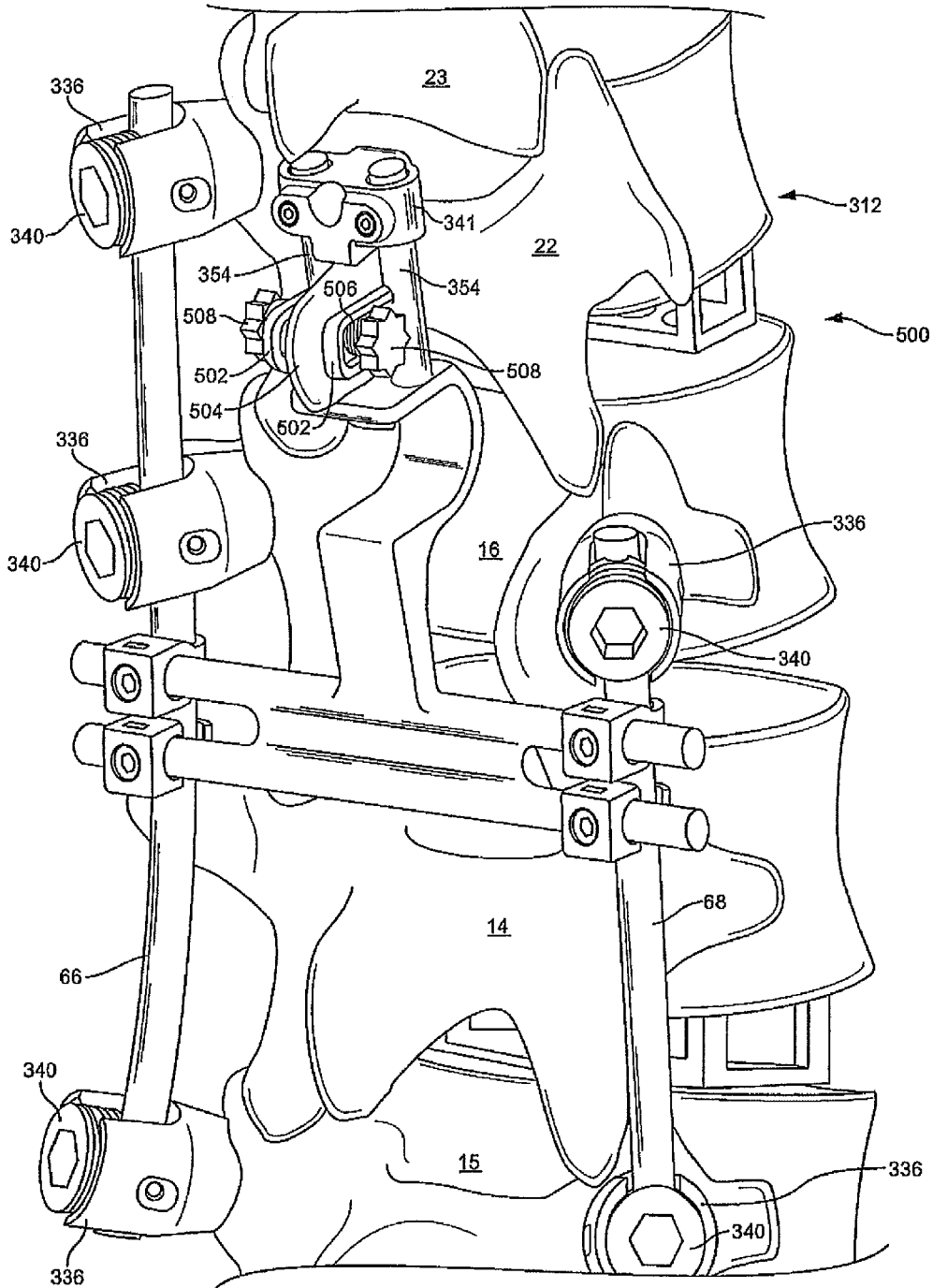


FIG. 32

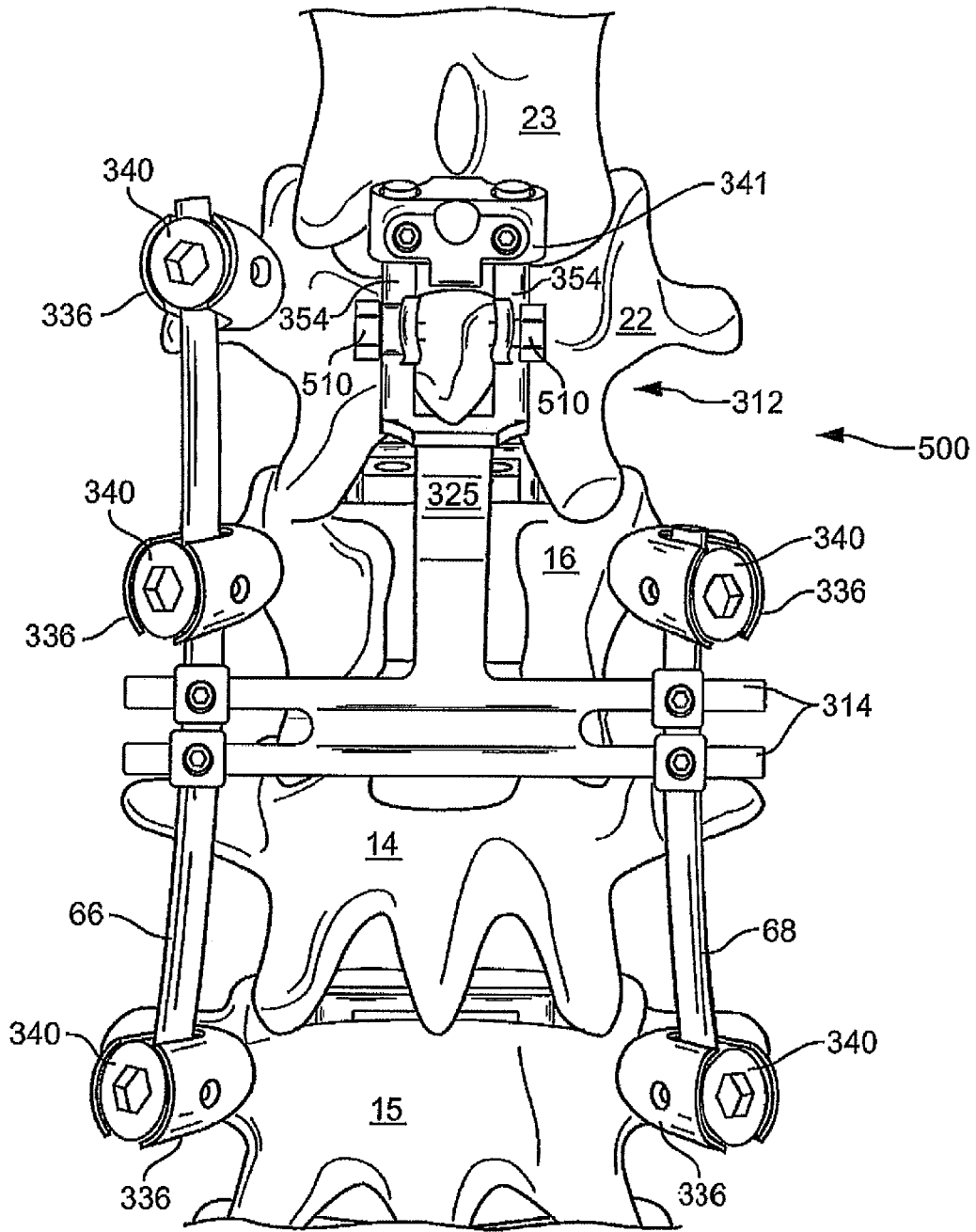


FIG. 33

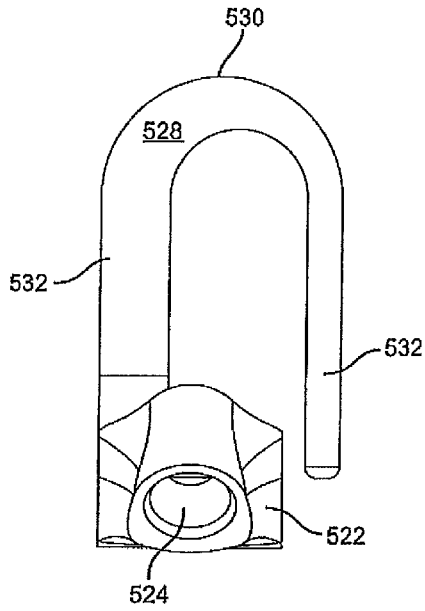


FIG. 34A

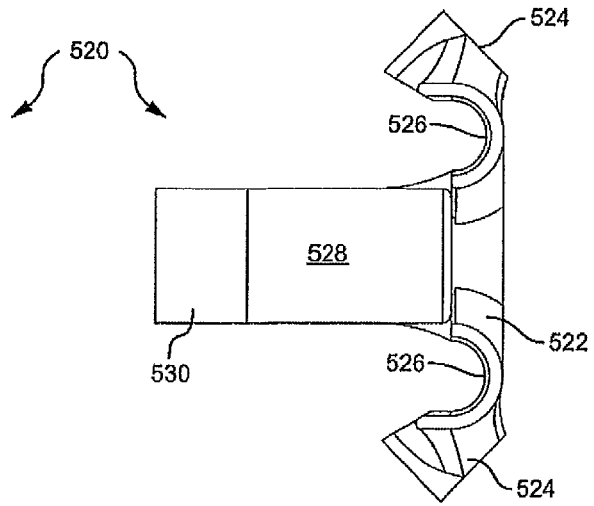


FIG. 34B

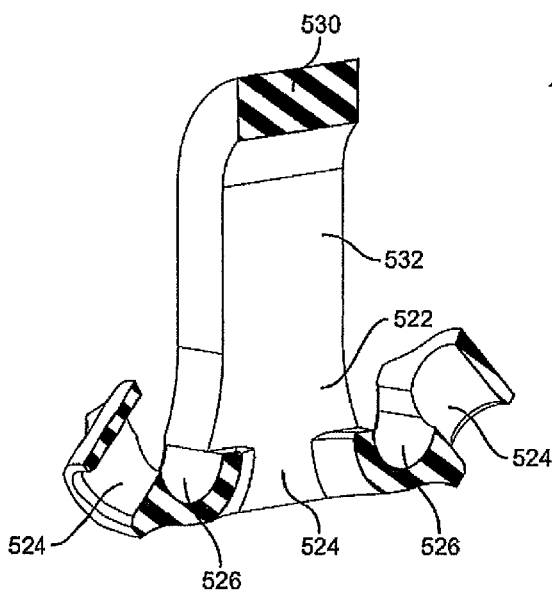


FIG. 34C

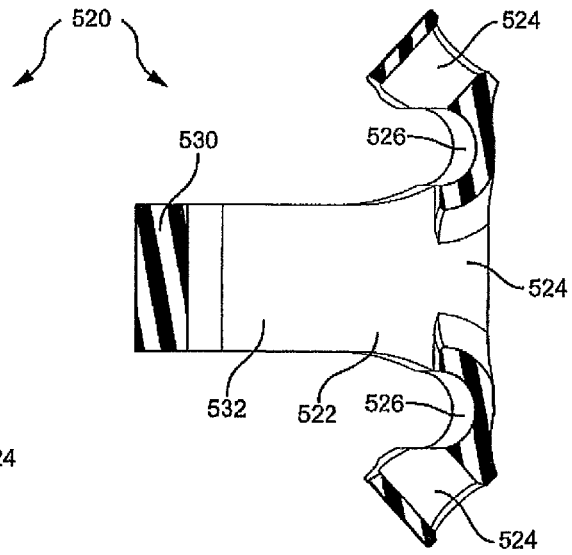


FIG. 34D

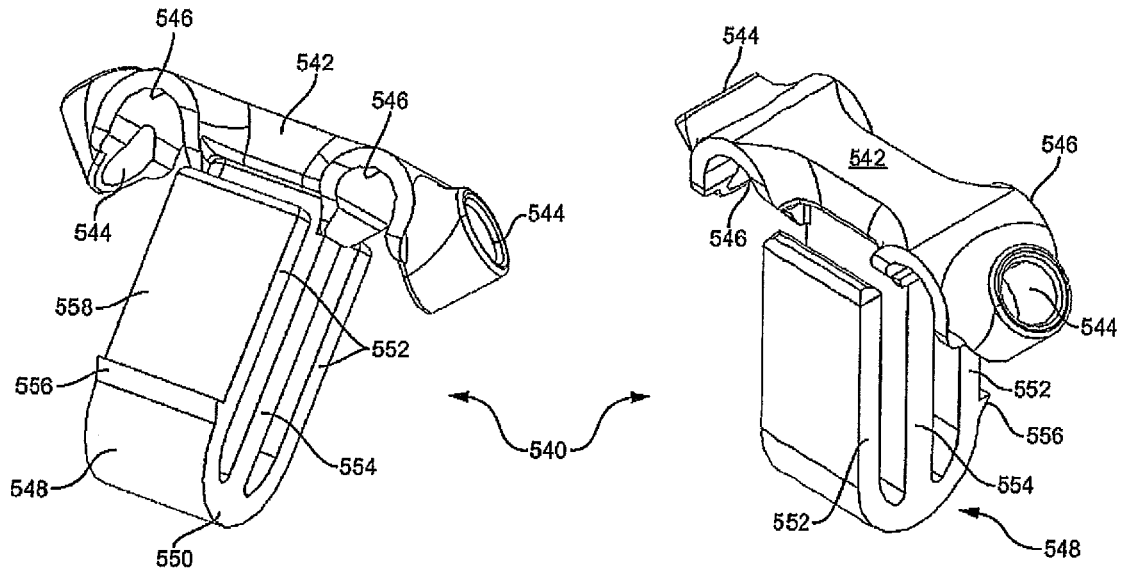


FIG. 35A

FIG. 35B

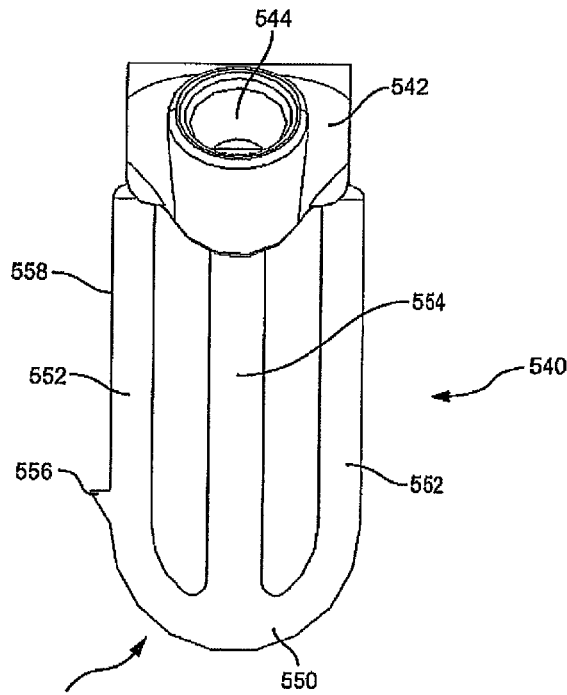


FIG. 35C

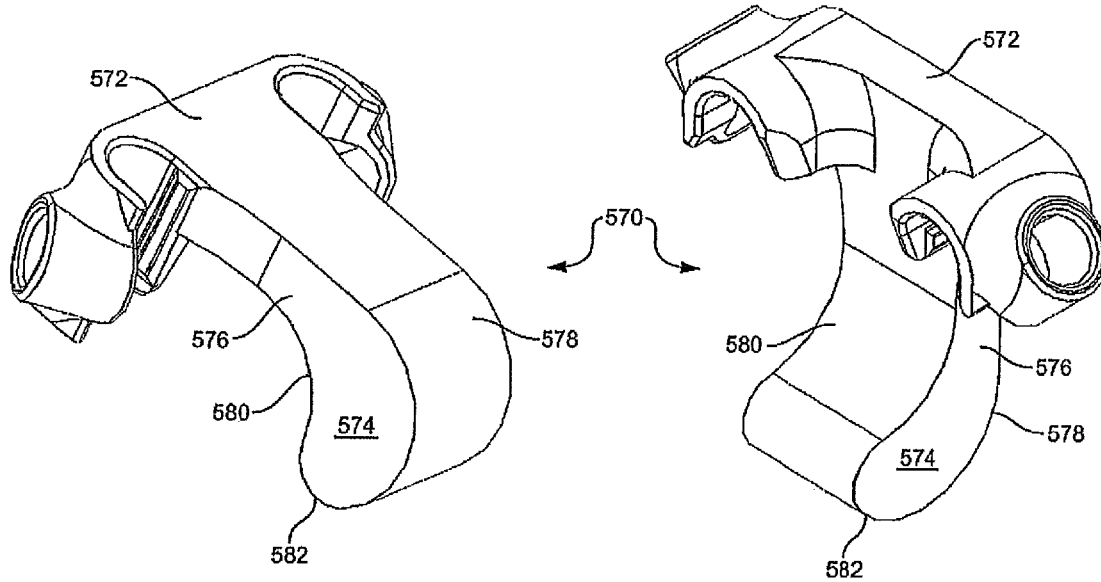


FIG. 36A

FIG. 36B

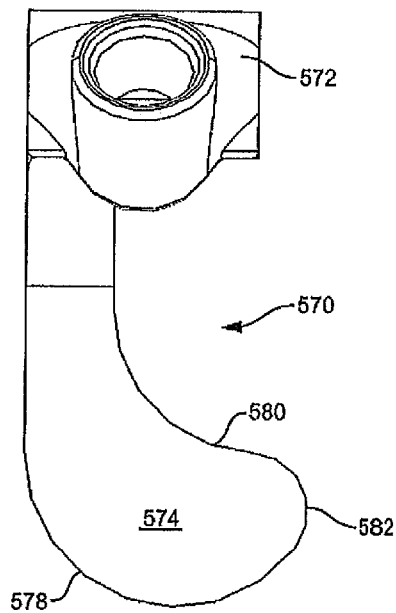


FIG. 36C

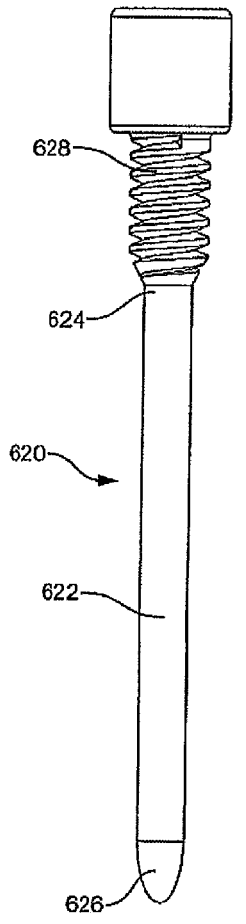


FIG. 37C

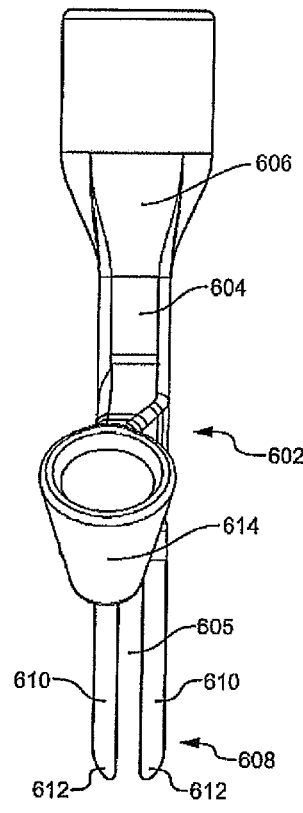


FIG. 37B

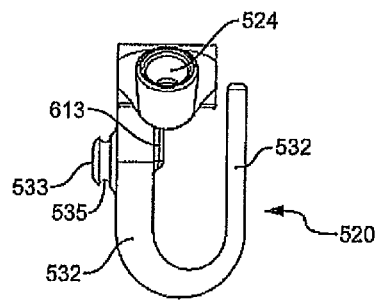


FIG. 37A

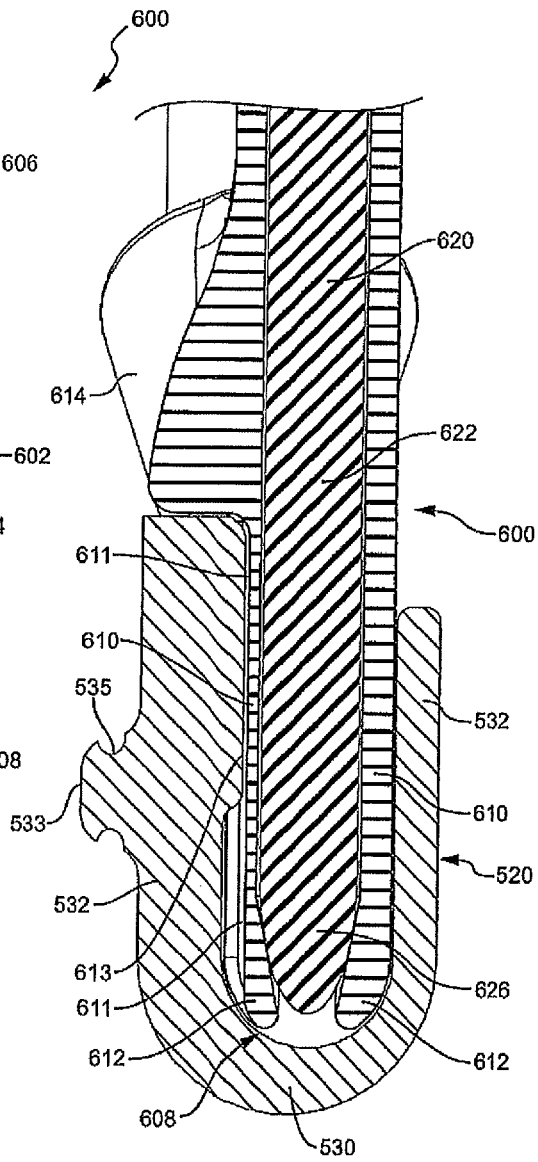


FIG. 37D

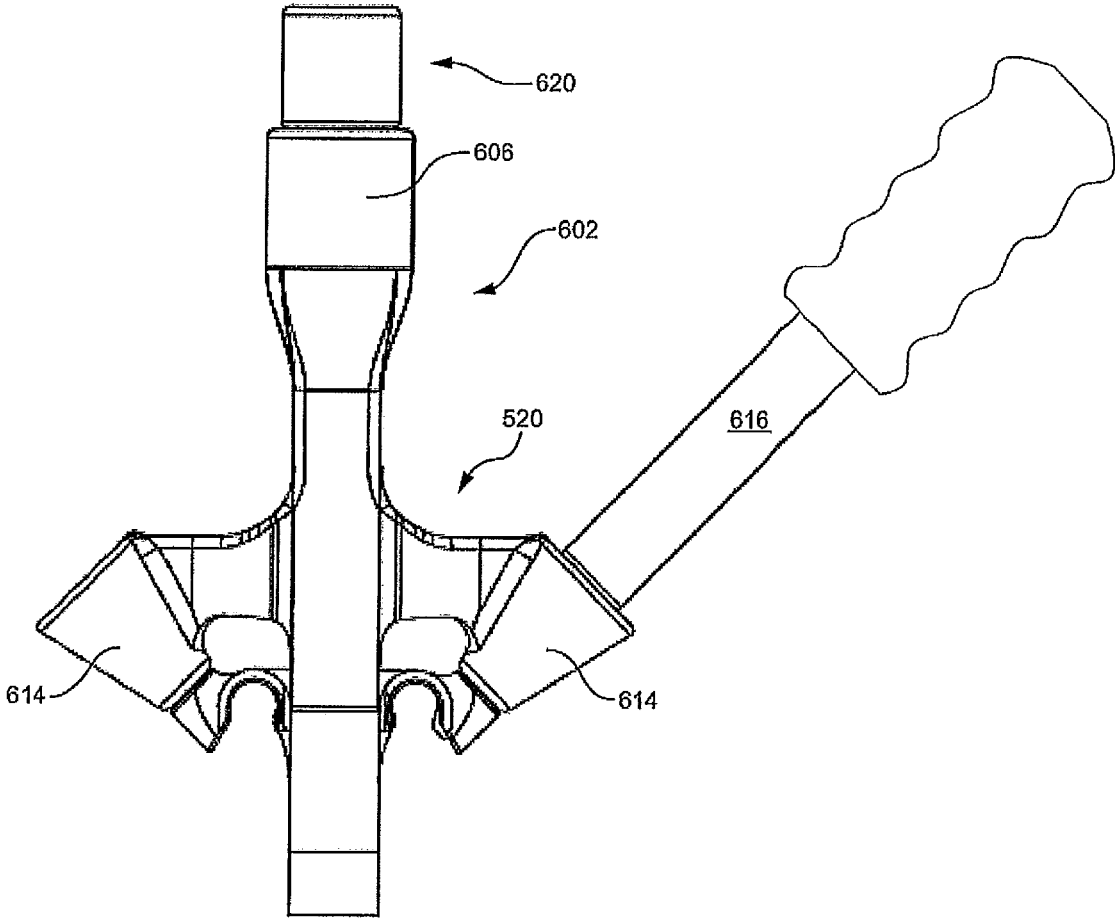


FIG. 38

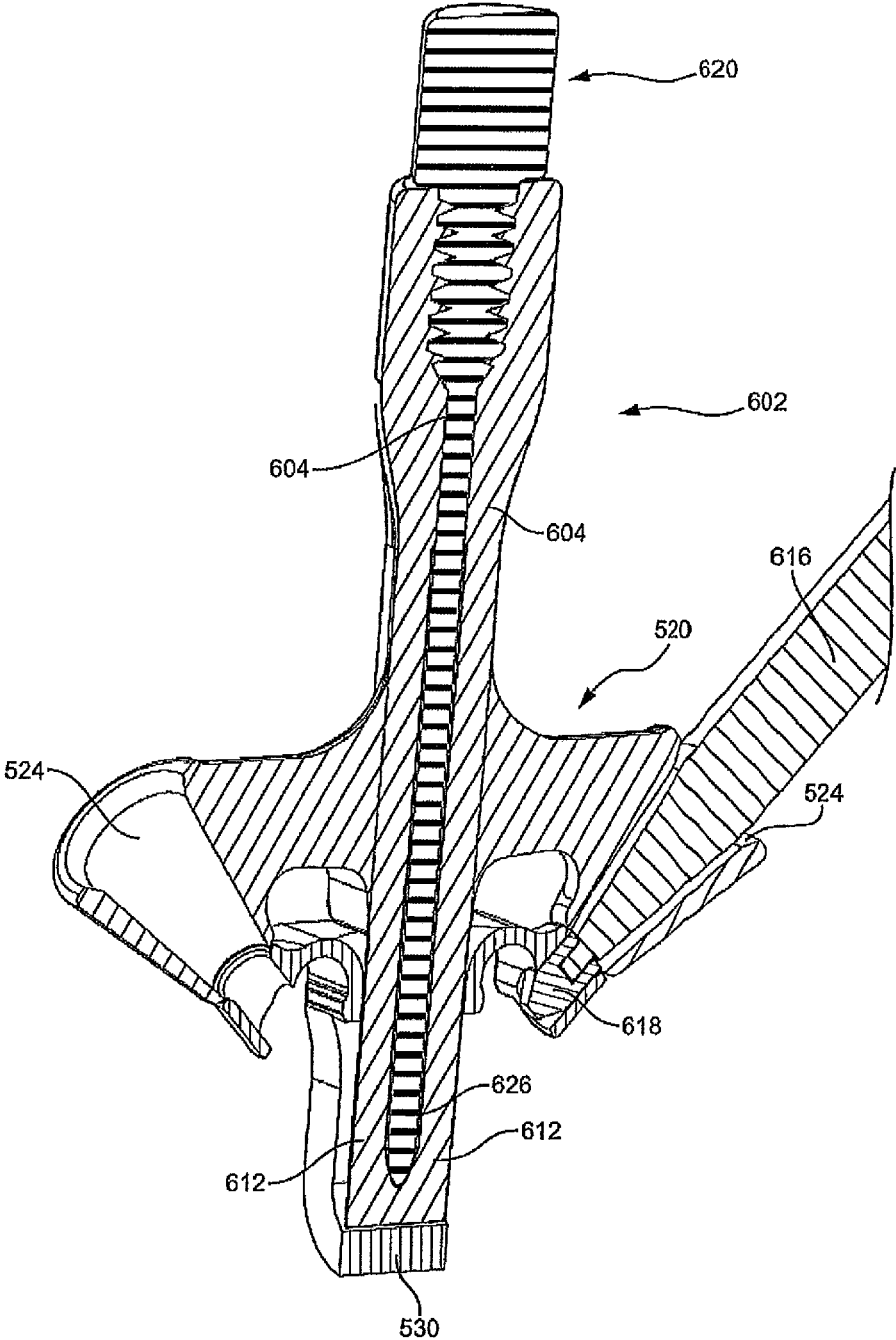


FIG. 39

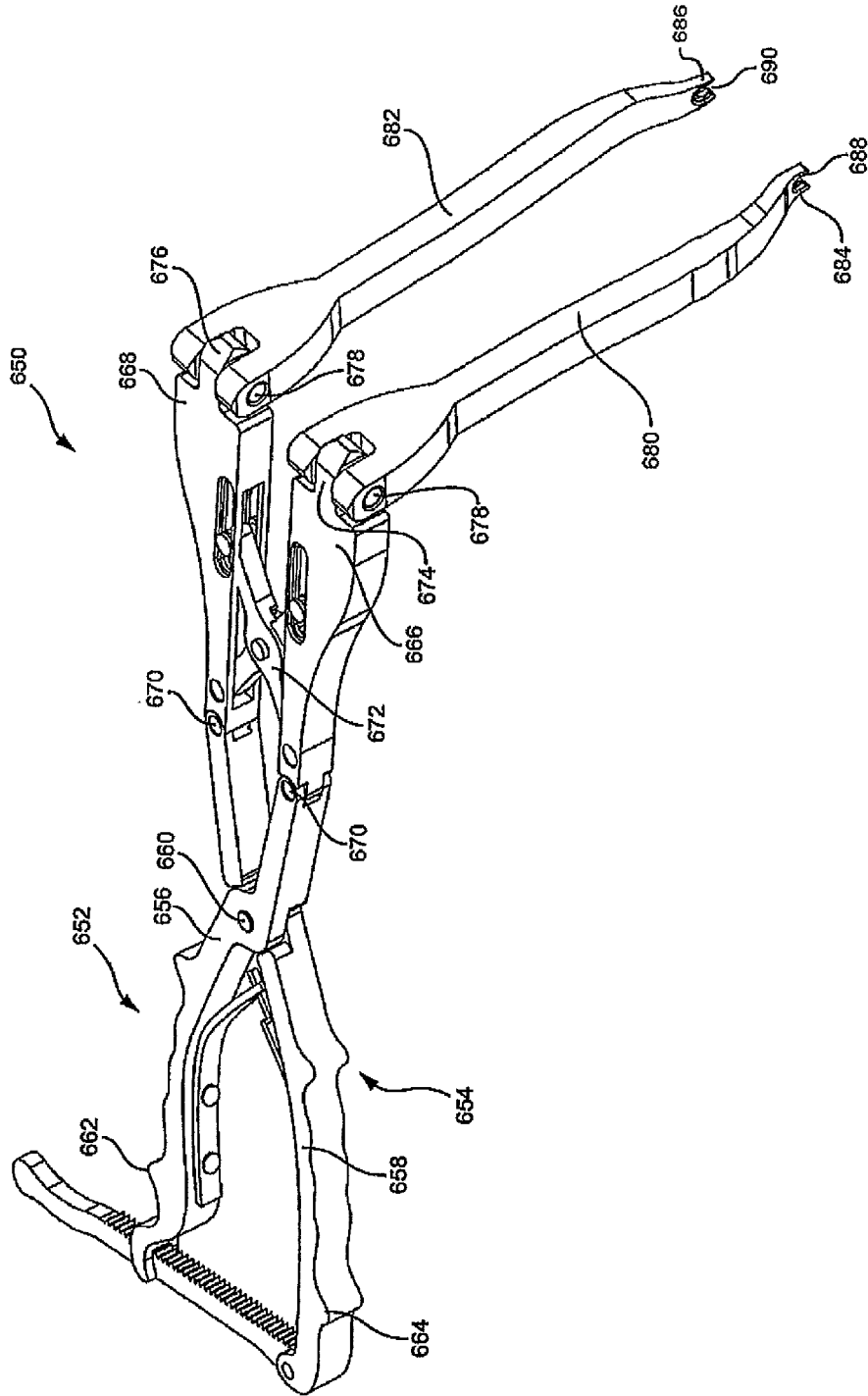


FIG. 40

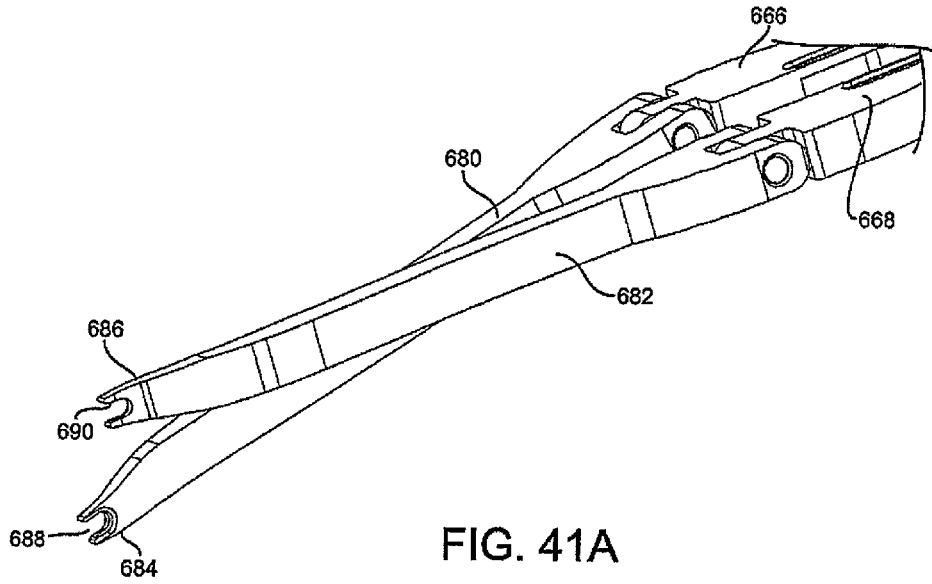


FIG. 41A

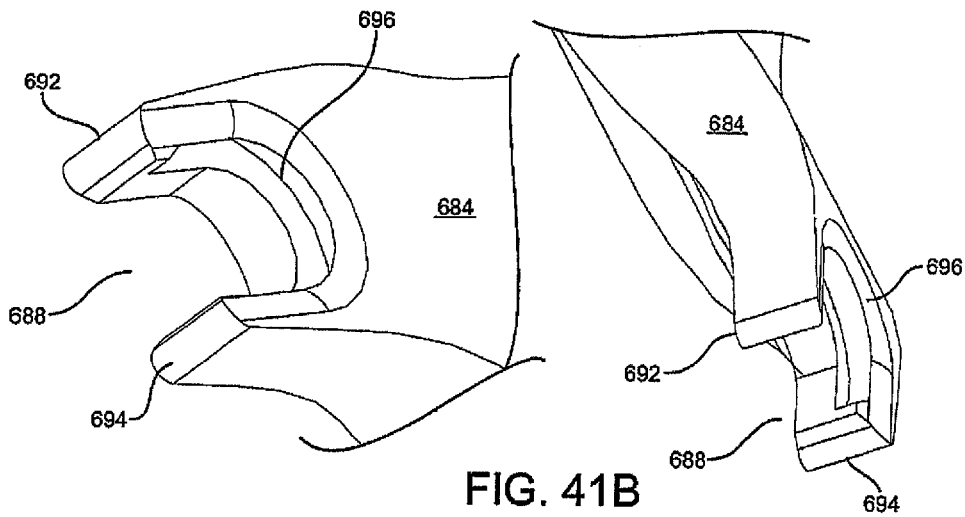


FIG. 41B

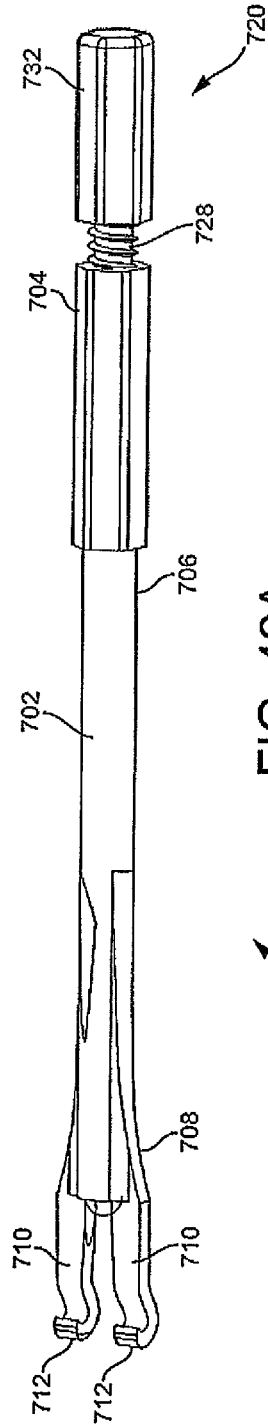


FIG. 42A

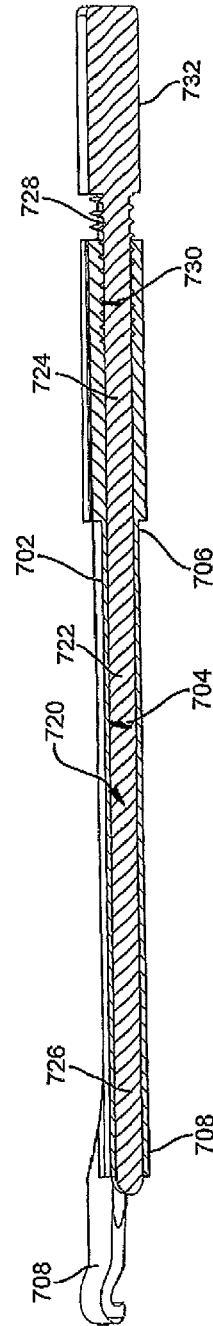


FIG. 42B

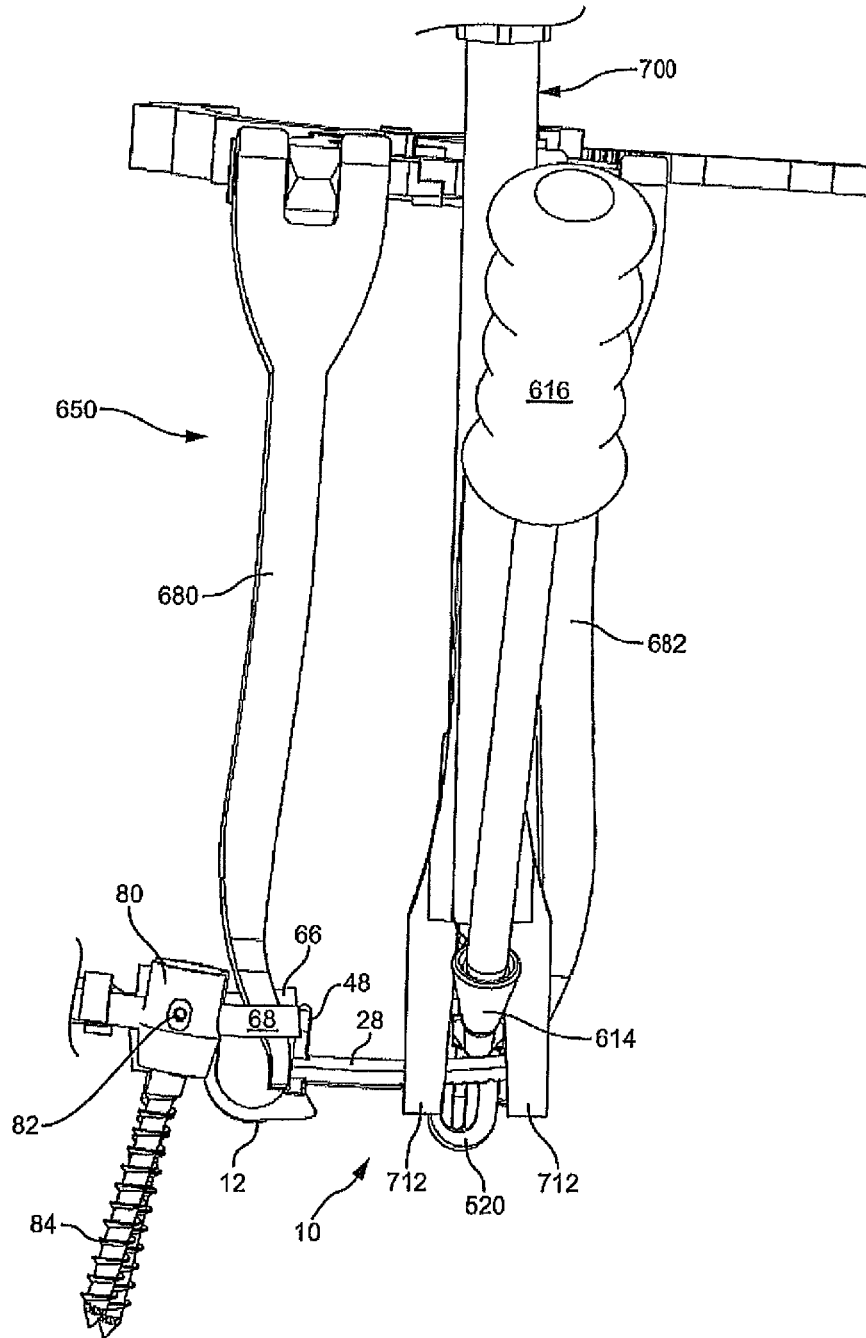


FIG. 43

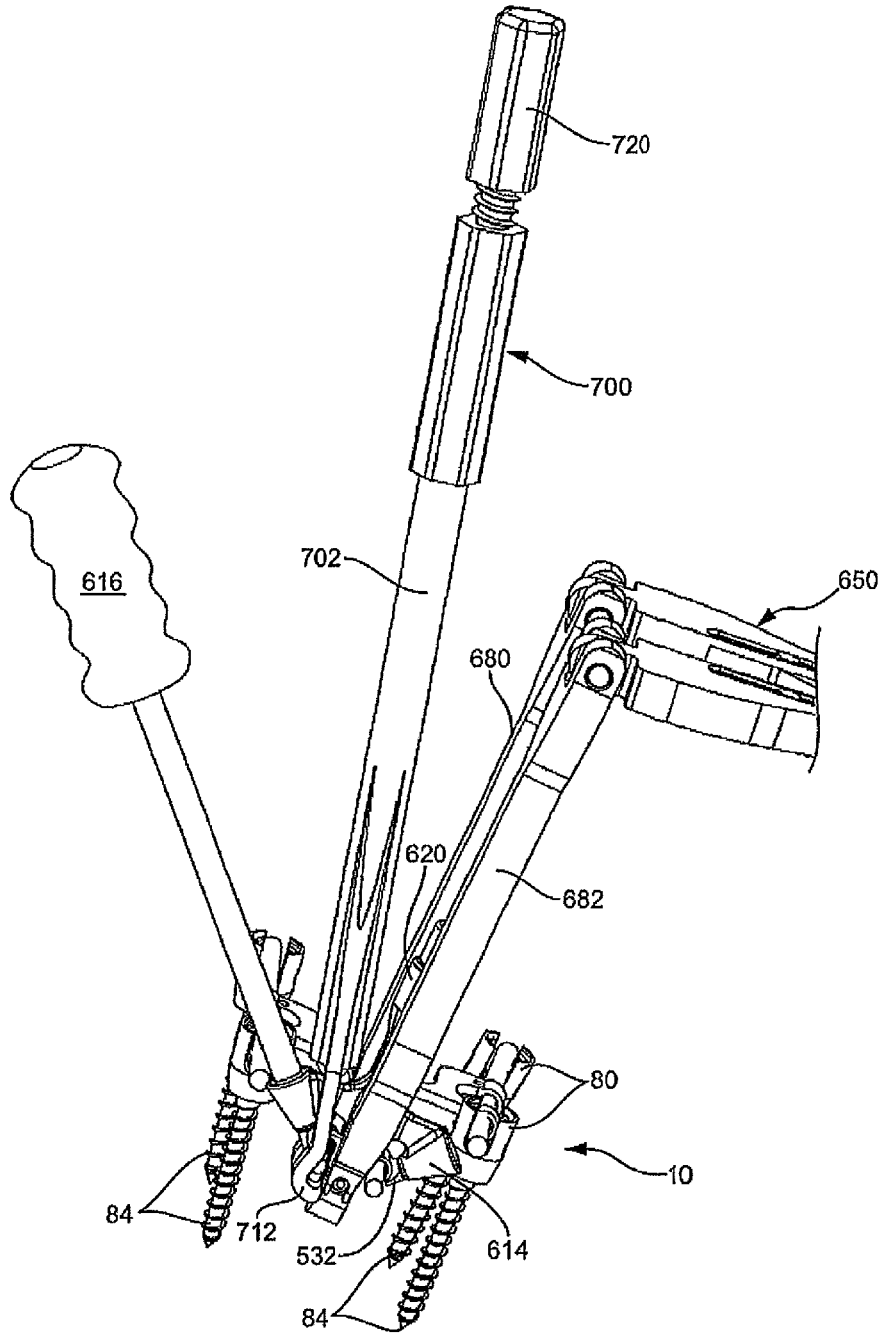


FIG. 44

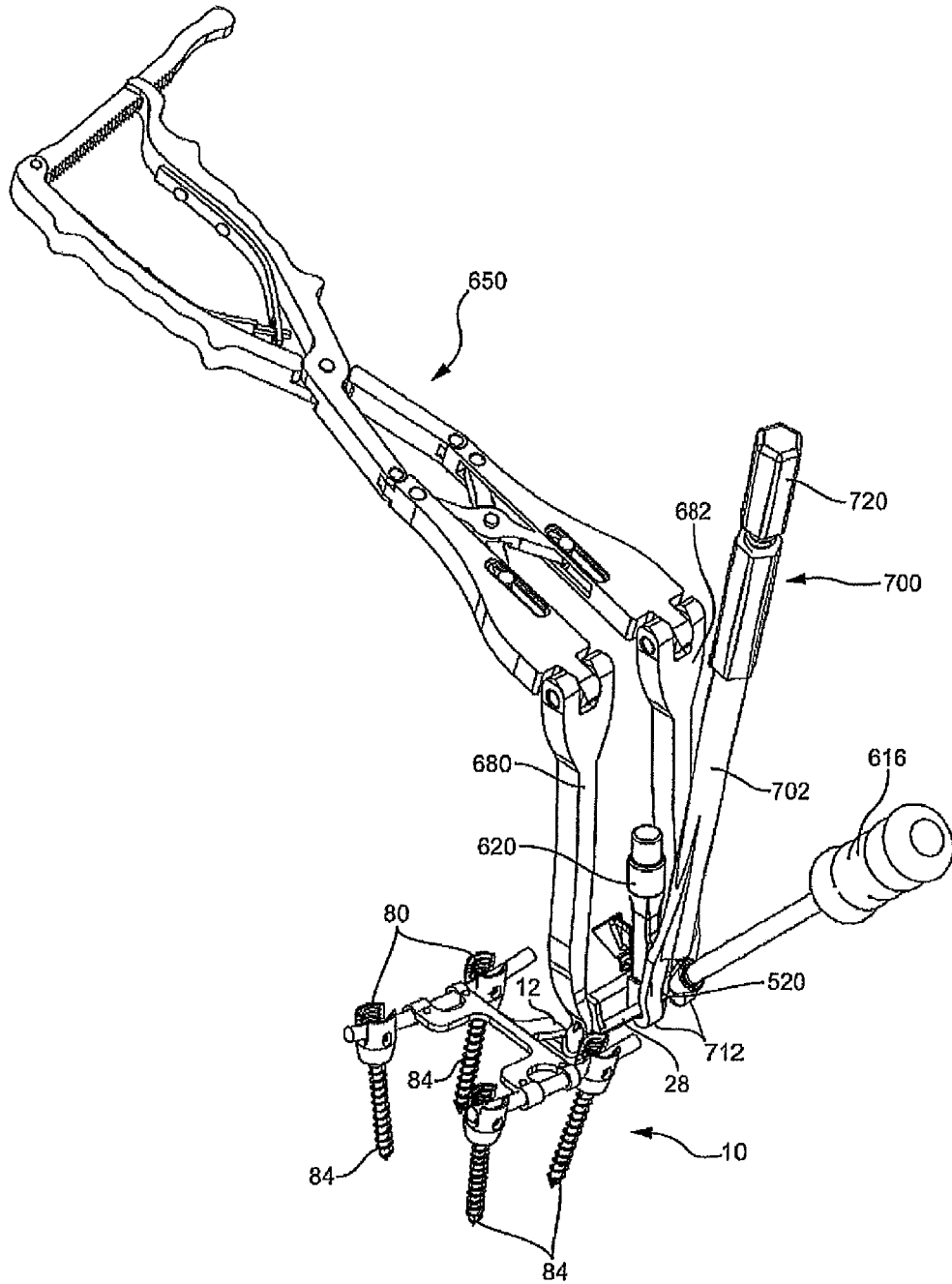


FIG. 45

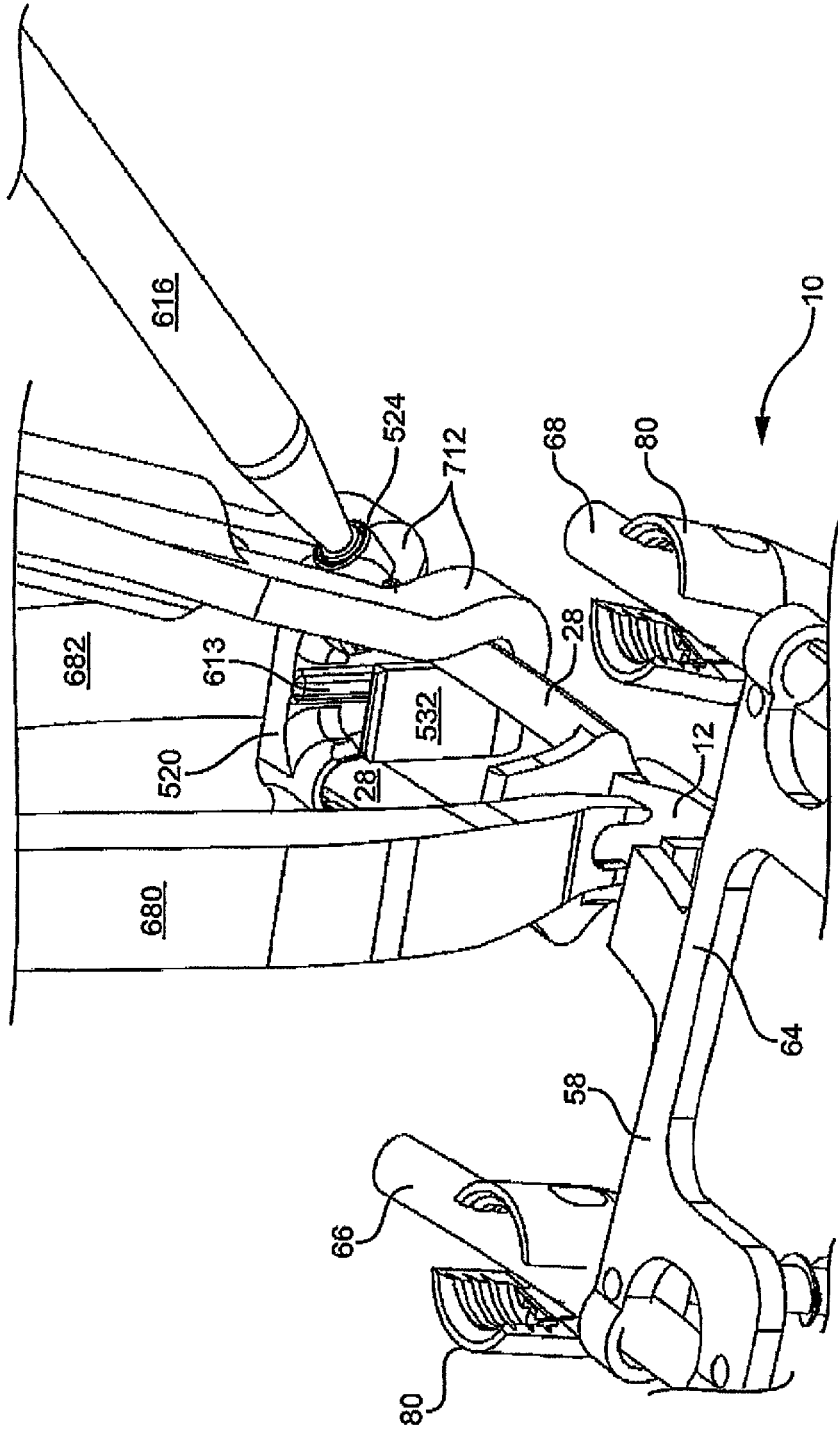


FIG. 46

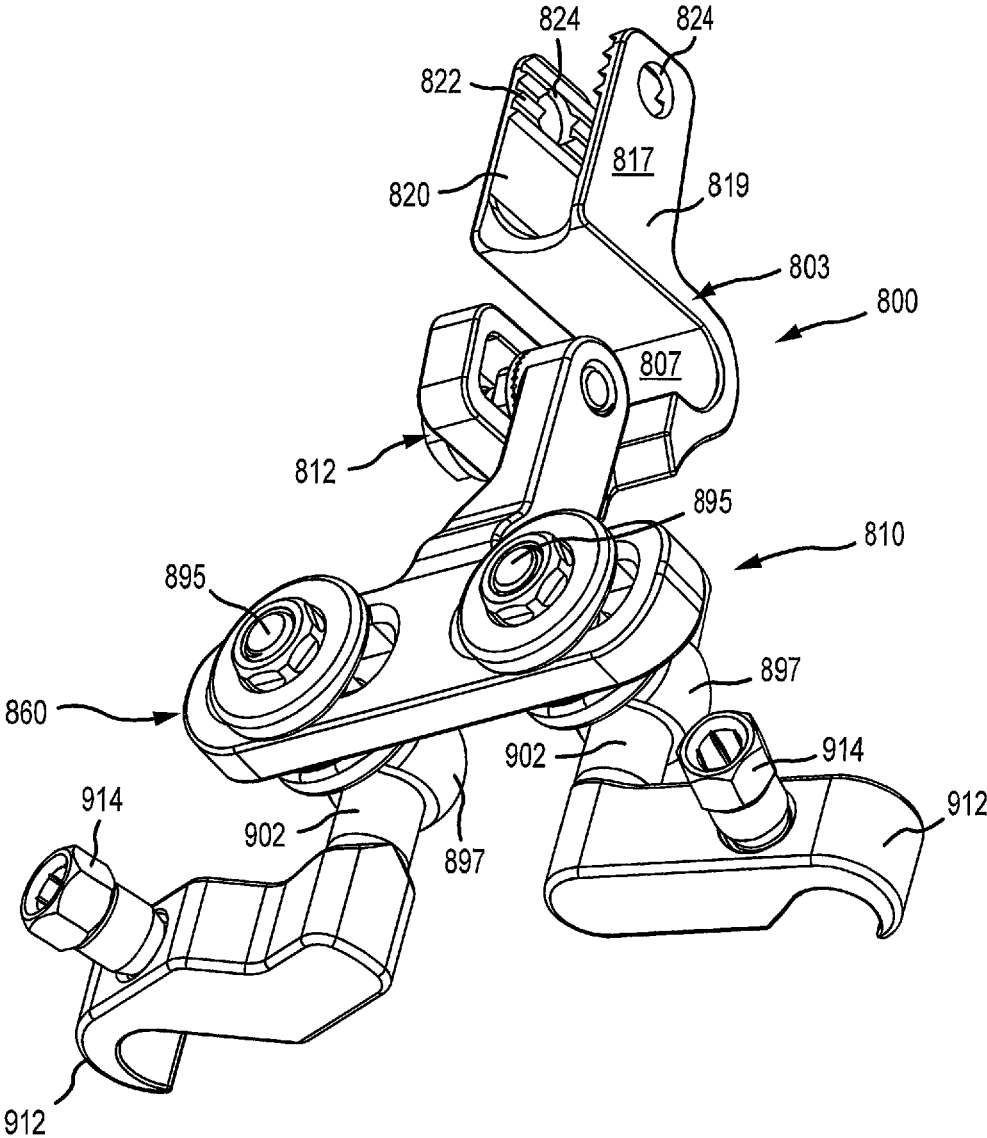


FIG.47

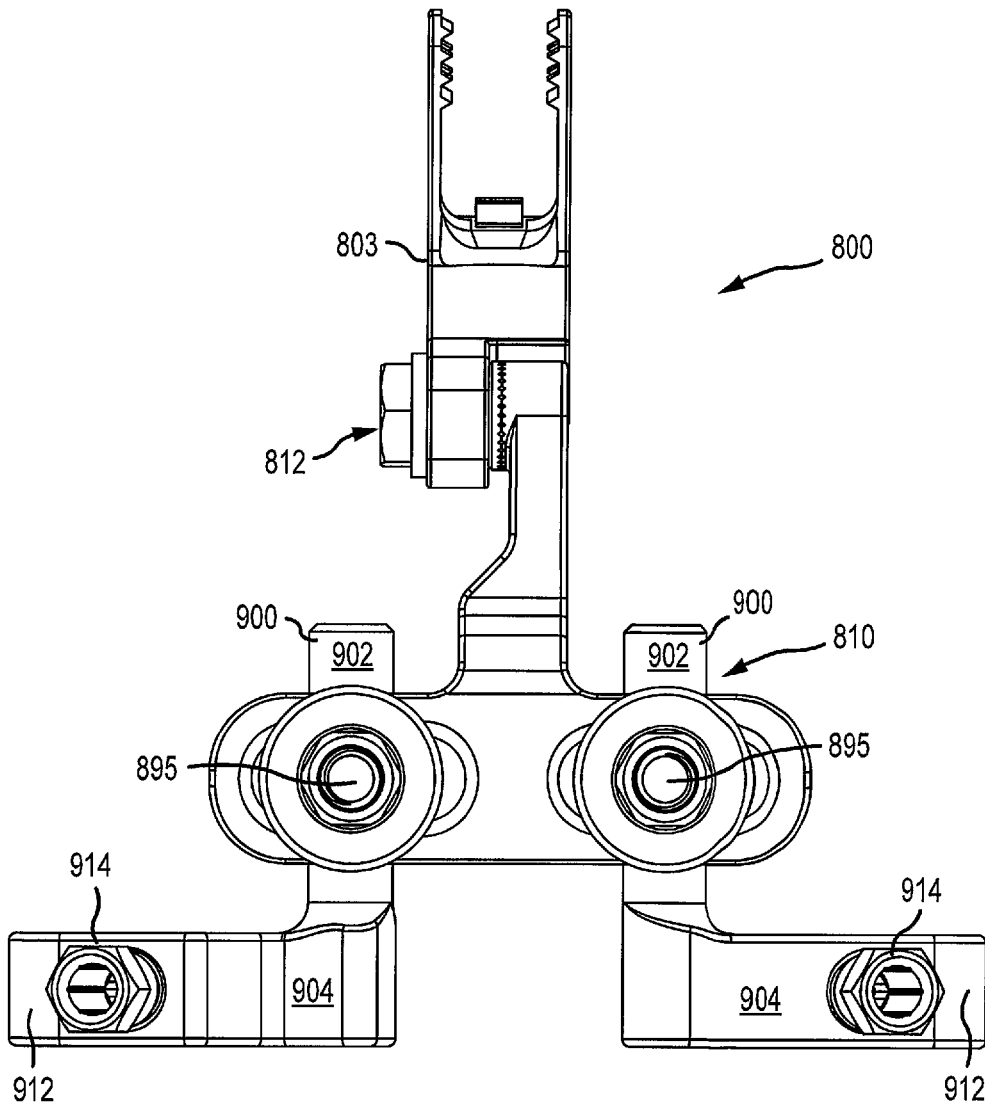


FIG.48

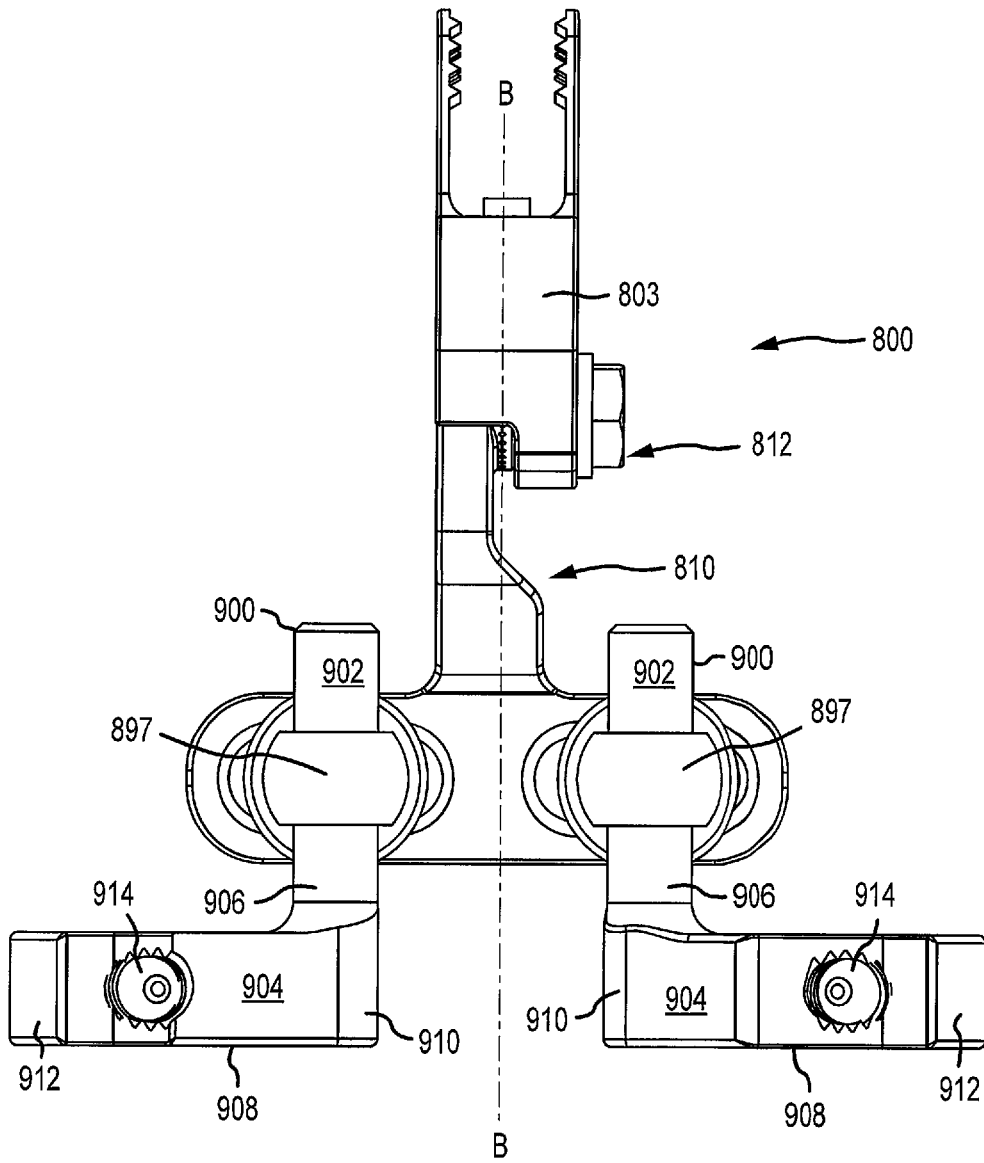


FIG.49

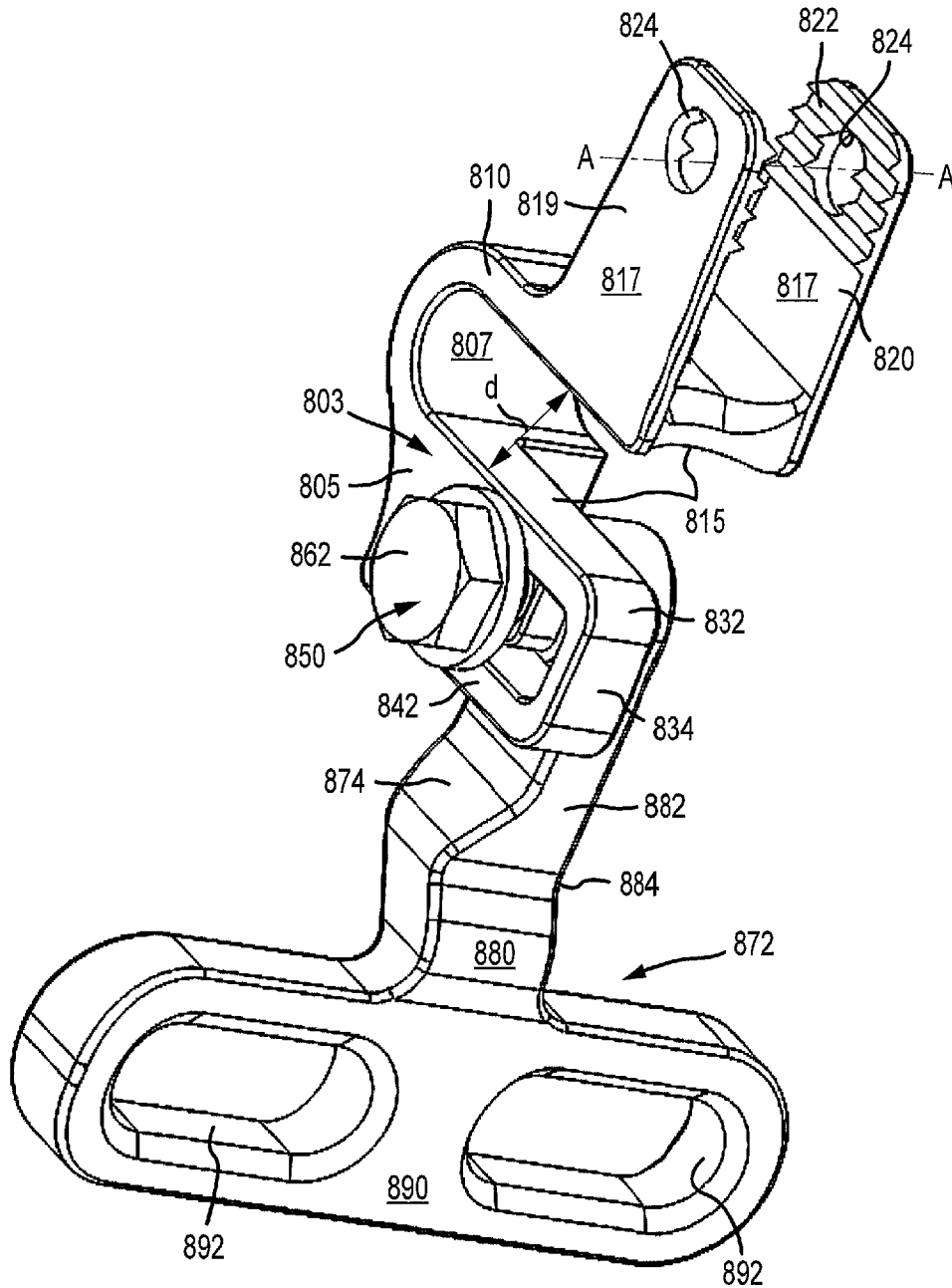


FIG.50

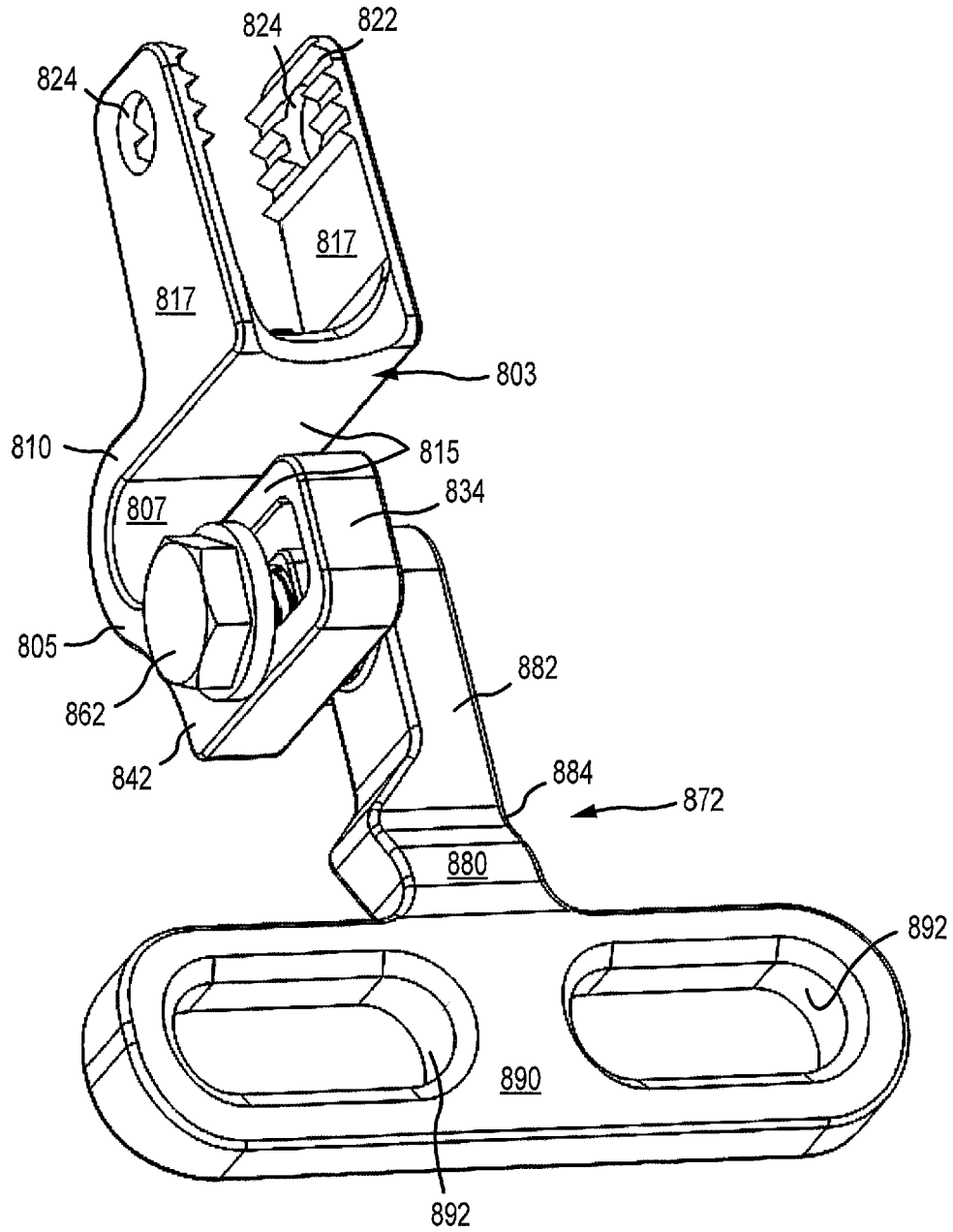


FIG. 51

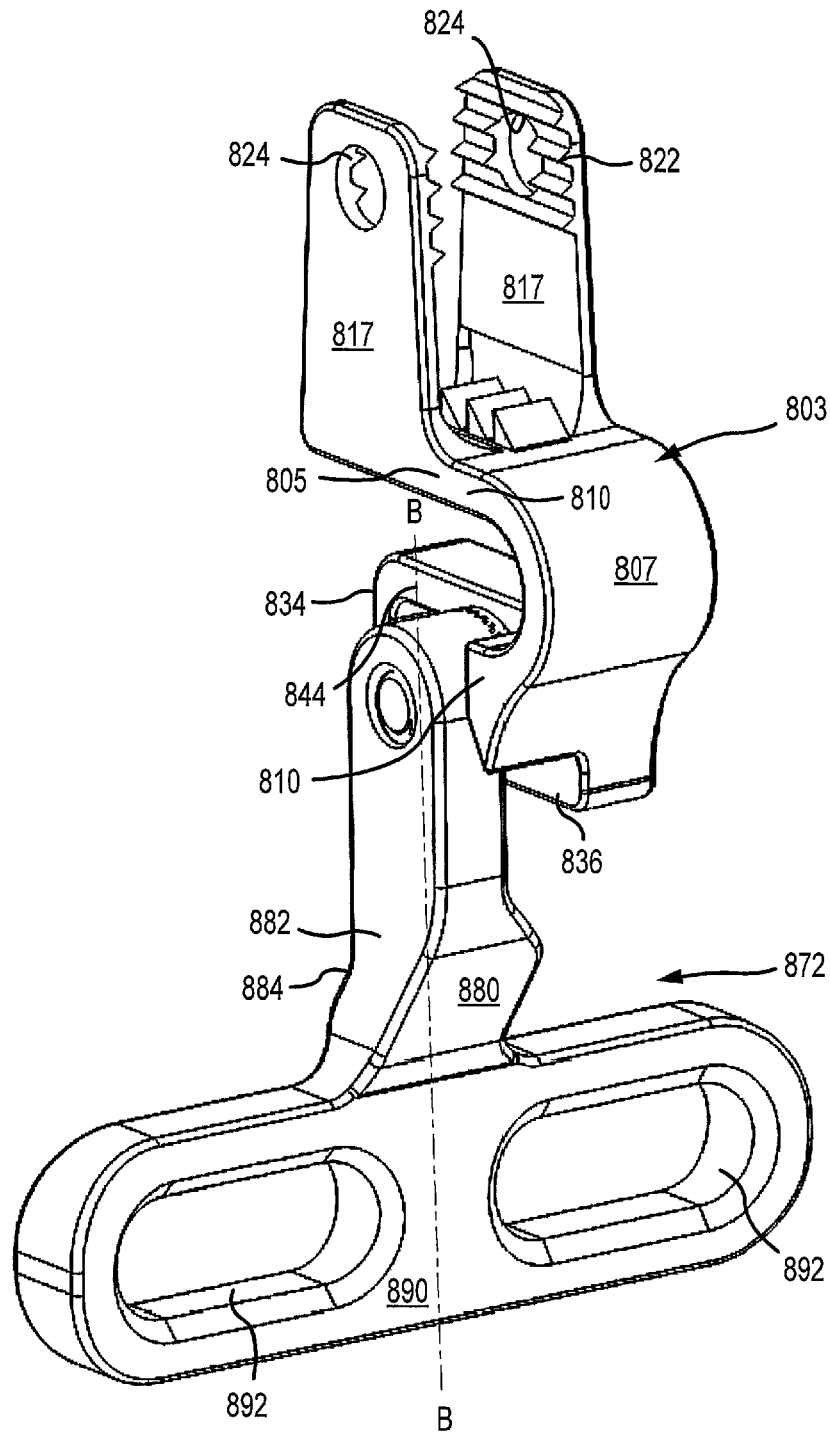


FIG. 52

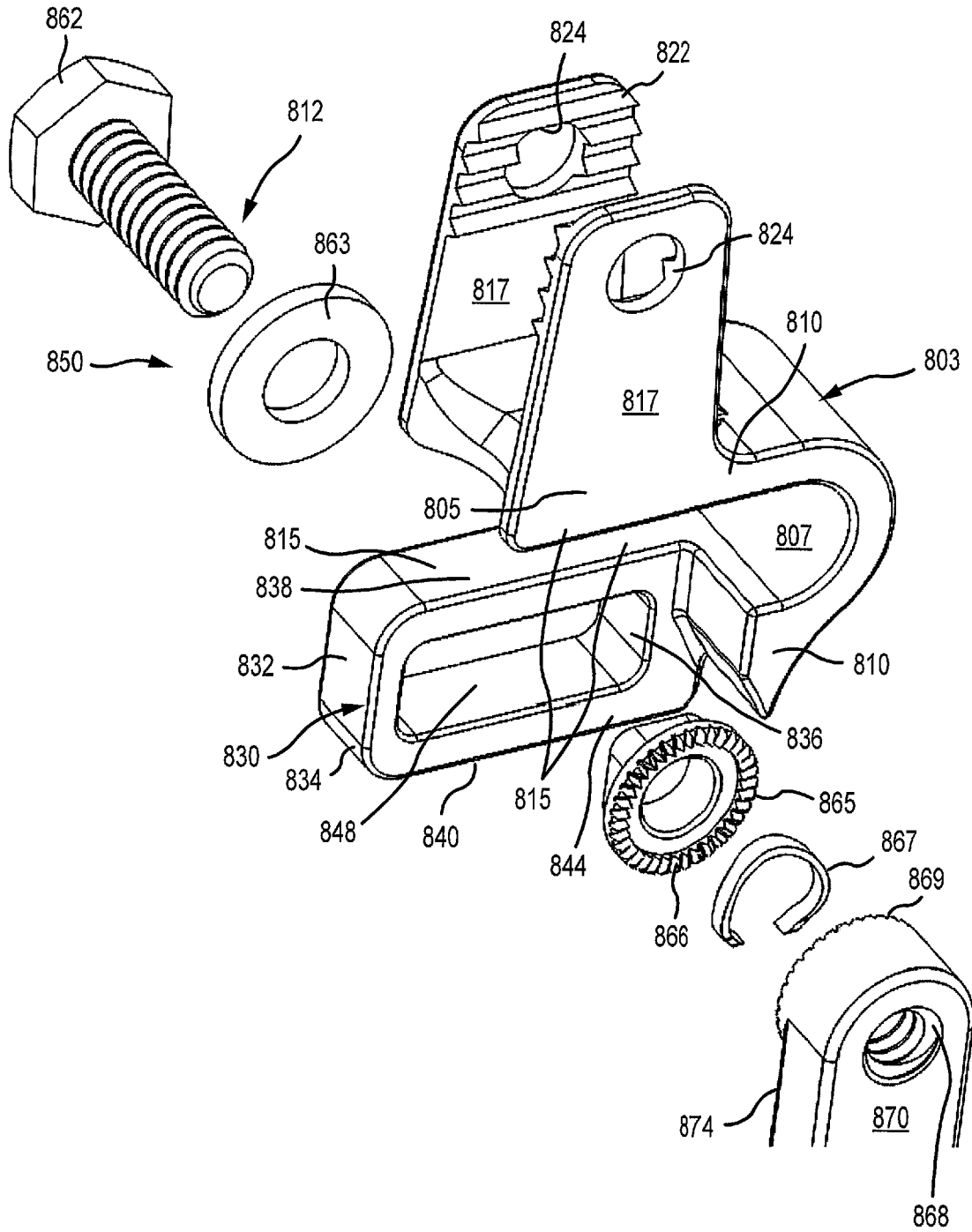


FIG.53

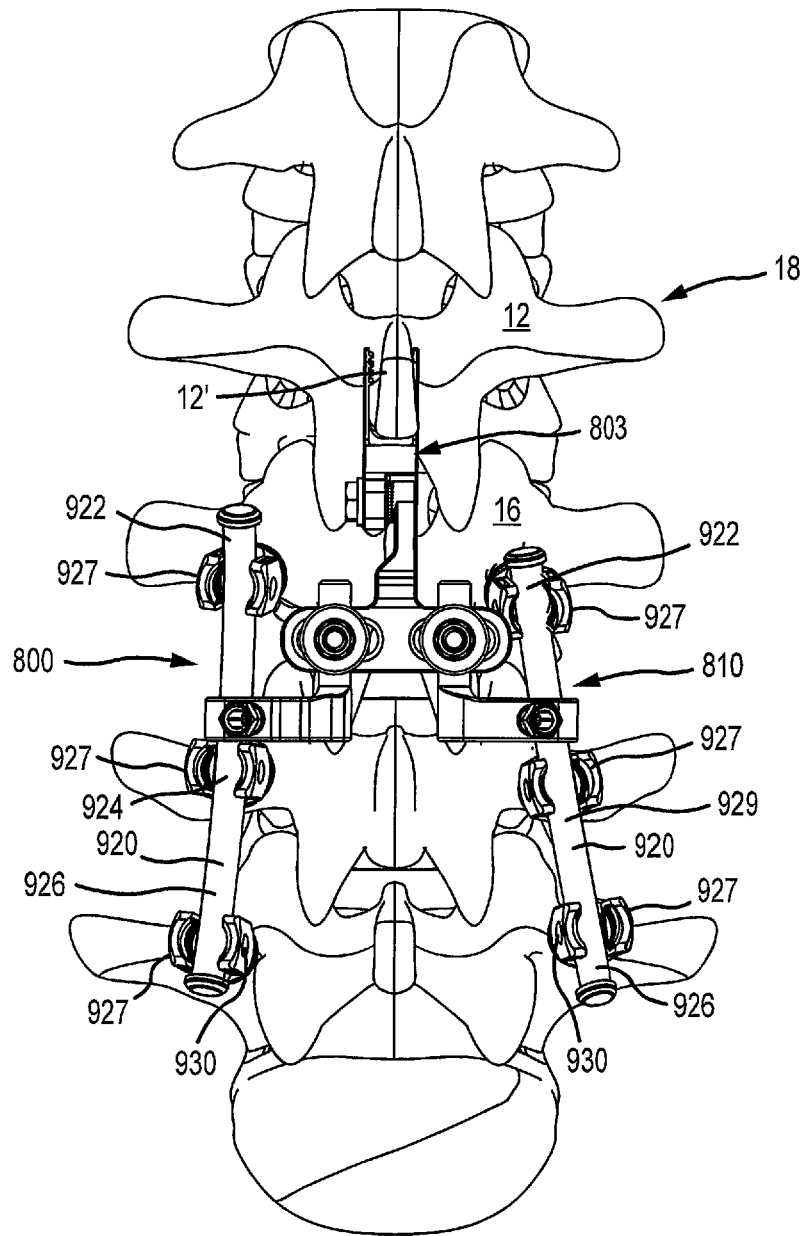


FIG.54

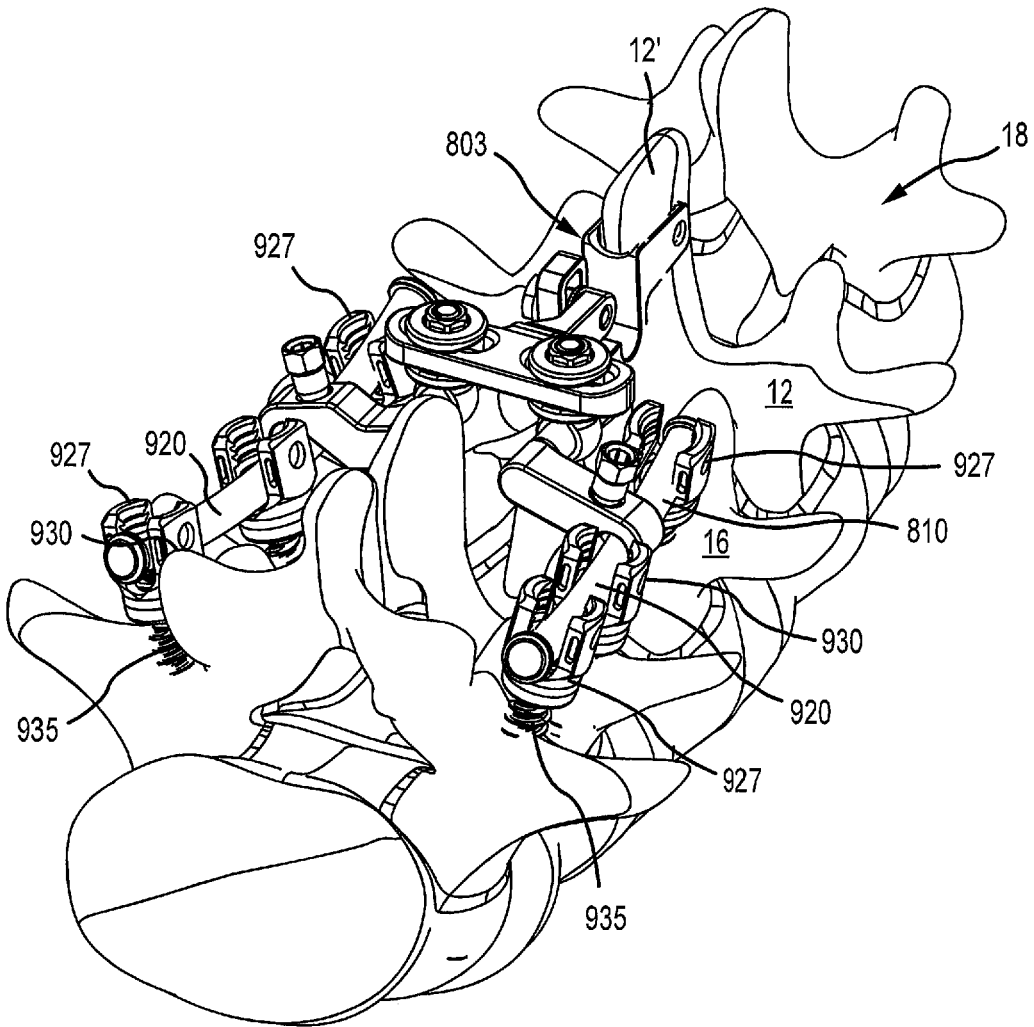


FIG.55

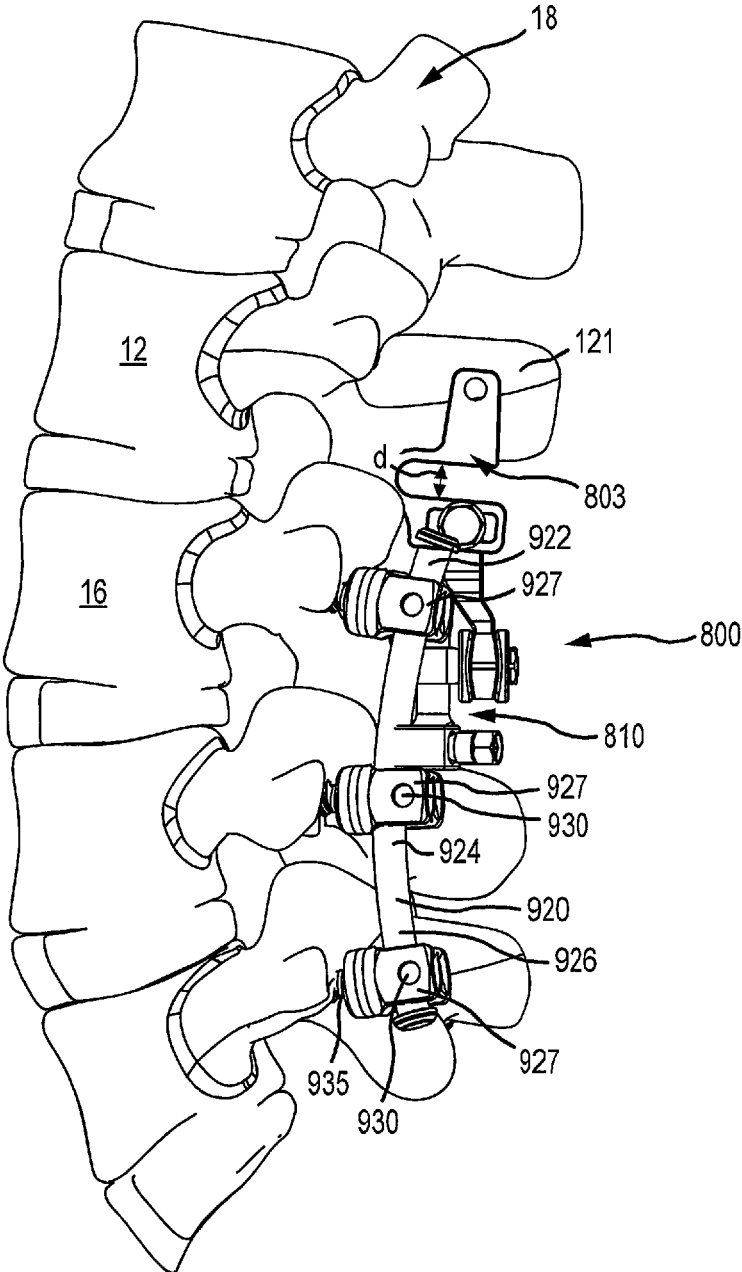


FIG.56

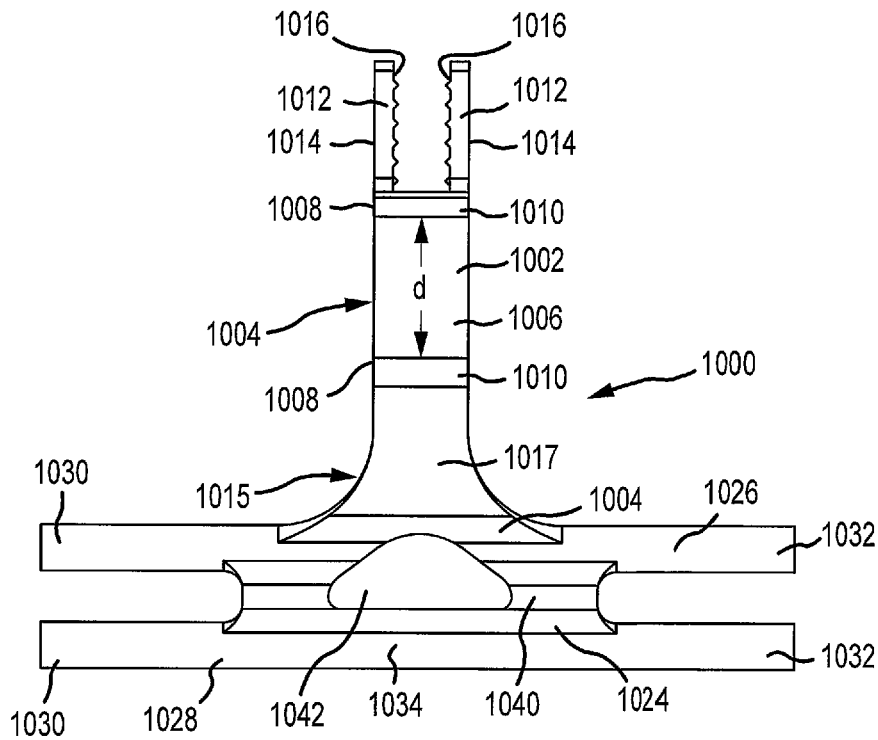


FIG. 57A

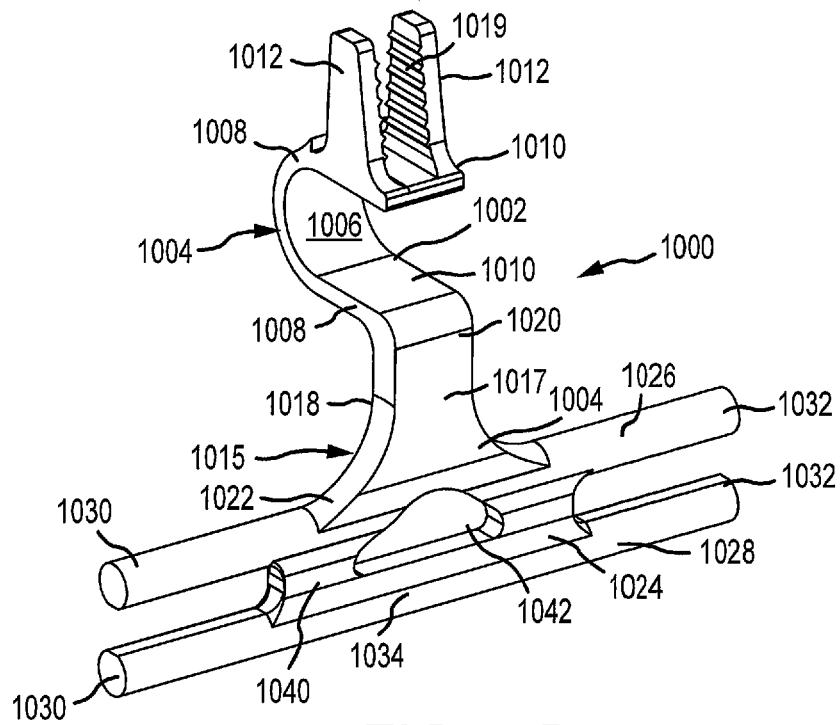


FIG. 57B

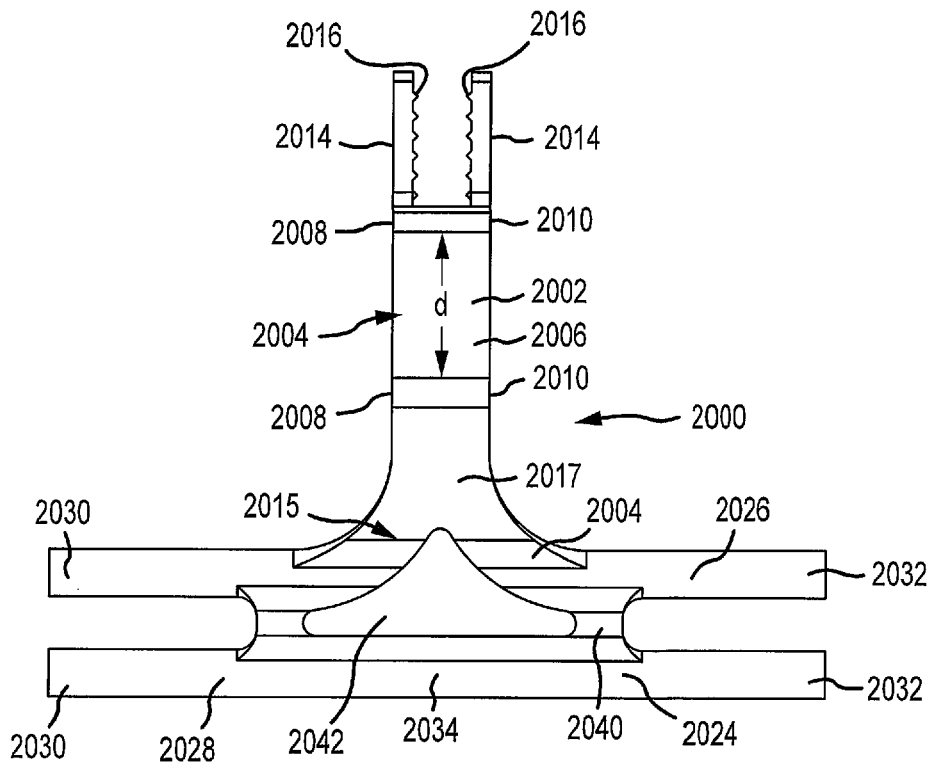


FIG. 58A

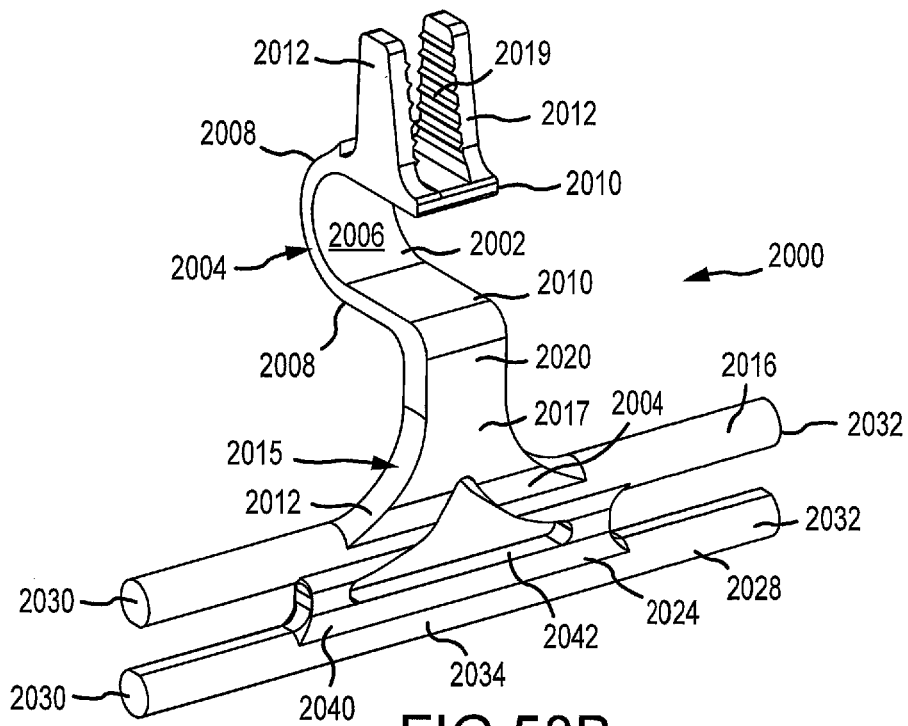


FIG. 58B

**SPINAL STABILIZATION SYSTEM WITH
ADJUSTABLE INTERLAMINAR DEVICES****CROSS-REFERENCE TO RELATED
APPLICATIONS**

The present application is a continuation-in-part application of U.S. patent application Ser. No. 14/498,333, now U.S. Pat. No. 10,154,861, filed on Sep. 26, 2014, which application is a continuation-in-part application of U.S. patent application Ser. No. 14/209,138, now U.S. Pat. No. 9,510,872, filed on Mar. 13, 2014, which application claims priority to U.S. Provisional Patent Application No. 61/794,543 filed on Mar. 15, 2013. Application Ser. No. 14/498,333 also claims the benefit of and priority to U.S. Provisional Patent Application Nos. 61/949,254 filed on Mar. 7, 2014, 61/939,484 filed on Feb. 13, 2014, 61/962,011 filed on Oct. 29, 2013, 61/883,398 filed on Sep. 27, 2013, and 61/883,018 filed on Sep. 26, 2013. The present application also claims the benefit of and priority under 35 U.S.C. 6119 to U.S. Provisional Patent Application Nos. 62/670,800 filed on Mar. 13, 2018, 62/631,631 filed on Feb. 17, 2018 and 62/574,101 filed on Oct. 18, 2017. All of the aforementioned patents and patent applications are hereby incorporated by reference in their entireties into the present application for all purposes.

FIELD OF THE INVENTION

The present invention relates generally to the field of medical apparatus and methods for using the same. More specifically, the present invention relates to systems and methods for treating spinal conditions, and specifically for systems for stabilizing vertebrae in the spinal column. More specifically, the present invention relates to adjustable and fixed interlaminar vertebral stabilization devices for placement between adjacent vertebra and including supporting devices for stabilization of the vertebral segments above and below the vertebra being treated.

