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Biyani

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(54) **LATERAL FIXATION ASSEMBLY FOR SPINAL COLUMN**

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2003/0055427	A1*	3/2003	Graf	606/61
2005/0228378	A1*	10/2005	Kalfas et al.	606/61
2005/0261685	A1*	11/2005	Fortin et al.	606/61
2006/0195087	A1*	8/2006	Sacher et al.	606/61
2006/0195088	A1*	8/2006	Sacher et al.	606/61
2006/0241591	A1*	10/2006	Biscup et al.	606/60
2008/0021451	A1*	1/2008	Coull et al.	606/54
2008/0039843	A1*	2/2008	Abdou	606/61
2008/0215095	A1*	9/2008	Biedermann et al.	606/246
2008/0234743	A1*	9/2008	Marik	606/257
2009/0204156	A1*	8/2009	McClintock et al.	606/278
2010/0004689	A1	1/2010	Biyani	
2010/0274288	A1*	10/2010	Prevost et al.	606/257

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A61B 17/70 (2006.01)

(52) **U.S. Cl.** **606/250**; 606/251; 606/258

(58) **Field of Classification Search** 606/53-60, 606/246-279

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,175,622	B2*	2/2007	Farris	606/250
7,922,746	B2*	4/2011	Miller	606/250
7,927,357	B2*	4/2011	Sacher et al.	606/258
7,942,907	B2*	5/2011	Richelsof	606/257
7,942,908	B2*	5/2011	Sacher et al.	606/258
8,043,340	B1*	10/2011	Law	606/257

OTHER PUBLICATIONS

Synthes Spine, Synex(tm) System Technique Guide, 2001.
Stryker, Thor(tm) Tumor Trauma Plate Operative Technique, 2008.

* cited by examiner

Primary Examiner — Eduardo C Robert

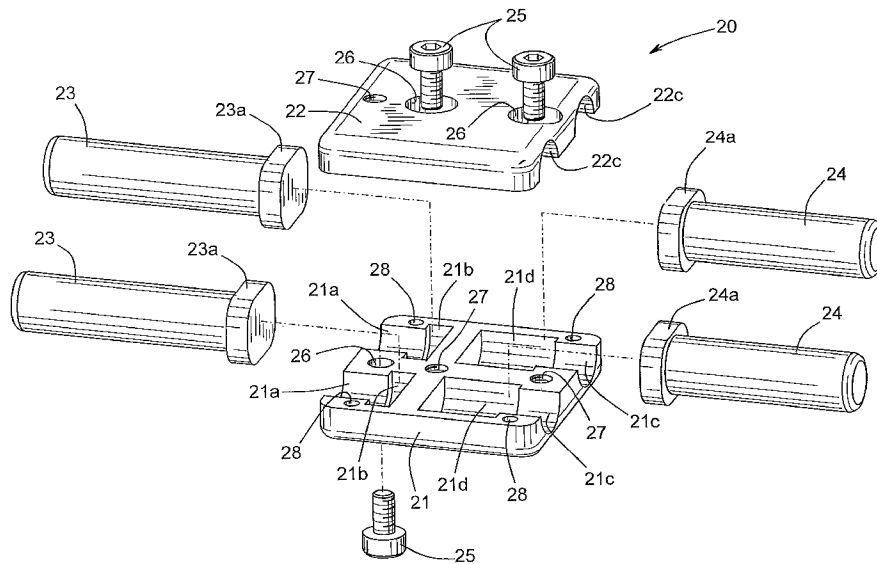
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(57) **ABSTRACT**

A lateral fixation assembly engages vertebrae in a spinal column. The lateral fixation assembly includes a housing having a first rod and a second rod supported thereon. The first rod is adapted to be secured to a first vertebra in the spinal column and is fixed in position relative to the housing. The second rod is adapted to be secured to a second vertebra in the spinal column and is movable relative to the housing. Respective pluralities of such first and second rods may be provided. Staples having varying thicknesses may be provided to facilitate the installation of the lateral fixation assembly on the vertebrae in the spinal column. A temporary blocking device can be used to prevent relative movement of the movable rod during the installation of the lateral fixation assembly.