BACKGROUND OF THE INVENTION

Injury to and/or diseases of the spine frequently result in damage to or abnormalities in the vertebrae, the intervertebral discs, the facet joints and to the connective tissue and ligaments around the spine. Such damage or abnormalities may result in spinal instability causing misalignment of the vertebral column and wear of the intervertebral discs and vertebral bony surfaces, a chronic and progressive deterioration which typically results in severe pain, loss or restriction of motion, and eventually, loss of mobility of the individual suffering from the condition.

One treatment option for addressing spinal disorders is via surgical intervention and the placement of fusion, stabilization and/or repair devices on or adjacent to the spine or between adjacent vertebrae. Certain surgical procedures are irreversible, for example, fusion techniques using bone grafts or synthetic implants to fuse vertebra, and may also significantly alter vertebral range of motion. Other procedures, for example procedures for installing spinal implants or pedicle screw systems for fixating two or more vertebrae, are intricate, time consuming and highly invasive. Alternative solutions include the insertion of interspinous or intralaminar spacers in the space between adjacent vertebrae to control relative motion between and to stabilize the two vertebrae. However, the stabilization does not extend above or below the insertion point, leaving the remaining portions

of the spinal column subject to unstable motion and the potential damage resulting therefrom.

Various prior art systems have attempted to address the problems described above. U.S. Pat. No. 5,645,599 issued to Samani on Jul. 8, 1997 (the '599 patent), discloses an interspinal implant device having a generally U-shaped, spring-like configuration for insertion between the spinal processes of adjacent vertebrae. Samani's device includes opposing pairs of upwardly and downwardly extending brackets adapted to be secured to the spinal process, thereby providing for flexible positioning of the adjacent vertebrae. However, the apparatus of the '599 patent does not attribute to the overall stability of the spinal column; its effect being limited to the two specific vertebrae to which it is attached. It is also difficult to attach multiple devices configured in accordance with Samani's disclosure at adjacent segments due to interference of the bracket portions.

Hochschuler et al. disclose various intra-laminar stabilization systems in U. S. Patent Application Publication No. US 2009/0204150 published on Aug. 13, 2009 (the '150 publication), and in U.S. Patent Application Publication No. US 2011/0106163 published on May 5, 2011 (the '163 publication). The '150 publication discloses a pair of oppositely disposed hook members that are translationally positioned on a rod and adapted to engage the laminar regions of adjacent vertebra and maintain a preselected spacing there between. However, the apparatus of the '150 publication does not stabilize other vertebrae in the spinal column, its effect being limited to the two adjacent vertebrae which it engages.

The Hochschuler et al. '163 publication discloses an interlaminar stabilizing system which includes a structure adapted to be disposed between two adjacent vertebrae as described above with respect to the apparatus of the '150 publication. The '163 structure further includes a support structure which is secured to the second vertebra to further restrict the interval spacing between the adjacent vertebrae. However, the system of the '163 disclosure also does not stabilize the vertebrae in the remaining portions of the spinal column for the reasons set forth above.

Moreover, none of the known prior art systems address the problem of "transition syndrome" or "adjacent segment disease" associated with fusion of adjacent vertebrae. In fusion, if a motion segment is eliminated via fusion, the unfused adjacent segments above and below the fused vertebrae take up and bear the additional forces induced by bending and rotational movement of the spine, which may result in so-called "transition syndrome" over the long term. In addition, none of the prior art systems provide for augmenting previously installed spinal hardware to enhance stability, adjust intervertebral distraction, and so forth.

Accordingly, a need exists for an improved spinal stabilization system which provides both flexibility and stability to the spinal column and which addresses the combination of problems not solved by the prior art.

SUMMARY OF THE INVENTION

In order to achieve the above-mentioned objectives, the present invention provides an improved spinal stabilization system for maintaining preselected spacing and movement between adjacent vertebrae and also which provides overall stability to the spinal column.

In one embodiment, a spinal stabilization system is provided which includes at least one interlaminar member adapted to be inserted between two adjacent vertebrae and a

stabilizing structure for stabilizing the vertebrae at least one layer above and below the two adjacent vertebrae.

In another embodiment, a spinal stabilization system is provided which includes a blocking member to limit movement of adjacent vertebrae to prevent narrowing of the spinal canal and nerve compression.

In yet another embodiment, a spinal stabilization system is provided which includes at least one adjustable cross-linking member to enhance stability of the spine.

In still another embodiment, a spinal stabilization system is provided which includes at least one adjustable interlaminar member adapted to be adjusted in response to the anatomy of a patient.

In an embodiment, a spinal stabilization system is provided which includes an interlaminar member adapted to be adjustable in response to the interlaminar spacing intermediate an adjacent pair of vertebrae.

In yet another embodiment, a spinal stabilization system is provided which includes an interlaminar member adapted to be angularly adjustable with respect to a cross-linking member.

In another embodiment, a spinal stabilization system is provided which includes an interlaminar member having a portion of variable shape adapted to be placed intermediate an adjacent pair of vertebrae, the variable shaped portion being shaped to conform to an interspinous anatomy unique to a patient being treated.

These and other features, aspects and advantages of the present invention will be apparent from the accompanying detailed description of the invention, which, taken with the appended drawings, discloses a preferred and alternate embodiments thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front plan view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 2 is a side perspective view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 3 is a side plan view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 4 is a bottom perspective view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 5 is a top perspective view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 6 is an enlarged side plan view of a portion of the spinal stabilization system of the present invention shown in FIG. 3 showing an upper portion of the stabilization system affixed to a spinal column;