18 Claims, 9 Drawing Sheets



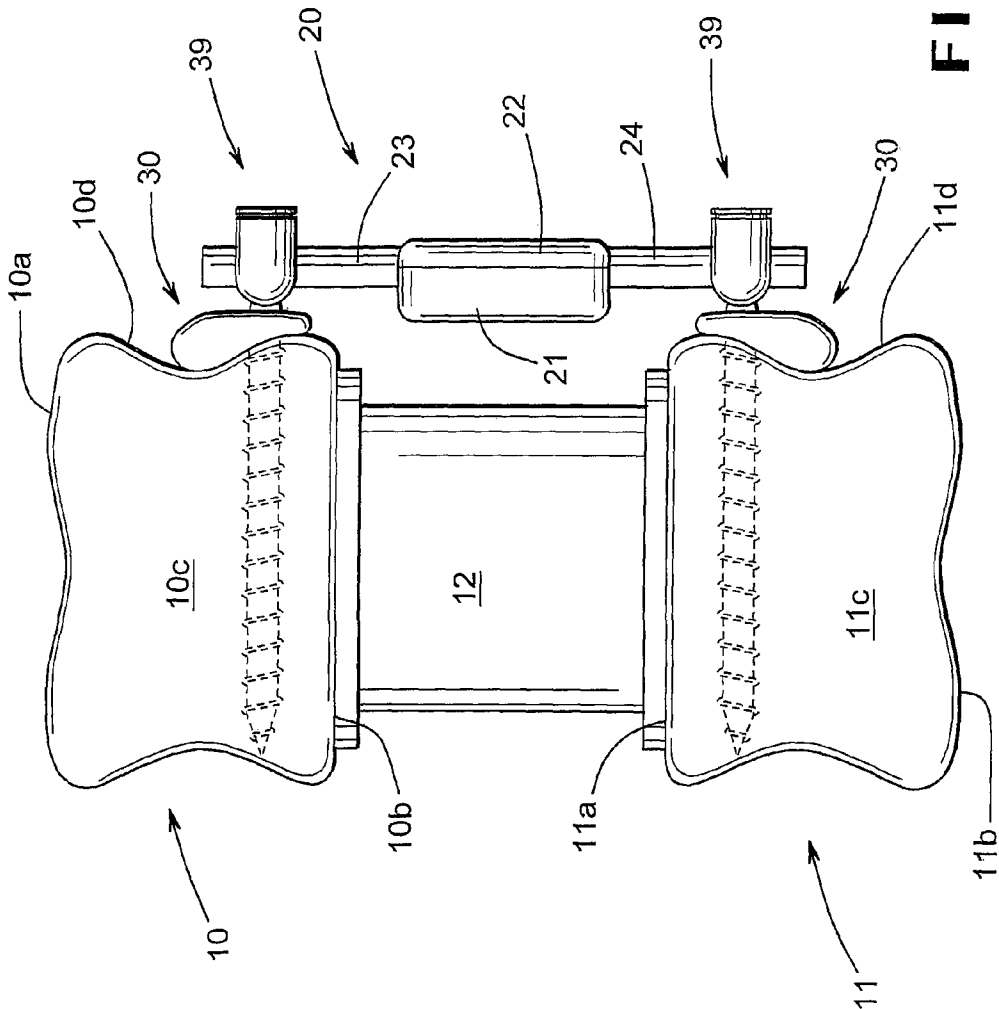


FIG. 1

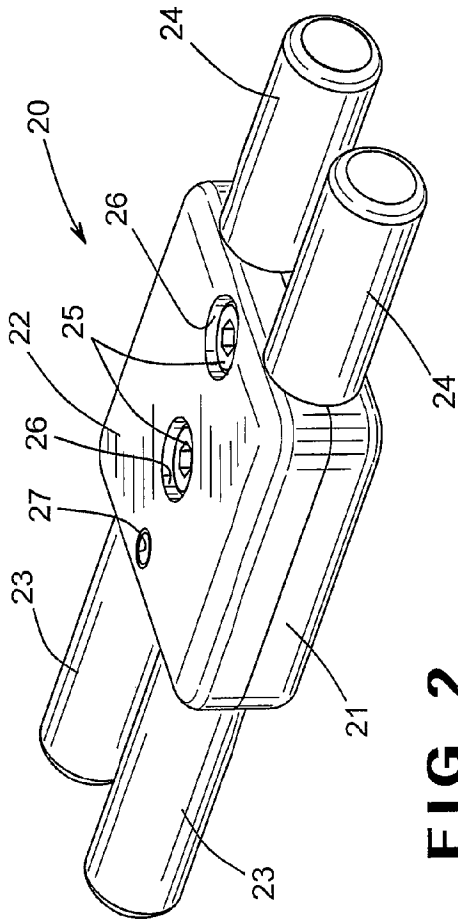