FIG. 7 is a side perspective view of a portion of the spinal stabilization system shown in FIG. 6;

FIG. 8 is an exploded front perspective view of a portion of the spinal stabilization system shown in FIGS. 6 and 7;

FIG. 9 is a rear perspective view of a portion of the spinal stabilization system shown in FIGS. 6, 7 and 8;

FIG. 10 is a front plan view of a spinal stabilization system in accordance with an embodiment of the present invention affixed to a spinal column;

FIG. 11 is a bottom front perspective view of a spinal stabilization system in accordance with an embodiment of the present invention affixed to a spinal column;

FIG. 12 is a top front perspective view of a spinal stabilization system in accordance with an embodiment of the present invention affixed to a spinal column;

FIG. 13 is a side perspective view of a spinal stabilization system in accordance with an embodiment of the present invention affixed to a spinal column;

FIG. 14(A) is a rear side perspective view of an interlaminar portion of a spinal stabilization system in accordance with an embodiment;

FIG. 14(B) is a side plan view of the interlaminar portion of a spinal stabilization system shown in FIG. 14(A);

FIG. 14(C) is a front plan view of the interlaminar portion of a spinal stabilization system shown in FIGS. 14(A) and 14(B);

FIG. 15 is a top front perspective view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 16 is a bottom front perspective view of the spinal stabilization system shown in FIG. 15;

FIG. 17(A) is a top front view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 17(B) is a bottom rear perspective view of the spinal stabilization system shown in FIG. 17(A);

FIG. 18 is a bottom front perspective view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 19(A) is a top front perspective view of the spinal stabilization system shown in FIG. 18;

FIG. 19(B) is a front side perspective view of portions of the spinal stabilization system shown in FIGS. 18 and 19(A);

FIG. 19(C) is a rear side perspective view of portions of the spinal stabilization system shown in FIGS. 18, 19(A) and 19(B);

FIG. 20 is a partial sectional side perspective view of portions of the spinal stabilization system shown in FIG. 1;

FIG. 21 is a rear perspective view of a spinal stabilization system in accordance with an embodiment of the present invention affixed to a spinal column;

FIG. 22 is a front perspective view of the spinal stabilization system shown in FIG. 21;

FIG. 23(A) is a front perspective view of the spinal stabilization system shown in FIG. 22 with additional elements shown affixed to a spinal column;

FIG. 23(B) is a front perspective view an alternate embodiment of the spinal stabilization system shown in FIG. 23(A) with additional elements shown affixed to a spinal column;

FIG. 24 is a side perspective view of a spinal stabilization system a spinal stabilization system in accordance with an embodiment of the present invention shown affixed to a spinal column;

FIG. 25 is a rear side perspective view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 26 is a front side perspective view of the spinal stabilization system shown in FIG. 25;

FIG. 27(A) is a side perspective view of portions of the spinal stabilization system shown in FIGS. 25 and 26;

FIG. 27(B) is a left partial sectional side perspective view of portions of the spinal stabilization system shown in FIGS. 25 and 26;

FIG. 27(C) is a right partial sectional side perspective view of portions of the spinal stabilization system shown in FIGS. 25 and 26;

FIG. 28 is a lower side perspective view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 29 is a bottom front perspective view of the spinal stabilization system shown in FIG. 28;

FIG. 30 is a side view of the spinal stabilization system of FIG. 28 shown affixed to a spinal column;

FIG. 31 is a front view of the spinal stabilization system shown in FIG. 30;

FIG. 32 is a side perspective view of a spinal stabilization a spinal stabilization system in accordance with an embodiment of the present invention shown affixed to a spinal column;

FIG. 33 is a front perspective view of the spinal stabilization system shown in FIG. 32;

FIG. 34(A) is a side view of an element of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 34(B) is a top view of an element of the spinal stabilization system shown in FIG. 34(A);

FIG. 34(C) is a right perspective side sectional view of an element of the spinal stabilization system shown in FIGS. 34(A) and 34(B);

FIG. 34(D) is a top sectional view of an element of the spinal stabilization system shown in FIGS. 34(A), 34(B) and 34(C);

FIG. 35(A) is a top perspective view of an element of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 35(B) is a bottom perspective view of an element of the spinal stabilization system shown in FIG. 35(A);

FIG. 35(C) is a side view of an element of the spinal stabilization system shown in FIGS. 35(A) and 35(B);

FIG. 36(A) is a top perspective view of an element of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 36(B) is a bottom perspective view of an element of the spinal stabilization system shown in FIG. 36(A);

FIG. 36(C) is a side view of an element of the spinal stabilization system shown in FIGS. 36(A) and 36(B);

FIG. 37(A) is a side view of an element of a spinal stabilization system insertion tool in accordance with an embodiment of the present invention;

FIG. 37(B) is a side view of an element of an insertion tool for installing a portion of a spinal stabilization in accordance with an embodiment;

FIG. 37(C) is a side view of another insertion tool for installing a portion of a spinal stabilization system in accordance with an embodiment;

FIG. 37(D) is a side sectional view of the element of a spinal stabilization system and the insertion tools therefor shown in FIGS. 37(A), 37(B) and 37(C), respectively;

FIG. 38 is a top view of the insertion tool of FIG. 37(A)-(D) shown in operative engagement with an element of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 39 is a sectional perspective view of the insertion tool shown in FIG. 38;

FIG. 40 is a top perspective view of a spinal stabilization system insertion tool in accordance with an embodiment of the present invention;

FIG. 41(A) is a perspective view of portions of the insertion tool shown in FIG. 40;

FIG. 41(B) is an enlarged perspective view of portions of the insertion tool shown in FIGS. 40 and 41(A);

FIG. 42(A) is a side plan view of a spinal stabilization insertion tool in accordance with an embodiment of the present invention;

FIG. 42(B) is a side sectional view of the insertion tool shown in FIG. 42(A);

FIG. 43 is a side view of the insertion tools of FIGS. 37-42 shown in operative engagement with a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 44 is a side perspective view of the insertion tools shown in FIG. 43;

FIG. 45 is a top perspective view of the insertion tools shown in FIGS. 43 and 44;

FIG. 46 is an enlarged perspective view of portions of the tools of FIG. 45.