FIG. 2

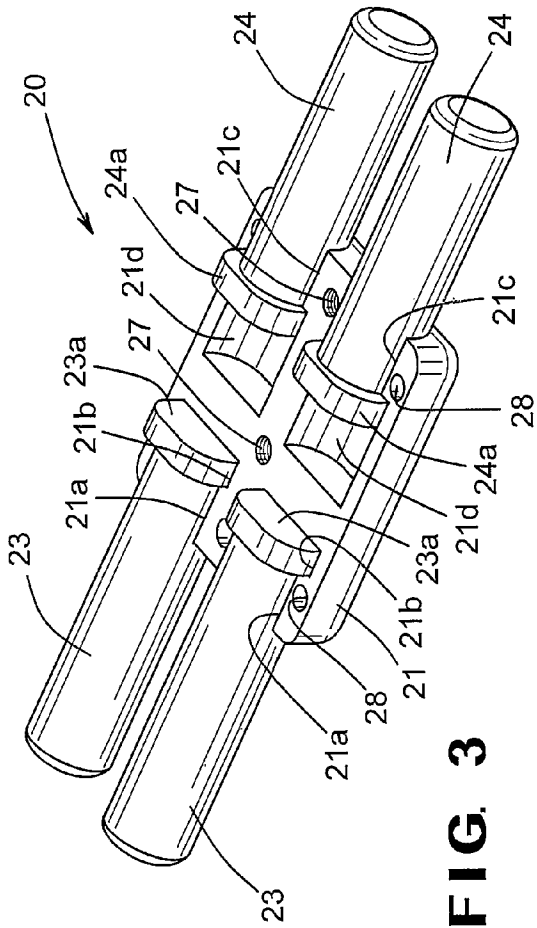


FIG. 3

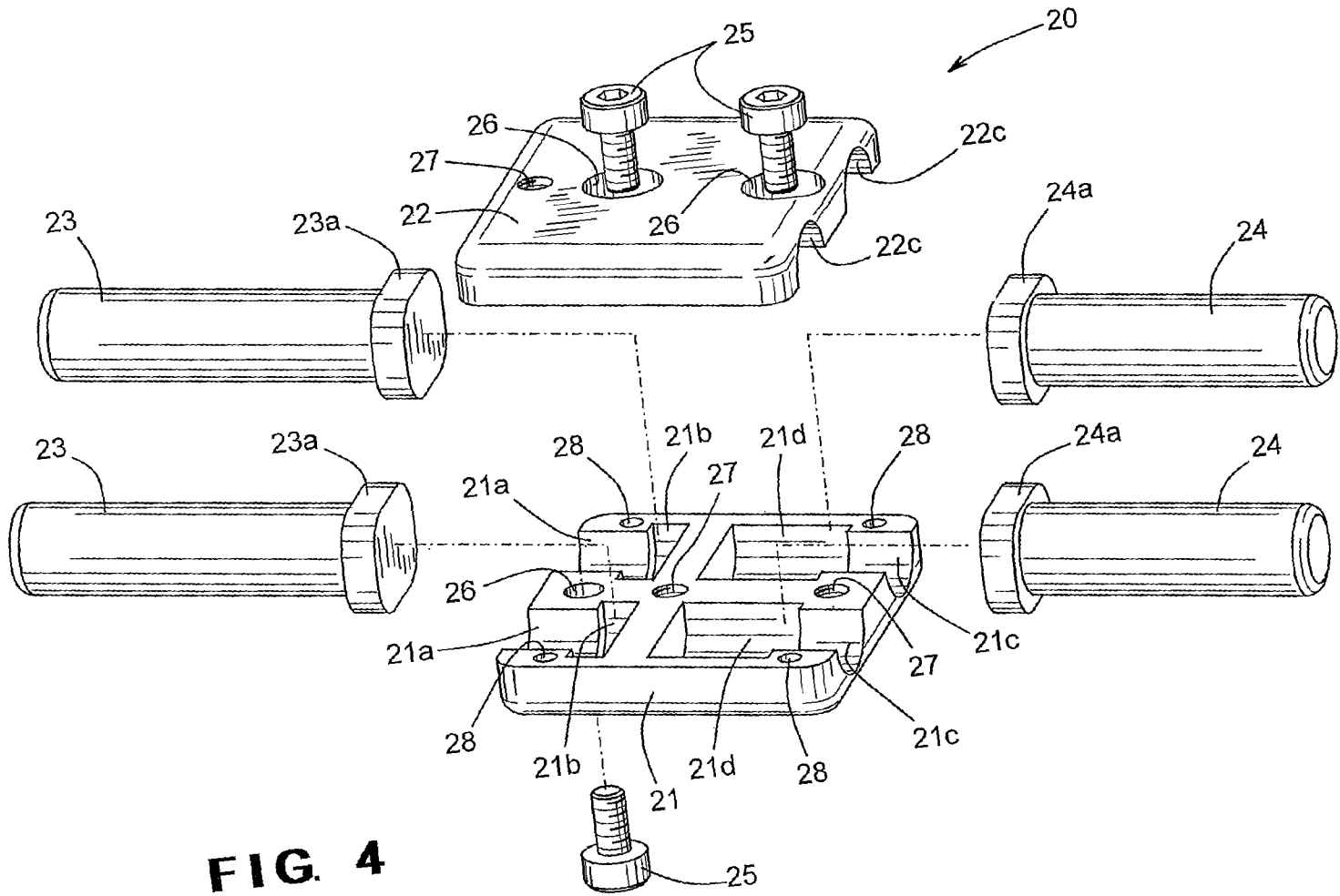