FIG. 47 is a bottom perspective view of a spinal stabilization system in accordance with an embodiment of the present invention;

FIG. 48 is a front plan view of the spinal stabilization system of FIG. 47;

FIG. 49 is a rear plan view of the spinal stabilization system of FIGS. 47 and 48;

FIG. 50 is a top perspective view of a portion of the spinal stabilization system of FIGS. 47-49;

FIG. 51 is a bottom perspective view of the portion of the spinal stabilization system of FIG. 50;

FIG. 52 is a rear perspective view of the portion of the spinal stabilization system of FIGS. 50 and 51;

FIG. 53 is an exploded top perspective view of the portion of the spinal stabilization system of FIGS. 50-52;

FIG. 54 is a front plan view of the spinal stabilization system of FIGS. 47-49 shown affixed to a spinal column;

FIG. 55 is a bottom perspective view of the spinal stabilization system of FIG. 54; and

FIG. 56 is a side plan view of the spinal column of FIGS. 54 and 55.

FIG. 57(A) is a front plan view of a portion of a spinal stabilization system in accordance with an embodiment;

FIG. 57(B) is a top perspective view of the portion of a spinal stabilization system of FIG. 57(A);

FIG. 58(A) is a front plan view of a portion of a spinal stabilization system in accordance with another embodiment; and

FIG. 58(B) is a top perspective view of the portion of a spinal stabilization system of FIG. 58 (A).

DESCRIPTION OF THE INVENTION

It should be noted that the present description is by way of illustration only, and that the concepts and examples presented herein are not limited to use or application with any single system or methodology. Hence, while the details of the system and methods described herein are for the convenience of illustration and explanation with respect to the exemplary embodiments, the principles disclosed may be applied to other types of spinal stabilization systems without departing from the scope of the present invention.

Referring now to FIG. 1, a spinal stabilization system according to an embodiment of the present invention is shown generally at 10 (which for purposes of brevity will be referred to herein as "the system"). The system includes a first interlaminar member 12 adapted to be positioned between adjacent vertebra in a spinal column. As shown in greater detail in FIGS. 6 and 7, the interlaminar member 12 is shown positioned between a first vertebra 14 and a second adjacent vertebra 16 in a spinal column 18.

The system further includes a second interlaminar member 20 adapted to be positioned between the second vertebra 16 and a third vertebra 22 in the spinal column 18. While the system 10 of the embodiment of FIG. 1 is described with reference to two interlaminar support members, it is to be understood that a third, fourth or more interlaminar support

members or components may be coupled to the system to permit stabilization or fixation of additional spinal segments in either or both directions along a patient's spinal column.

Both the first and second interlaminar members are operatively connected to a support structure shown generally at numeral **25** in FIG. **1**. By way of example, in the embodiment shown, the support structure and the first interlaminar member are integrally formed from a single piece of material such as titanium or stainless steel suitable for use as a medical implant device. However, it is to be understood that other means for connecting the interlaminar device to the support structure such as hinges, pins, threaded fasteners and the like may also be used without departing from the scope of the invention.

The support structure **25** comprises a pair of support members or guide rods **28** secured to the first interlaminar support member **12** and extending in a direction upwardly therefrom substantially parallel to one another. In the embodiment shown, guide rods **28** are of an exemplary generally circular cross-sectional configuration. However, it is to be understood that other structured shapes such as oval square, hexagonal, and I-beam cross sections may also be used with equal efficiency.

The second interlaminar member **20** includes a body portion **21** of a preselected thickness t , which is most clearly illustrated in FIGS. **3** and **9**. Thickness t is selected based upon the spacing between the second and third vertebrae and may be smaller in size than the spacing to allow for flexion or extension of the spinal column **18**. Alternatively, it may be sized for interference fit between the laminae/spinous processes. The body portion **20** may take many variations in size, scope, and physical properties such as hardness, flexibility, and so forth, depending upon the patient's anatomical structure and the problems being addressed.

The body portion **21** further includes a pair of oppositely positioned ears **30** extending laterally outwardly from the body portion in opposing directions, each of the ears containing an aperture **32** structured and arranged to slideably receive one of the support members or guide rods **28**. As will be discussed in greater detail below, the second interlaminar member is movably supported by upwardly extending support members or guide rods, and the position of the second interlaminar member **20** relative to the first interlaminar member **12** may be adjusted depending upon the dimensions of the specific spinal column on which the system is installed and the range of motion desired. Once the position of the second interlaminar member **20** has been selected, it is locked in place by a pair of set screws or other suitable fastening means **34** extending through each of the ears **30** and adapted to releasably engage the respective guide rod extending therethrough, as shown in FIG. **1** and in greater detail in FIG. **4**.

Referring now to FIGS. **2**, **3**, **7** and **8**, the first interlaminar member **12** is depicted in greater detail. The first interlaminar member comprises a body **40** defined by an elastic midsection **42**, two spaced apart end portions **44**, and a pair of juxtaposed legs **46**, each leg extending substantially parallel to one another from one of the respective ends in a direction generally outwardly away from the spinal column **18** (FIG. **7**) and spaced apart a preselected distance d . Distance d is determined by the size of the first interlaminar member **12**, which is, in turn, may be selected based upon the spacing between the first and second vertebrae **14** and **16**, respectively. Depending upon the situation, the first interlaminar member may be intended to fuse the first and second vertebrae, or it may be intended to permit limited motion therebetween while at the same time maintaining the

stability of vertebra **16** relative to vertebra **14**. Accordingly, it may be sized to be a tight fit, and the elastic properties of the body **40** act as a spring or shock absorber in the interface between the two vertebrae. In the embodiment shown in the above-referenced figures, the elastic midsection **42** of the body **40** is U-shaped. However, other shapes or configurations, by way of example, a V-shape, a W-shape or other function configurations may also be used effectively. Further, the uppermost one of the legs **46** is longer than the lower one of the legs, thereby forming a handle **48** which may be used to insert and position the system during surgery and also to increase the contact surface area with the adjacent spinous process. As noted above, depending upon the problem being addressed, the U-shaped body may be rigid—or flexible.

Referring again to FIG. **1**, the support structure **25** further includes a T-shaped frame member **50** operatively connected to the first and second interlaminar members **12** and **20** and which extends generally downwardly therefrom in a direction substantially parallel to the spinal column **18**. The T-shaped frame member comprises an elongate body **52** having first and second end portions **54**, **56**, the first end portion being operatively connected to the first interlaminar member **12**, and the second end portion to an elongate cross member **58**. The cross member has first and second end portions **60**, **62** and a midpoint **64** and is structured and arranged to be connected to the second end portion **56** of the body **52** at approximately the midpoint **64**. Each of the ends **60**, **62** of the cross member **58** are adapted to receive and adjustably secure first and second support members **66** and **68**, respectively. In the embodiment shown, each of the end portions **60**, **62** have an aperture **70**, **72** formed therein respectively for receiving one of the support members **66**, **68**, each of which may be held in a preselected position by a set screw **74** or other interconnection coupling means as is known in the art.

In the embodiment shown, by way of example only and not of limitation, the support members are in the form of spinal or guide rods **66**, **68**, each guide rod having an upper end **76** and a lower end **78**. Each of the upper and lower ends of the support members **66**, **68** has a securing device **80** slideably positioned thereon and adapted to be secured thereto by means of set screws **82**. By way of example, each of the securing devices **80** is adapted to receive a pedicle screw **84**, each pedicle screw being structured and arranged to be secured to one of the vertebra of the spinal column **18**.

The installation and operation of the spinal support system **10** of the present invention are illustrated in greater detail in FIGS. **6**, **7** and **10-13**. The system advantageously may be installed where other spinal fixation or fusion devices or similar medical apparatus are already in place to add stability to the spinal column above and below the installation point, to control flexion, extension, axial compression, and/or rotational movement of the spine or selected vertebrae with respect to one another, and to prevent impingement of adjacent vertebrae, spinal processes, pedicle screws and medical hardware on one another. By way of example, as best shown in FIGS. **6** and **7**, a surgeon may insert the system **25** into the space between adjacent vertebrae **14** and **16** by gripping handle **48** and making the insertion. The tight fitting U-shaped body **40** not only serves to control any motion between the adjacent vertebrae or even eliminate it entirely, thereby effectively stabilizing or fixing the vertebrae, but also serves as a dampening cushion or spring device by virtue of the spring-like elasticity of the body **40** translated to the vertebrae via legs **46**. Thereafter, the second interlaminar member **20** may be

selectively positioned intermediate vertebra **16** and vertebra **22** to permit flexion on a forward direction but to limit extension in the rearward direction and to limit compression of the spinal segment, thereby imparting enhanced stability to the spinal column above the fused vertebrae.

In the embodiment of FIG. 7, the body **40** of interlaminar member **12** is formed integrally with those portions of the system **10** above and below it, it is to be understood that it could comprise a separate element of the system and be adjustably moveable inwardly by rack and pinion gearing or ratcheting devices to provide a precise fit in the interlaminar space between vertebrae **14** and **16** positioned as closely to the spinal canal as safety considerations permit. The upper leg and handle **48** extending therefrom may be longer than the lower leg **46**, whereby the contact surface area engaging the spinal process **17** positioned there above, is enlarged. This structure effectively distributes the associated forces over a larger surface contact area, thereby reducing the risk of fracture of the spinal process.

In a similar manner, support structure **25**, via the T-shaped frame member **50** and support members or guide rods **66** and **68**, provides support to the portion of the spinal column located below the fused vertebrae **14** and **16**. As shown in FIGS. 10-13, the securing devices **80**, which are coupled to heads (shown shown) of pedicle screws **84**, may be positioned in first vertebra **14** and in either vertebra **15** immediately adjacent to vertebra **14**, and/or at a lower level as shown by vertebra **17**, thus extending the stabilizing effect of the novel support system of the present invention to multiple levels in the spinal column **18**. More than one level may be addressed simply by lengthening the rods **66** and **68** and slideably positioning multiple securing devices **80** thereon for selective positioning along the spinal column.

In one aspect of the present invention, elongate body **52** may be comprised of multiple pieces. For example, one or more linear racks may be configured in operable relation with gear mechanisms, thereby forming a ratchet device (not shown), in order to extend the distance between first and second end portions **54** and **56** thereby permitting a surgeon during the course of the surgical procedure to adjust and align components of the implant in relation to the patient's bony anatomy and subsequently securing them in place. For example, a ratchet mechanism configuration may permit the surgeon to progressively extend elements of the implant to better oppose a lamina, e.g., after **60/62** are secured to **66/68**.

In another aspect, the cross member midpoint **64** may be configured to be adjustably (e.g., pivotably or translatably) connected or secured to the second end portion **56** of the body **52** at approximately the midpoint **64** in order to allow a surgeon during the course of the surgical procedure to adjust and align components of the implant in relation to the patient's bony anatomy and in relation to support members **66** and **68**. By way of example and not of limitation, FIGS. 14(A)-(C) illustrate an interlaminar member **90** adapted to be positioned between adjacent vertebra in a spinal column. The interlaminar member includes a body portion **92** having a first end portion **94** and a second end portion **96**, the second end portion being structured and arranged to adjustably receive the elongate cross member **58** (FIG. 1) in order to allow a surgeon to further adjust and align components of the implant in relation to the patient's bony anatomy. By way of example and not of limitation, the second end portion **96** may include an open-ended aperture or channel **98** for receiving and selectively positioning the elongate member **58** and a means for securing the elongate member in a desired position along a patient's spinal process. The elongate cross member **58** may have a cross-sectional configu-

ration which is complementary to the cross section of the channel or aperture, be it rectangular, hexagonal, circular, or another shape.

In the embodiment shown, the securing means includes an aperture **99** formed transversely in the channel **98** and adapted to receive a locking mechanism, e.g., one or more set screws, clamps, pins, pegs and the like such that when the locking mechanism is engaged, the second end portion **96** is in a fixed relation to the elongate cross member **58**. This configuration may permit translational and/or rotational movement(s) between the second end portion and the elongate cross member to permit alignment of the various elements of the spinal stabilization system **10** (FIG. 1) with a patient's unique anatomical structure, and, following alignment, the locking mechanism may be engaged to fix the relative position of the system components with respect to one another and with respect to the spinal process.

According to particular embodiments, interlaminar member **20** may be configured to permit connection to guide rods **28** via an approach that is substantially perpendicular to the longitudinal axis of guide rods **28**. In other words, after the other components of the system have been implanted via a posterior approach to the posterior aspect of the spine the interlaminar member **20** may follow a generally similar approach trajectory and then secured to the guide rods **28** with, e.g., set screws in a similar manner to the engagement between the ends **60**, **62** of the cross member **58** and first and second support members **66** and **68**. Furthermore, in another aspect, an interlaminar member **20** may be used alone (and may alternatively be configured to be similar to the U-shaped body **40**) and may be directly engaged with a first and second support members **66** and **68** and positioned between the lamina and spinous processes of the spine.

In yet another aspect, each of the ends **60**, **62** of the cross member **58** may be configured to permit a degree of adjustability (e.g., pivotably or translatably) to receive and adjustably secure first and second support members **66** and **68** respectively. For example any transverse connector or cross-link variable adjustment mechanism or fastener known in the art may be employed to accomplish the desired fixation between the ends **60**, **62** of the cross member **58** and first and second support members **66** and **68**. A spinal stabilization system **100** incorporating these features is illustrated generally at **100** in FIGS. 15 and 16.

System **100** includes an interlaminar member **102** of substantially the same configuration as the interlaminar member **12** described above in the embodiment of FIG. 1. Interlaminar member **102** is adapted to be positioned between adjacent vertebra in a spinal column and is operatively connected to a support structure shown generally at numeral **104**. As described hereinabove with respect to the embodiment of FIG. 1, in the embodiment shown in FIGS. 15 and 16, the support structure and the interlaminar member are integrally formed from a single piece of material such as titanium or stainless steel suitable for use as a medical implant device. However, it is to be understood that other means for connecting the interlaminar device to the support structure such as hinges, pins, threaded fasteners and the like may also be used without departing from the scope of the invention.

The support structure **104** comprises a pair of spaced-apart support members or guide rods **106** secured to the interlaminar member **102** and extending in a direction upwardly therefrom substantially parallel to one another. Each of the guide rods **106** includes an ear or bracket element **108** extending generally outwardly therefrom in a direction either toward or away from the spinal column (not

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shown) and includes an aperture **110** formed therein adapted to receive a securing device such as a pin or a threaded fastener for attaching the system to a vertebra.

While not shown in the drawings, it is to be understood that the guide rods **106** and ear or bracelet elements **108** connected thereto may be adjustably moveable by a ratcheting or other suitable mechanism in a direction towards each other, thereby applying a clamping force to a spinal process positioned therebetween. Each of an inner surfaced or face **109** may also include a rough textured finish or have sharp extensions, or "spikes" (not shown) formed thereon and extending outwardly therefrom which may imbed themselves in the surface of a spinal process, thereby preventing slippage.

In a similar manner, ridges **111** formed on an upper surface **113** of number **102** also engage the bony structure of a vertebra, thereby enhancing the engagement of the system **100** with the spinal column.

The support structure **104** further includes an elongate body **112** having first and second end portions **114**, **116**, the first end portion being operatively connected to interlaminar member **102**; the second end portion being operatively connected to a pair of elongate cross members **118** adjustably positioned in overlapping juxtaposition with respect to one another and the second end portion **116** of the support structure, as will be described hereinbelow in greater detail. Each of the cross members has first and second end portions **120**, **122**, each of the first end portions **120** having a longitudinally extending aperture or slot **124** formed therein, and each of the second end portions includes a connector **126** adapted to receive and adjustably secure a support member of the system, such as a guide rod **66**, **68** as illustrated in FIG. 1, by a locking member **128**. Locking member **128** may be in the form of a set screw, a pin, a clamp or other such suitable locking means as is known generally in the art.

As shown in greater detail in FIG. 16, the second end portion **116** has an elongate longitudinally extending aperture or slot **130** formed therein structured and arranged to receive securing means shown generally at **134** for adjustably securing elongate cross members **118** thereto. By way of example and not of limitation, securing means **134** includes a collar **136** slideably positioned on end **116** and having a generally transversely extending aperture **138** formed therein for receiving a first end portion **120** of an elongate cross member **118**. A fastener, by way of example a bolt **140**, extends through each of the slots **124** in the elongate cross members **118** placed in overlapping slideable juxtaposition with respect to one another, the slot **130** in the second end **116** of the support structure **104** and into an aperture, by way of example a threaded aperture (not shown) which is formed in the collar **136**. This configuration permits translational and/or rotational movement and adjustment in the generally caudal or cephalad directions of both the first and second ends **120**, **122** of the cross members **118** with respect to the elongate body **112**, thereby permitting precise alignment of the interlaminar member **102** with a lamina and spinal process. Thereafter, the locking mechanism is engaged to fix the elements of the system in position with respect to one another and the patient's spine. While not shown in the figures, a second locking mechanism or stop such as a pin, strap, a band, a fastener, a clamp, and the like, as is known in the art, may also be connected to the elongate cross members **118** after they and the other elements of the system are aligned and fastener **140** is tightened to prevent movement of the elongate cross members relative to one another in response to loading transmitted thereto via the

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elongate body **112**. This would be of particular concern in the event that the securing means **134** would loosen after installation.

Referring now to FIGS. 17(A) and (B), an embodiment **150** of a spinal stabilization system of the present invention is illustrated which includes a support structure **152** having an elongate body in the form of a rod or dowel **154** having first and second end portions **156**, **158**, the first end portion being operatively connected to interlaminar member **102**; the second end portion being operatively connected to a pair of elongate cross members **118** adjustably positioned in overlapping juxtaposition with respect to one another and the second end portion **158** of the support structure, as described above with respect to the embodiment of FIGS. 15 and 16. However, in the embodiment of FIG. 17, a securing means **160** is provided in the form of a spherical or tubular collet **162** received over the first end portion **156** and secured thereto by a collar **164** and setscrew **166** or other suitable means of applying a compressive restraining force to the collet **162**. The securing means **160** provides both translational and rotational movement of the interlaminar member **102** with respect to the support system **152**, thereby permitting very precise alignment of the interlaminar member with a lamina and spinal process.

A second similar securing means **168** having a spherical or tubular collet **170** received over the second end portion **158** of rod **154** and secured thereto by a collar **172** and setscrew or other suitable compressive securing means (not shown) applies a compressive restraining force to the collet **162**. In the manner described above with respect to the collet and securing means at the first end **156**, the collet **170** provides both translational and rotational movement of the overlapping elongate cross members **118** with respect to the rod **154** and interlaminar member **102**, thereby assisting in establishing very precise alignment of the interlaminar member with a lamina and spinal process. In the embodiment shown, collets **170** are mounted on collar **172** of securing means **168**. However, for enhanced stability, the collets could also be mounted on transverse cross members, such as members **314** as shown in FIG. 24, instead.

In the embodiment of FIGS. 17(A) and (B), each of the second end portions **122** of the overlapping elongate cross members **118** includes a connector adapted to receive and adjustably secure a support member of the system, such as a guide rod **66**, **68** as illustrated in FIG. 1, as hereinabove described. In the embodiment of FIGS. 17(A) and (B), the connector is shown in the form of a compressible collet **174** extending circumferentially around the guide rod and releasably secured in position by a compression nut **176** or other suitable locking means secured thereto.

In an embodiment **190** of the spinal stabilization system of the present invention as shown in FIGS. 18-23(A) and 23(B), the elongate body of the support structure as described in exemplary form above with respect to the embodiments of FIGS. 1-17 is depicted in the form of at least two elongate body members, by way of example, rods or dowels **192**. Each rod includes a first and a second end **194**, **196**; each first end **194** being structured and arranged to be connected to an interlaminar support member **198** and each second end **196** being operatively connected to a pair of elongate cross members **118** adjustably positioned in overlapping juxtaposition with respect to one another, as described in detail above. The spherical or tubular collets **170** provide a pivotal connection of the rods to the members **118** so that each of the rods may be individually movable in any direction relative to one another and to a patient's vertebrae **14**, **15**, **16** and **22**, as shown in FIGS. 21 and 22.

Alternatively, the rods may be tied together by a transversely extending crosspiece (not shown) so that the rods may be movable relative to the cross members 118, yet not moveable relative to one another, thereby facilitating the positioning and attachment of one or more interlaminar support members 198 thereto by suitable connections such as set screws 199 threadably inserted into apertures 200 formed in the interlaminar support member as shown in FIGS. 18, 19, 20 and 23.

In the embodiment of FIG. 23(A), the interlaminar support members 198 are shown installed with a leg 46 that is not attached directly to a rod 192 positioned on the side closest to the transverse cross members 118, thereby directing the spring forces from the cross members relatively uniformly into the adjacent vertebrae 22, 16 and 14. However, with reference to the embodiment of FIG. 23(B), by installing the support members such that they face each other, the spring forces are directed into vertebra 16, thereby compressing it in this application.

Referring now to FIGS. 24-27, a spinal stabilization system 300 of the present invention is illustrated according to an embodiment which includes a support structure 310 structured and arranged to secure the system to a patient's spinal process or column 312 to stabilize multiple levels of vertebra 15, 14, 16, and 22, in ascending order. The support structure 310 includes a plurality of transversely extending elongate cross members 314 adjustably positioned one above the other in general alignment with the spinal column 312. In the embodiment shown, by way of example and not of limitation, the cross members are in the form of a pair of transversely extending rods which span the spinal column in with respect to one another. However, it is to be understood that three or more cross members of various shapes and configurations may also be used without departing from the scope of the present invention. In the embodiment of FIG. 24, an intervertebral body fusion device ("IBFD") 311 is shown inserted between each of the adjacent vertebrae 15, 14; vertebrae 14, 16; and vertebrae 16, 22 to provide additional stability to the spinal column 312.

As shown in greater detail in FIGS. 25 and 26, each cross member 314 comprises an elongate body 316 having first and second end portions 318, 320 and a midpoint 322 and is structured and arranged to be operatively connected at approximately the midpoint to a first interlaminar support member 325. Each of the ends 318, 320 of the cross members are adapted to receive a connector or securing device 326 for adjustably securing first and second support members 66 and 68 respectively, as described above with respect to other embodiments of the present invention and in greater detail below.