FIG. 4

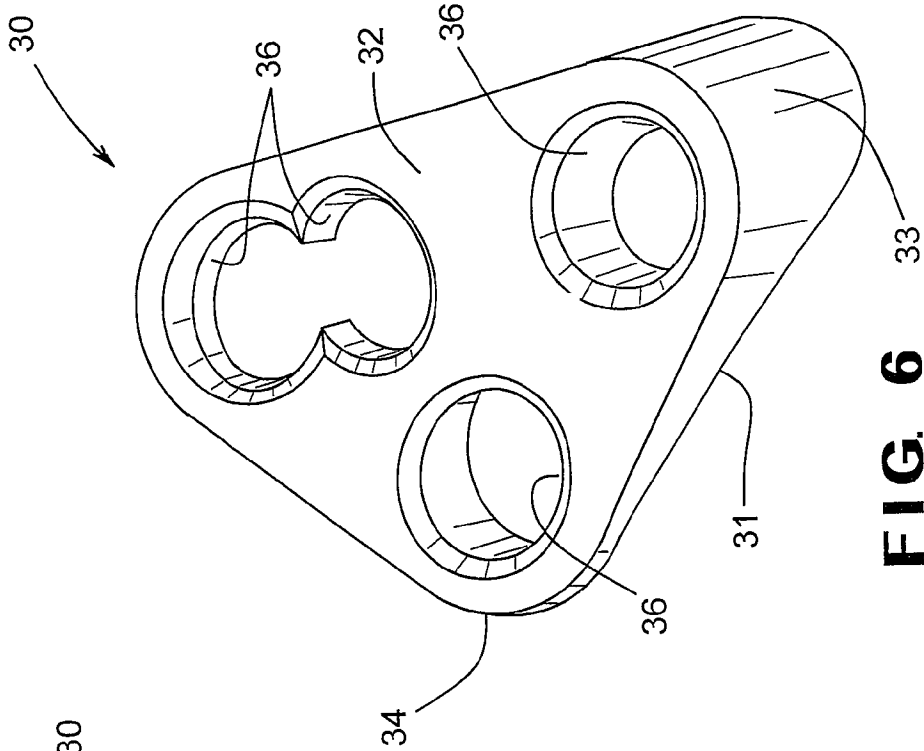


FIG. 6

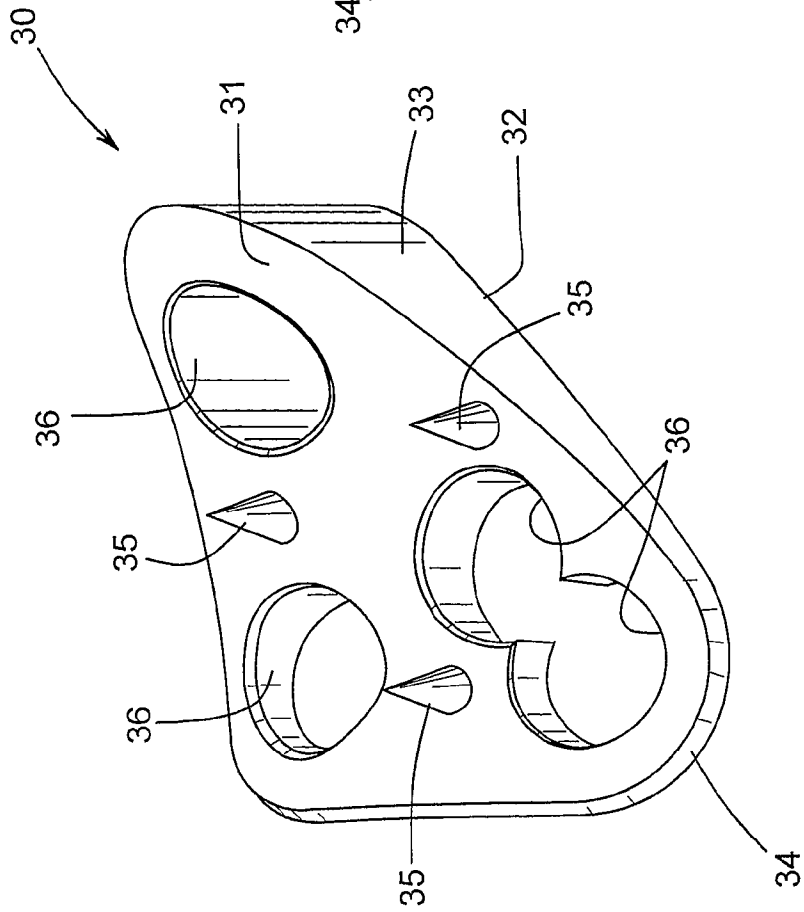