FIG. 27 illustrates the elements of each connector 326 in greater detail. Each connector has an aperture 328 formed therein respectively for receiving one of the ends 318, 320 of the elongate body portion 316 of cross member 314, each of which may be held in a preselected position by a set screw or other fastening means 330. Each connector further includes a retainer or bracket element 331, which, in the embodiment shown, is in a generally J or hook shaped configuration adapted to conform to the shape of the support members 66, 68; however, other configurations and shapes may also be employed to adapt to the configurations of the support members which may be used. In the embodiment shown, by way of example only and not of limitation, the support members are in the form of guide rods 66, 68, each guide rod having an upper end 332 and a lower end 334. The guide rods 66, 68 may be secured following alignment and adjustment of the system 300 to a patient's anatomy and

spinal structure (as shown generally in FIG. 24) by pressure transmitted from a respective set screw 330 via an end of a cross member 320 indicated by arrow 333 in FIG. 27(C).

Each of the upper and lower ends of the support members 66, 68 has a securing device 336 slideably positioned thereon and adapted to be secured thereto by means of set screws 338. By way of example, each of the securing devices 336 is adapted to receive a bone screw 340, each bone screw being structured and arranged to be secured to one of the vertebra of the spinal column 312.

Referring again to FIGS. 25 and 26, the elements of the interlaminar support member 325 and other elements of the support system 300 are disclosed in further detail. Similar in construction to the embodiment of the system of FIG. 1, interlaminar member 325 is adapted to be positioned between adjacent vertebrae in a spinal column. As shown in greater detail in FIG. 24, the interlaminar member 325 is shown positioned between a first vertebra 16 and a second adjacent vertebra 22 in a spinal column 312.

The system further includes a second interlaminar member 341 adapted to be positioned between the second vertebra 22 and a third vertebra 23 in the spinal column 312. Both the first and second interlaminar members are operatively connected to a support structure shown generally at numeral 342. By way of example, in the embodiment shown, the support structure 342 and the first interlaminar member 325 are integrally formed from a single piece of material such as titanium or stainless steel suitable for use as a medical implant device, and the interlaminar structure 325 may be welded at 344 to one of the cross members 314. However, it is to be understood that other means for forming and/or interconnecting the various elements of the system such as hinges, pins, threaded fasteners, casting techniques and the like may also be used without departing from the scope of the invention.

Interlaminar member 325 comprises a U-shaped body 346 defined by an elastic midsection 348, two spaced apart end portions 350, and a pair of juxtaposed legs 352, each leg extending substantially parallel to one another from one of the respective ends in a direction generally outwardly away from the spinal column 312 and spaced apart a preselected distanced (FIG. 24). Distanced is determined by the size of the interlaminar member 325, which is, in turn, is selected based upon the spacing between the vertebrae 16 and 22, respectively. The interlaminar member is intended to fuse the vertebrae. Accordingly, it is sized to be a tight fit, and the elastic properties of the U-shaped body 348 act as a spring or shock absorber in the interface between the two vertebrae. Further, the uppermost one of the legs 352 may be used as a handle to insert and position the system during surgery.

As discussed above with respect to the embodiment of FIG. 1, while the body 346 is described as being U-shaped, it is to be understood that many other shapes and configurations may also be effectively employed without departing from the scope of the present invention. It is also to be noted that both interlaminar members 325 and 341 include pointed ridges or teeth 327 extending outwardly therefrom which are adapted to engage portions of vertebra 22 positioned therebetween to prevent slippage of the stabilization system 300 following installation.

The system 300 further comprises a pair of support members or guide rods 354 secured to the interlaminar support member 325 and extending in a direction upwardly therefrom substantially parallel to one another. The second interlaminar member 341 includes a body portion 356 of a preselected thickness t, which is selected based upon the

spacing between vertebrae **22** and **23**, and is intended to be smaller in size than the spacing to allow for flexion of the spinal column **312**.

The body portion **356** further includes a pair of oppositely positioned ears **358** extending laterally outwardly from the body portion in opposing directions, each of the ears containing an aperture **360** structured and arranged to slideably receive one of the support members or guide rods **354**. As will be discussed in greater detail below, the second interlaminar member is movably supported by the upwardly extending support members or guide rods, and the position of the second interlaminar member **341** relative to the first interlaminar member **325** may be adjusted depending upon the dimensions of the specific spinal column on which the system is installed and the range of motion desired. Once the position of the second interlaminar member **341** has been selected, it is locked in place by a pair of set screws or other suitable fastening means **362** extending through each of the ears **358** and adapted to releasably engage the respective guide rod extending therethrough. A plurality of spaced-apart recesses **362** adapted to receive the ends of may be formed in each of the guide rods to assist in positioning interlaminar member **341**.

Increased stability to a spinal fixation system may be provided by employing additional pedicle screws at selected locations in the system. For example, in accordance with another embodiment of the instant invention, a spinal fixation system **400** with increased stability is depicted in FIGS. **28-31**. Of substantially the same configuration as the spinal stabilization **300** of the embodiment shown in FIG. **24**, the system **400** includes a pair of oppositely disposed brackets **402** each connected to one of the support members or guide rods **354**. Each bracket includes an aperture or slot formed therein, each slot being adapted to receive at least one pedicle screw **340**. As best shown in FIG. **29**, apertures **406** formed in the uppermost leg **352** of the first interlaminar support member **325** and in the second interlaminar support member **341**, respectively are each likewise adapted to receive a pedicle screw **340**. The reader will appreciate that the pedicle screws received in each of the apertures **404** are positioned at a divergent angle with respect to one another, and the pedicle screws received in apertures **406** are positioned at a convergent angle with respect to one another, thus providing enhanced stability to the stabilization system **400** by a uniform distribution of the structural loading imposed thereon by the dynamics of the patient's post-operation movements.

FIGS. **32** and **33** illustrate yet another embodiment **500** of a spinal stabilization system of the present invention structured to provide enhanced system and spinal stabilization. In this embodiment, each of the support members or guide rods **354** includes an ear or bracket member **502** operatively connected thereto and extending transversely outwardly therefrom in a direction generally away from the spinal column **312** and parallel and adjacent to an outwardly extending portion **504** of vertebra **22**.

Each bracket has an aperture or eyelet **506** formed therein adapted to receive a retention device **508** adapted to releasably engage vertebra portion **504**, each of the fasteners being oppositely disposed so as to cooperate with each other in applying a clamping force to the vertebra portion. In the embodiment shown, by way of example and not of limitation, the fasteners are in the form of threaded fasteners or bolts, each having a knurled knob **510** attached thereto to facilitate installation tightening thereof; however, it is to be understood by those skilled in the art that other forms of retaining devices such as pins, clamps and the like may be

used without departing from the scope hereof. As described above with respect to an earlier embodiment, each bracket **502** may include an inner surface or face (not visible in the figures) which has sharp protrusions, or teeth Extending outwardly therefrom adapted to engage and even imbed in outwardly, extending portion **504** of vertebra **22** to prevent slippage following installation of the system.

Referring now to FIGS. **34-36**, exemplary embodiments of interlaminar support members are illustrated in greater detail. Depending upon the application and the degree of support required to stabilize a particular patient's spinal column, an interlaminar support member may be of a generally rigid construction, a generally flexible construction, or it may contain both generally rigid and generally flexible portions. As will be described below in greater detail, the rigid or flexible portions of a support member are typically compressed by a separate compression tool upon installation against first and second oppositely disposed bone surfaces of adjacent vertebrae, such as vertebrae **14** and **16** shown in FIGS. **6** and **7**, and are retained in position by the elements of the support system and locking means such as threaded fasteners, set screws and the like, as described above.

According to an embodiment depicted in FIGS. **34(A)-(C)**, an interlaminar support member **520** comprises a generally T-shaped body **522** having a plurality of apertures **524** formed therein, each aperture adapted to receive a pedicle screw or other suitable fastener (not shown) for securing the support member to a vertebra, and a plurality of recesses **526**, each recess being structured and arranged to adjustably receive a support member (such as guide rod **28** of the embodiment of FIG. **1**). Interlaminar support member **520** further includes a U-shaped body **528** defined by an elastic midsection **530** and two spaced apart juxtaposed legs **532**, each leg, when in place in a spinal process, extending substantially parallel to one another from the elastomeric midsection in a direction generally outwardly away from the spinal column. The interlaminar support member is intended to fuse the adjacent vertebrae. Accordingly, it is sized to be a tight fit, and the elastic properties of the U-shaped body **528** act as a spring or shock absorber in the interface between the two vertebrae.

Referring to FIGS. **35(A)-(C)**, an interlaminar support member **540** is illustrated which includes a generally T-shaped body **542** having a plurality of apertures **544** formed therein, each aperture adapted to receive a pedicle screw or other suitable fastener (not shown) for securing the support member to a vertebra, and a plurality of recesses **546**, again each recess being structured and arranged to adjustably receive a support member (such as guide rod **28** of the embodiment of FIG. **1**). The support member **540** further includes a U-shaped body **548** defined by an elastic midsection **550** and two spaced apart juxtaposed legs **552**, the U-shaped body being operatively connected to the T-shaped body by a planar arm member or bracket **554** positioned intermediate the legs **552**. As described above with respect to the embodiment of FIG. **34**, each leg, when in place in a spinal process, extends substantially parallel to one another and to the bracket **554** from the elastomeric midsection **550** in a direction generally outwardly away from the spinal column. At least one of the legs further includes a wedge or V-shaped protrusion **556** extending outwardly therefrom and transversely across an outer surface **558** thereof, the protrusion being structured and arranged to resistively engage one of the oppositely disposed bone surfaces of adjacent vertebrae upon installation of the support system to prevent unintended displacement thereof.

In accordance with another embodiment **570** of an interlaminar support member as shown in FIGS. **36(A)-(C)**, a generally T-shaped body member **572**, of similar configuration to the T-shaped body members of the embodiments of FIGS. **34** and **35**, includes a generally J-shaped member **574** extending transversely therefrom defined by a pair of oppositely disposed sides **576** and curved upper and lower surfaces **578**, **580** which intersect to define a rounded or knob-shaped end portion **582**. The support member **570** is installed intermediate a pair of adjacent vertebrae by forcibly inserting the rounded end portion therebetween and then rotating it about the end portion to a desired position, whereupon it is secured in place by pedicle screws and guide rods, as described above.

In other aspects of the instant invention, the elements of the stabilization system may be adapted to be adjusted in response to a patient's anatomical structure. For example, the U-shaped body portion of an interlaminar device as hereinabove described may be configured to include a triangular or wedge-shaped body portion for ease of implantation and fitting in situations where a patient's anatomy may not accommodate a U-shaped configuration. The final implanted profile of an implant device may also be adjusted for purposes of bone-implant conformity, and the material thickness and physical properties of the device may be tailored to provide a specific stiffness, enhanced fatigue resistance and a preselected range of motion in a chosen direction, depending upon the patient's overall condition and flexibility.

In a similar manner, the crosslink members may also be too short or too long for a patient's anatomical structure. Accordingly, the system of the present invention may include crosslink members of varying lengths or having adjustable lengths, thicknesses, diameters or thicknesses and stiffness properties which may be selected by the practitioner depending upon the patient's requirements.

In a similar manner, the vertical section of the interlaminar device which extends intermediate the shaped body portion which is positioned intermediate adjacent vertebrae and at least one crosslink member may be provided in varying fixed lengths or in an adjustable configuration, by way of example, in the form of a pair of overlapping elongate members which may be adjusted to a desired length during the implantation process and then fixed by suitable fastening systems such as screws, cooperating nuts and bolts, and the like. Moreover, to achieve proper placement of the system, the angulation between the crosslink member and the vertical section of the system is adjustable to accommodate the spinal curvature of the patient's spine. This feature may be provided by incorporating a wedge, an angulated L-shape, an S-shape or some other geometric shape into a lower vertical connection portion of the interlaminar device. It may also be achieved by modifying the lengths, thicknesses, spacing, surface texture and angular relationships between the legs of the interlaminar device to ensure ease of insertion and correct orientation with respect to the vertebrae, thus providing proper conformation with the interlaminar space and uniform support following installation.

Robust fixation of the system, in particular the connections between the crosslink member(s), the pedicle screws and the hook devices interconnecting them is achieved via judicious selection of size, strength or stiffness so that all of the interconnected components interact as a system to provide stability against axial, sagittal and coronal torsions. A unique feature of the foregoing is the overall adaptability of the system to the requirements of the patient's anatomical

structure and the issues being addressed. Once the sizes, configurations and physical properties of the system components have been determined, the system may be installed on the patient's spine and fine-tuned to provide the requisite stiffness, support and range of motion.

In particular aspects, the different elements of the system may be configured with tool engagement features in order to permit a surgeon to grasp the implant with a tool assembly or insertion tool to ease implantation of the various components. For example, the insertion tool may be configured as a pair of pliers or hemostats. As another example, a threaded portion of a tool assembly may reversibly secure to a complementary threaded portion of the implant in order to ease implantation.

Accordingly, a tool assembly may be comprised of a cannulated shaft with a retainer shaft housed substantially within, the retainer shaft further configured with a threaded portion at its proximal end which may extend out of a proximal end of the retainer shaft and a handle located and attached to a proximal end of the retainer shaft. The proximal end of the retainer shaft may have a feature that permits rotation of the retainer shaft via another tool, such as the mechanical arrangement that exists between a wrench and nut, in order to secure the tool assembly to the implant. After implantation of the implant the tool assembly may be decoupled and removed.

Referring now to FIGS. **37-39**, a spinal stabilization system insertion tool apparatus, for ease of reference also referred to herein as a seating tool, adapted to install an interlaminar support member **520** (FIG. **34**) is shown generally at **600**.

Apparatus **600** comprises a first tool **602** including a cylindrical body portion or cannulated shaft **604** having an internal aperture **605** extending substantially longitudinally the length thereof. The body portion further includes proximal and distal ends **606**, **608**, the distal end comprising a pair of spaced apart longitudinally extending segments **610** each terminating in a rounded or tapered end portion **612** structured and arranged to be releasably inserted into the support member **520**, as shown in FIG. **37(0)**. One of the segments **610** includes an alignment member **611** extending the length thereof, the alignment member being structured and arranged to cooperate with a guide member **613** formed in the interlaminar support member **520** to align insertion tool apparatus **600** properly therein for precise insertion of the interlaminar member into a spinal column. Interlaminar support member **520** also includes a second alignment feature which is illustrated in the form of a knob or extension **533** having a channel or recess **535** extending circumferentially thereabout, the knob and channel being adapted to receive portions of an installation apparatus, which will be discussed in greater detail below.

As shown in greater detail in FIGS. **37(8)**, **38** and **39**, tool **602** includes at least one alignment guide **614** secured thereto and structured and arranged to be in operative alignment with an aperture **524**. The alignment guide is adapted to receive a fastener installation tool **616** for installing a set screw or other fastening means **618** into the aperture **524** of the support member.

Referring again to FIG. **37**, and specifically to FIG. **37(C)**, a second seating tool **620** according to embodiment is shown which includes a body portion **622** having a proximal end **624** and a distal end **626**, the distal end being tapered for ease of insertion into the internal aperture **605** of first tool **602**. The proximal end of the second tool includes a threaded portion **628** adapted to be threadably received by corresponding mating internal threads inside the proximal end

606 of the first tool 602 so that upon insertion of the body portion 622 of the second tool into the internal aperture 605 and in response to rotation thereof via a handle 630 secured to the proximal end of the second tool, the tapered end 626 engages each of the end portions 612 forcing them into locking engagement with the interlaminar support member 520 as shown in the side sectional view of FIG. 37(0). The support member may then be delivered to and inserted into the implantation site in a spinal column, and the set screws 618 may be inserted in alignment guides 614 and apertures 524 and tightened by tool 616. After the insertion and securing operations are completed, the second tool may be removed from the first tool by backing out the threaded portion, thereby releasing the grip of the ends 612 on the support member and permitting removal of the insertion tool apparatus from the support member.

Referring to FIGS. 40, 41(A) and 41(B), a third plier-like tool for inserting a spinal stabilization system configured in accordance with the structure of the system 10 shown in the embodiment of FIG. 1 is illustrated at 650. In the configuration shown, the tool is designed to deliver parallel compressive forces to displace one member of the system a distance closer relative to another component. Alternatively, the tool may be configured to deliver distractive forces to system components whereby one component of the system is displaced a distance further relative to another component.

Tool 650 includes first and second arms 652, 654, each arm having a body portion 656, 658 pivotally interconnected at a midpoint 660 thereof, a first end portion or handle 662, 664 and a second end portion 666, 668, each second end portion being pivotally pinned to a respective body portion by a pin 670. The second end portions 666, 668 are structurally supported and cross linked to one another by a linkage mechanism, and each further includes an ear or bracket member 674, 676 extending longitudinally outwardly therefrom, each ear being adapted to receive a pin 678 for rotatably mounting an arm 680, 682 thereto respectively. Each arm includes a distal forked end portion 684, 686 having an aperture or recess 688, 690 formed therein, each recess being structured and arranged to releasably engage a portion of the spinal stabilization system 10 for installation thereof on a patient's spinal column.

Referring to FIGS. 41(A) and 41(B), one forked end portion, end 684, is shown enlarged so that the features thereof may be understood in greater detail. Each end includes a pair of finger-like members 692, 694 extending outwardly therefrom and general parallel to one another to form the aperture 688. The end portion further includes a recess 696 which extends circumferentially around the aperture and is adapted to receive a retainer, by way of example and not of limitation, a snap ring or other retaining device as is known in the art, to secure the end 684 to a portion of a spinal stabilization system for purposes of installation. By way of further example, aperture 688 and fingers 692, 694 are adapted to fit over knob 533 and recess 535 on interlaminar support member 520 shown in FIG. 37 (A) and to cooperate therewith to achieve precise positioning and insertion of member 520 into a spinal column.

FIGS. 42(A) and (B) illustrate the elements of a fourth tool or rod reducer 700 structured to be used in conjunction with the third tool 650 and to cooperate therewith in the procedure of installing a spinal stabilization system 10. Similar in construction to the first tool 602, the fourth tool includes a cylindrical body portion or cannulated shaft 702 having an internal aperture 704 extending substantially longitudinally the length thereof. The body portion further includes proximal and distal ends 706, 708, the distal end

comprising a pair of spaced apart longitudinally extending arms 710 each terminating in a curved or hooked member 712 structured and arranged to releasably engage a portion of the support system 10.

FIGS. 42(A)-(B) illustrate a moveable rod member 720 which cooperates with cannulated shaft 702 to form the rod reducer 700. The rod member includes a body portion 722 having a proximal end 724 and a distal end 726, the distal end being rounded or tapered for ease of insertion into the internal aperture 704 of shaft 702. The proximal end of the rod member includes a threaded portion 728 adapted to be threadably received by corresponding mating internal threads 730 inside the proximal end 724 of the cylindrical body portion 702 so that upon insertion of the body portion 722 of the rod member into the internal aperture 704 and in response to rotation thereof via a handle 732 secured to the proximal end of the rod member, the tapered end 726 cooperates with hooked members 712 to engage and align an element of the spinal stabilization system for installation on a spinal column, as will now be set forth with greater specificity.

Referring to FIGS. 43-46, a method of installing a spinal stabilization system 10 using the installation apparatus and tools hereinabove described and the operating interrelationship and cooperation of the tools during the installation will now be described. As a general background introduction, after the vertebrae in the portion of a spinal column have been identified and exposed by a surgeon, an implant trial is used to determine an appropriate fit of an implant. Implant trials of increasingly larger size may be delivered into the implantation region until an implant trial is chosen that appropriately fits the various surfaces of the implant trial against the bony surfaces of the lamina and spinous process. The implant trial may be forcibly delivered into the implantation region by using a hammer or mallet to strike an impact plate (not shown) at a proximal end of the tool. Numerous trials and templates corresponding to various configurations and dimensions of the components of the implant systems may be used during the course of the procedure in order for a surgeon to select the appropriately dimensioned and configured implant system best suited to a particular patient.

Prior to surgical site or bone preparation, trial insertion, or implant placement, a surgeon or other medical person may select a suitable procedure to fixation or stabilize a portion of the spinal column. The procedure may include fusing the intervertebral joints with or without delivering an implant in the joint space, e.g., an intervertebral body fusion device ("IBFD"). The procedure may alternatively or additionally include placing pedicle screws or hooks in operable relation with spinal rods thereby forming a construct to which embodiments of the present disclosure may be operably coupled. If the surgeon selects a procedure involving delivery of an implant as disclosed herein up to and in engagement with a portion of the spinal column, the surgeon may select an implant configuration for delivery into the posterior aspect of a vertebral column of the patient including attachment to both a spinal lamina and a pedicle screw and spinal rod construct based on preoperative or intraoperative data. The data may be the result of post-processing of raw or other imaging data (e.g., CT or MRI DICOM files). The post-processing may include the use of a software program (e.g., 3DSLICER available from <http://www.slicer.org>) that may be used for medical image processing and visualization of image data. Other data may include the patient's weight, activity level, and general health.

The preoperative or intraoperative data may assist in the planning and selecting of desirable procedure trajectories

(e.g., starting and stopping points on patient's soft tissue and near or within bone tissue), implant component types and dimensions (e.g., lengths, heights, widths, diameters, thread pitches, and angles relative to other components), delivery tool configurations and dimensions, and bone preparation tool types, dimensions, and configurations. A particular system for preparing and stabilizing the portion of the vertebral column may be selected, for example, for a hypermobile segment, which may include one or more implant components or the entirety of the system that is resistant to the expected forces present at that particular patient's spinal segment. The determination of fixation or stabilization sufficiency may be calculated based on the patient's data and also on the performance results of various bench and/or finite element analysis ("FEA")—tested implant assembly configurations. For example, a calculated implant and/or screw trajectory may be considered and determined from certain patient imaging and post-processing data with an overlaid implant assembly. Further, the implant assembly may be selected to include a first and a second interlaminar component dimensioned and configured to extend as far anteriorly toward the spinal canal as possible in order to center the interlaminar components as close to the center of the spinal column's axial compressive loading and in order to increase total implant surface to bone surface contact area to better distribute the loading of the spine over a lower percentage of the total joint surface. This load distribution reduces the possibility of spinous process fractures and other complications.

Specific measurements and characteristics of the patient's anatomy may influence the selection of a particular system or its components. For example, the patient's bone density may be measured at numerous locations in proximity to and surrounding the elements of the implant assembly. Lower bone density (e.g., osteopenia, osteoporosis) corresponding to a T-score lower than -1, unstable spondylolistheses, or hypermobility may require the use of an implant assembly with a greater rigidity or more points of fixation to the bone and or spinal rods. Additionally, the relative angles between the implant surfaces and screw or screws, and also the relative angles between multiple screws (e.g., parallel, divergent, convergent) may be preselected based on the patient's anatomy.

A comparison of the preoperative or intraoperative data (e.g., lamina and/or spinous process surface area, spinal segment mobility, loading, bone density, desirable anatomic pathways) and the selected implant assembly and bone preparation tools may be conducted to ensure or validate compatibility before the manufacture ships the implant system and/or before the surgeon employs the system in a surgical procedure. After validation of the implant assembly and preparation tools, the selected assemblies may be shipped to the surgeon and the surgeon may proceed with the surgical fusion procedure utilizing the selected assemblies.

In particular embodiments, pre-operative imaging may be used to manufacture custom implants to better match an individual patient's anatomy or to correct a structural misalignment of the spinal column. The various surfaces or faces of the implant may be selected to match the contour of the bone surface to which the implant surface will contact. For example, the surface or faces of the interlaminar components which contact the lamina and spinous process may be configured to be generally planar or even concave to match the contour of a bony surface including wrapping a portion of the surface around a greater portion of the lamina or spinous process. In one aspect, the faces or surfaces of the

implant may be generally a surface negative of the surfaces to which said surfaces are desired to contact.

Referring now to FIG. 43, typically, a surgeon will employ a depth measuring device or a depth gauge (not shown), as is known in the art, to determine the depth from the guide rods 28 to the patient's spinal column so that the size of the interlaminar support member for the intended implant location may be determined accurately. A spinal stabilization system 10 is positioned at the desired location along the column at the insertion point. The spinal stabilization system 10 includes a first interlaminar member 12 adapted to be positioned between adjacent first and second vertebrae in a spinal column (FIG. 6) and a second interlaminar member 520 adapted to be positioned between the second vertebra and a third vertebra therein. Both the first and second interlaminar members are operatively interconnected with one another via support members or guide rods 28.

A first step entails the installation of pedicle screws 84 and securing devices 80 attached to each at the proper locations in a spinal column. Guide rods 66, 68 may then be inserted into a respective securing device 80 and secured thereto by set screws 82. At this point, any lamina and/or spinal process may be removed as necessary to decompress the vertebrae and measurements may be taken as described above. A transverse member (58 in FIG. 1) may then be attached to the spinal or guide rods 66, 68, and a first interlaminar support member 12 may be placed at the desired location along the spinal column. The set screws 82 securing the guide rods 66, 68 are tightened, and lateral images and depth gauges are employed to measure the distances required for precise insertion of the interlaminar member. Similar measurements are made for the second interlaminar member 520 and it is positioned over the spinal column at the intended insertion point.

Referring now to FIGS. 44 and 45, rod reducer tool 700 is attached to one of the guide rods 28 with arms 710 positioned on either side of the interlaminar member 520 thereby straddling it and each hooked member 712 operatively connected to the guide rod. By rotating handle 720, tool 700 aligns guide rod, interlaminar member 520, set screw alignment guide 614 and the patient's spinal column properly for precise insertion of the member therein and installation and tightening of a set screw or other suitable fastening means by tool 616, as will be described below.

At this time, compression/insertion tool 650 is attached to the stabilization system 10 with one forked end 684 in operative engagement with leg member 48 of interlaminar member 12, and the other forked end in operative engagement with knob 533 and recess 535 on interlaminar member 520, whereby upon activation of the repressor 650, either compressive or distractive forces are applied to each of the interlaminar members 12 and 520 to position them along rods 28 at a preferred spacing as determined by the measurements taken earlier.

The seating tool 620 is now positioned over alignment guide 613 in support member 520, as best viewed in FIG. 46, and secured thereto by expanding members 612 into operative engagement with the interlaminar support member. The support member may then be delivered to and inserted into the implantation site in a spinal column, and the set screws 618 may be inserted in alignment guides 614 and apertures 524 and tightened by tool 616. After the insertion and securing operations are completed, the various tools may be removed from the support member and other elements of the spinal stabilization system and the incisions may be sutured to begin the patient's healing and recovery process.

Referring now to FIG. 47-49, an adjustable spinal stabilization system according to another embodiment of the present invention is shown generally at **800**. The system includes an interlaminar member **803** adapted to be positioned between adjacent vertebra in a spinal column. As shown in greater detail in FIGS. 54-56, the interlaminar member is shown positioned between a first vertebra **12** and a second adjacent vertebra **16** in a spinal column **18**.

The interlaminar member is operatively connected to a support structure **810**, portions of which are shown generally at numeral **810** in FIG. 47, the entire support structure being illustrated in FIGS. 54-56. By way of example, in the embodiment shown, the support structure and the interlaminar member may be formed from material such as titanium or stainless steel suitable for use as a medical implant device and are operatively adjustable interconnected by a threaded fastener assembly **812**, the specific elements of which are illustrated in greater detail in FIG. 53 and will be described in greater detail below. However, it is to be understood that other means for connecting the interlaminar device to the support structure such as hinges, pins, and the like may also be used without departing from the scope of the invention.

Referring now to FIGS. 50-53, the interlaminar member **803** is shown in greater detail. The interlaminar member comprises a body **805** defined by an elastic midsection **807**, the elasticity of which may be adjusted by material property selection and/or size, two spaced apart end portions **810**, and a pair of juxtaposed legs **815**, each leg extending substantially parallel to one another from one of the respective ends in a direction generally outwardly away from the spinal column **18** (FIG. 56) and spaced apart a preselected distance *d*. Distance *d* is determined by the size of the interlaminar member **803**, which is, in turn, may be selected based upon the spacing between the first and second vertebrae **14** and **16**, respectively. Depending upon the situation, the interlaminar member may be intended to fuse the first and second vertebrae, or it may be intended to permit limited motion therebetween while at the same time maintaining the stability of vertebra **16** relative to vertebra **14**. Accordingly, it may be sized to be a tight fit, and the elastic properties of the body **805** act as a spring or shock absorber in the interface between the two vertebrae. In the embodiment shown in the above-referenced figures, the elastic midsection **807** of the body **805** is U-shaped. However, as noted above with respect to other embodiments, other shapes or configurations, by way of example, a V-shape, a W-shape, a S-shape or other function configurations may also be used effectively.

The interlaminar member **803** further includes a pair of spaced-apart support members or plates **817** secured to an upper one of the pair of juxtaposed legs **815** of the interlaminar support member **805** and extending in a direction upwardly therefrom substantially parallel to one another. Each of the plates includes an outer surface **819** and an inner surface **820**, each inner surface having a plurality of teeth **822** formed therein and extending substantially parallel to one another in a direction generally cranially along the spinal column **18** (as shown in FIGS. 54-56) or alternatively if the assembly is flipped to support a vertebra below the spinal construct, caudally along the spinal column (not shown). Each support member or plate **817** further includes an aperture **824** formed therein and coaxially aligned along axis A-A, the apertures and the plates cooperating with one another to be positioned adjacent opposite sides the spinous process **12'** of vertebra **12** and to be secured thereto by a suitable fastener, such as, by way of example, a bolt, a screw or the like. According to other aspects, the intralaminar member may be fixed or otherwise attached to the spinous

process or lamina by having a configuration as shown and described throughout the present disclosure, as shown in any of the referenced provisional applications, or any other means or mechanism known in the art, e.g., a pair of brackets flared out laterally dimensioned to receive laminar screws, tethers, clamps, wires, latches, etc.

As best shown in FIG. 53, the interlaminar member further includes an attachment member **830** operatively connected to a lower of the two spaced apart end portions **810** and the legs **815** of the body **805**. In the embodiment shown, the attachment member includes a generally rectangular body **832** extending in a downward or caudal direction therefrom. The body includes first and second end portions **834**, **836**; top and bottom body portions **838**, **840** and generally parallel, oppositely disposed first and second side portions **842**, **844** extending intermediate the first and second end and side portions respectively. The body includes an aperture **848** formed therein adapted to receive a fastening apparatus **850** for securing the interlaminar member to a support structure **860**, which will be described in greater detail below. As shown, the attachment member **830** is connected to the lower of the two spaced apart end portions offset from the center; however, in other aspects it may be connected centrally and the leg **882** may in an aspect be configured as a clevis and may be located on both sides of the attachment member **830** or vis versa where the attachment member **830** comprises a pair of attachment members spaced apart from one another to receive the leg **882** therebetween. In the embodiment shown, the fastening apparatus includes a bolt **862**, a washer **863**, a lock nut **865** having serrated teeth **866** formed thereon and a squared portion opposite the face having the serrated teeth and a spacer spring **867**. The bolt is structured and arranged to be inserted through the washer and then through the aperture **848** in the body of the attachment member and then through the lock nut and spacer spring whereupon it is threadably inserted into a mating female threaded aperture **868** formed in an end **870** of a portion or member **872** of the support structure **860**. The end has serrated teeth **869** formed on an inner surface **872** thereof, the teeth being adapted to engage the teeth **866** of the lock nut **865** whereby the proper orientation of the interlaminar member relative to a patient's upper spinous process may be attained and locked in place. The spacer spring **867** is configured to maintain a separation between the serrated teeth **869** and **866** in order to permit movement between the components until the components are locked thereby compressing the spacer spring which permits the serrated teeth pair to engage another to prevent movement. The squared portion of the lock nut **865** is configured to travel along a length of the aperture **848** and when the components are locked help prevent undesirable movement between the aperture and fastening apparatus **850**.

Referring to FIGS. 50-52, member **872** of the support structure is shown in greater detail. It includes a generally T-shaped body portion **880** including an upwardly extending member or leg **882** which is formed to contain an angle **884** extending anteriorly toward the spinal column **18** to facilitate installation and adjustment of the stabilization system to accommodate a patient's skeletal structure. A crosslink member **890** is operatively connected to the leg **882**, and, by way of example, may be formed integrally therewith. The crosslink member has a at least one elongate aperture **892** formed therein structured and arranged to receive at least one suitable fastener for securing the member **872** to other elements of the support structure **860**, whereby the medio-lateral positioning of the interlaminar member may be varied

in response to the dimensions of a patient's skeletal structure. In the embodiment shown, the crosslink member includes two elongate apertures **892** symmetrically spaced apart relative to a longitudinal axis B-B of the member **872** of the support structure. In other aspects, one elongate aperture may extend substantially the entire length occupied by the two apertures shown in the Figures.

Referring back to FIGS. **47-49**, and with further reference to the incorporated provisionals which better show the individual components, the support structure includes a pair of threaded eye bolts **895**, each positioned in one of the apertures **892**, each eyebolt having an eye portion or aperture **897** formed in a proximal end thereof, each adapted to receive and releasably secure a first or upper end **900** of a guide rod **902** therein and to adjustably position each on a patient's spinal column in response to the patient's skeletal structure and dimensions. Each guide rod **900** includes a cross member **904** operatively connected to a second or lower end **906** thereof, each cross member having a transversely extending body **908** including a first end **910** operatively connected to a respective lower end **906** of one of the guide rods **900** and a second end **912** adapted to releasably secure a second support member **920** thereto, as shown in FIGS. **54-56**. In the embodiment shown, each of the ends **912** is in the form of hook-shaped member adapted to receive and retain a support member **920** with a set screw or retention fastener **914** threadably positioned therein; however, it is to be understood that other end configurations and guide rod retentions devices may also be used without departing from the scope of the present invention.

Referring now to FIGS. **54-56**, each of the second support members is in the form of spinal or guide rod **920**, each guide rod having an upper end **922**, a mid-portion **924** and a lower end **926**. Each of the upper and lower ends and the mid-portion of the support members has a securing device **927** slideably positioned thereon and adapted to be secured thereto by means of set screws **930**. By way of example, each of the securing devices **927** is adapted to receive a pedicle screw **935**, each pedicle screw being structured and arranged to be secured to one of the vertebra of the spinal column **18**, thus facilitating the installation, adjustment and operation of the spinal stabilization in the manner as hereinabove described with respect to other embodiments of the present invention.

Referring now to FIGS. **57A** and **57B**, a portion of an adjustable spinal stabilization system according to yet another embodiment of the present invention is shown generally at **1000**. The system includes an interlaminar member **1002** adapted to be positioned between adjacent vertebra in a spinal column as hereinabove described with respect to other embodiments hereof and is operatively connected to a support structure **1004**. In the embodiment shown, the support structure and the first interlaminar member are integrally formed from a single piece of material such as titanium or stainless steel suitable for use as a medical implant device. However, it is to be understood that other means for connecting the interlaminar device to the support structure such as hinges, pins, threaded fasteners and the like may also be used without departing from the scope of the invention.

The interlaminar member comprises a body **1004** defined by an elastic midsection **1006**, two spaced apart end portions **1008**, and a pair of juxtaposed legs **1010**, each leg extending substantially parallel to one another from one of the respective ends in a direction generally outwardly away from a patient's spinal column **18** (FIG. **56**) and spaced apart a preselected distance *d*. Distance *d* is determined by the size

of the interlaminar member, which, in turn, may be selected based upon the spacing between a patient's vertebrae. Depending upon the situation, the interlaminar member may be intended to fuse adjacent vertebrae, or it may be intended to permit limited motion therebetween while at the same time maintaining the stability of vertebra with respect to one another. Accordingly, it may be sized to be a tight fit, and the elastic properties of the body's midsection **1006** act as a spring or shock absorber in the interface between the two vertebrae. In the embodiment shown in the above-referenced figures, the elastic midsection **1006** of the body is U-shaped. However, other shapes or configurations, by way of example, a V-shape, a W-shape or other function configurations may also be used effectively.

The interlaminar member **1002** further includes a pair of spaced-apart support members or plates **1012** secured to an upper one of the pair of juxtaposed legs **1010** of the interlaminar support member and extending in a direction upwardly therefrom substantially parallel to one another. Each of the plates includes an outer surface **1014** and an inner surface **1016**, each inner surface having a plurality of teeth **1019** formed therein and extending substantially parallel to one another in a direction generally outwardly away from the spinal column **18**, the plates cooperating with one another to be positioned adjacent opposite sides a spinous process of a patient's vertebra.

The spinal stabilization system **1000** further includes a T-shaped frame or support member **1015** operatively connected to the interlaminar member **1002** and which extends generally downwardly therefrom in a direction substantially parallel to the spinal column **18**. The T-shaped frame member comprises an elongate body **1017** having first and second end portions **1020**, **1022**, the first end portion being operatively connected to the interlaminar member **1002**, and the second end portion to an elongate cross member **1024**. The elongate body **1017** is formed to contain an angle **1018** extending laterally outwardly away from a patient's spinal column to facilitate installation and adjustment of the stabilization system to accommodate a patient's skeletal structure.

The cross member includes first and second generally transversely and parallel extending cross members **1026** and **1028**, each having end portions **1030**, **1032** and a midpoint **1034** and is structured and arranged to be connected to the second end portion **1022** of the body **1017** at approximately the midpoint of member **1026**. Each of the ends of the cross members are adapted to receive and adjustably secure first and second support members in the form of spinal or guide rods **920** respectively, as shown in FIGS. **54-56**. The cross members are connected by a spacer member **1040** which has an aperture **1042** formed therein to reduce the weight of the system and to provide additional access to a patient's spinal processes during installation.

Referring to FIGS. **58A** and **58B**, a portion of an adjustable spinal stabilization system according to still another embodiment of the present invention is shown generally at **2000**. The system is similar in configuration to the system of FIGS. **57A** and **57B**, but has an aperture **2042** which is slightly larger and of a different configuration than aperture **1042** of the previous embodiment. System **2000** includes an interlaminar member **2002** adapted to be positioned between adjacent vertebra in a spinal column as hereinabove described with respect to other embodiments hereof and is operatively connected to a support structure **2004**. In the embodiment shown, the support structure and the first interlaminar member are integrally formed from a single piece of material such as titanium or stainless steel suitable for use as

a medical implant device. However, it is to be understood that other means for connecting the interlaminar device to the support structure such as hinges, pins, threaded fasteners and the like may also be used without departing from the scope of the invention.

The interlaminar member comprises a body **2004** defined by an elastic midsection **2006**, two spaced apart end portions **2008**, and a pair of juxtaposed legs **2010**, each leg extending substantially parallel to one another from one of the respective ends in a direction generally outwardly away from a patient's spinal column, again as shown as element **18** in FIG. **56**, and spaced apart a preselected distance *d*. Distance *d* is determined by the size of the interlaminar member, which, in turn, may be selected based upon the spacing between a patient's vertebrae. Depending upon the situation, the interlaminar member may be intended to fuse adjacent vertebrae, or it may be intended to permit limited motion therebetween while at the same time maintaining the stability of vertebra with respect to one another. Accordingly, it may be sized to be a tight fit, and the elastic properties of the body's midsection **2006** act as a spring or shock absorber in the interface between the two vertebrae. In the embodiment shown in the above-referenced figures, the elastic midsection **2006** of the body is U-shaped. However, other shapes or configurations, by way of example, a V-shape, a W-shape or other function configurations may also be used effectively.

The interlaminar member **2002** further includes a pair of spaced-apart support members or plates **2012** secured to an upper one of the pair of juxtaposed legs **2010** of the interlaminar support member and extending in a direction upwardly therefrom substantially parallel to one another. Each of the plates includes an outer surface **2014** and an inner surface **2016**, each inner surface having a plurality of teeth **2019** formed therein and extending substantially parallel to one another in a direction generally outwardly away from the spinal column **18**, the plates cooperating with one another to be positioned adjacent opposite sides a spinous process of a patient's vertebra.

The spinal stabilization system **2000** further includes a T-shaped frame or support member **2015** operatively connected to the interlaminar member **2002** and which extends generally downwardly therefrom in a direction substantially parallel to the spinal column **18**. The T-shaped frame member comprises an elongate body **2017** having first and second end portions **2020**, **2022**, the first end portion being operatively connected to the interlaminar member **2002**, and the second end portion to an elongate cross member **2024**. The elongate body **2017** is formed to contain an angle **2018** extending laterally outwardly away from a patient's spinal column to facilitate installation and adjustment of the stabilization system to accommodate a patient's skeletal structure.

The cross member includes first and second generally transversely and parallel extending cross members **1026** and **1028**, each having end portions **2030**, **2032** and a midpoint **2034** and is structured and arranged to be connected to the second end portion **2022** of the body **2017** at approximately the midpoint of member **2026**. Each of the ends of the cross members are adapted to receive and adjustably secure first and second support members in the form of spinal or guide rods **920** respectively, as shown in FIGS. **54-56**. The cross members are connected by a spacer member **2040** which has an aperture **2042** formed therein to reduce the weight of the system and to provide additional access to a patient's spinal processes during installation.

Changes may be made in the above methods and systems without departing from the scope hereof. It should thus be

noted that the matter contained in the above description and/or shown in the accompanying figures should be interpreted as illustrative and not in a limiting sense. The following claims are intended to cover all generic and specific features described herein, as well as all statements of the scope of the present systems and methods, which, as a matter of language, might be said to fall there between.

What is claimed is:

1. An adjustable stabilization system for stabilizing multiple levels of a patient's spine, the patient having a head, a pelvis, and a spinal column operatively connected at a caudal end thereof to the patient's pelvis and operatively connected at a cephalad end thereof to the patient's head, the spinal column including a plurality of operatively interconnected vertebrae positioned at multiple levels intermediate the caudal and cephalad ends thereof, each of the plurality of vertebrae being separated from an adjacent vertebra by an intervertebral space formed between the adjacent vertebrae, the system comprising:

a interlaminar member adapted to be positioned in an intervertebral space intermediate a first one of the plurality of operatively interconnected vertebrae and a second adjacent one of the plurality of operatively interconnected vertebrae, the interlaminar member including a U-shaped body having a midsection, and two spaced apart end portions, and a pair of juxtaposed legs extending parallel to one another from one of the respective ends in a direction outwardly away from the spinal column when the interlaminar member is implanted;

a pair of spaced-apart support members or plates secured to an upper one of the pair of juxtaposed legs of the interlaminar member and extending in a direction upwardly therefrom parallel to one another;

a support structure structured and arranged to secure the adjustable stabilization system to the patient's spinal column whereby multiple levels of the plurality of operatively interconnected vertebrae are stabilized, the support structure including a T-shaped body portion having an upwardly extending member having a top portion opposite a bottom portion and including an angle extending laterally outwardly away from the patient's spinal skeletal structure, the top portion operably coupled with a bottom one of the pair of juxtaposed legs of the interlaminar member, a crosslink member operatively connected to the bottom portion of the upwardly extending member, the crosslink member having at least one elongate aperture formed therein structured and arranged to receive at least one fastener for securing the interlaminar member to the support structure whereby the mediolateral positioning of the interlaminar member may be varied in response to dimensions of a patient's skeletal structure;

a fastener positioned in the at least one elongate aperture and adapted to receive and releasably secure a first end of a guide rod therein; the fastener comprising an eye bolt having an eye portion formed in a proximal end thereof, the eye portion being adapted to receive and releasably secure the first end of the guide rod.

2. The stabilization system of claim **1**, wherein the guide rod includes a cross member operatively connected to a second or lower end thereof, the cross member having a transversely extending body including a first end operatively connected to the second or lower end of the guide rod and a second end adapted to releasably secure a second support member thereto.

3. The stabilization system of claim 2, wherein the second end is in the form of hook-shaped member adapted to receive and retain the second support member.

4. The stabilization system of claim 3, wherein the second end further includes a retention fastener threadably positioned therein.

5. The stabilization system of claim 4, wherein the second support member is a spinal guide rod.

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