FIG. 5

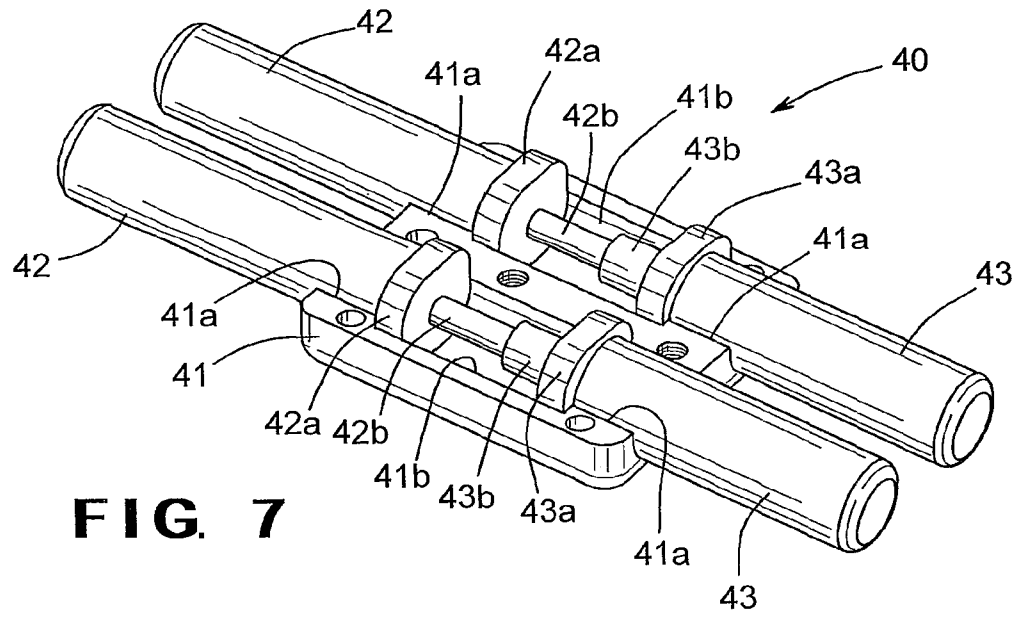


FIG. 7

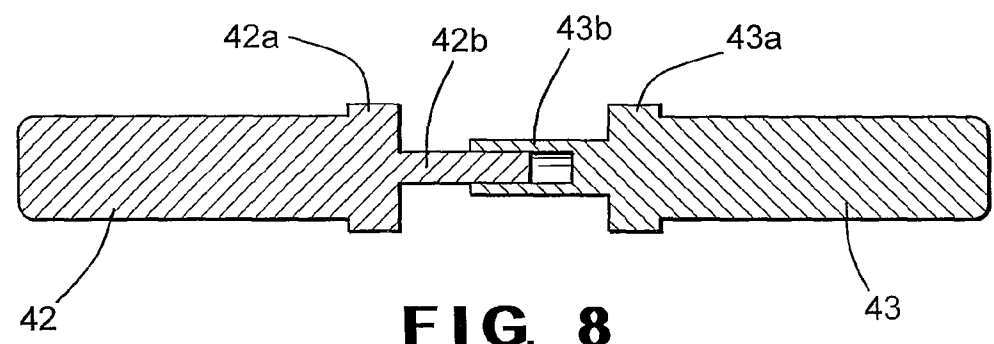
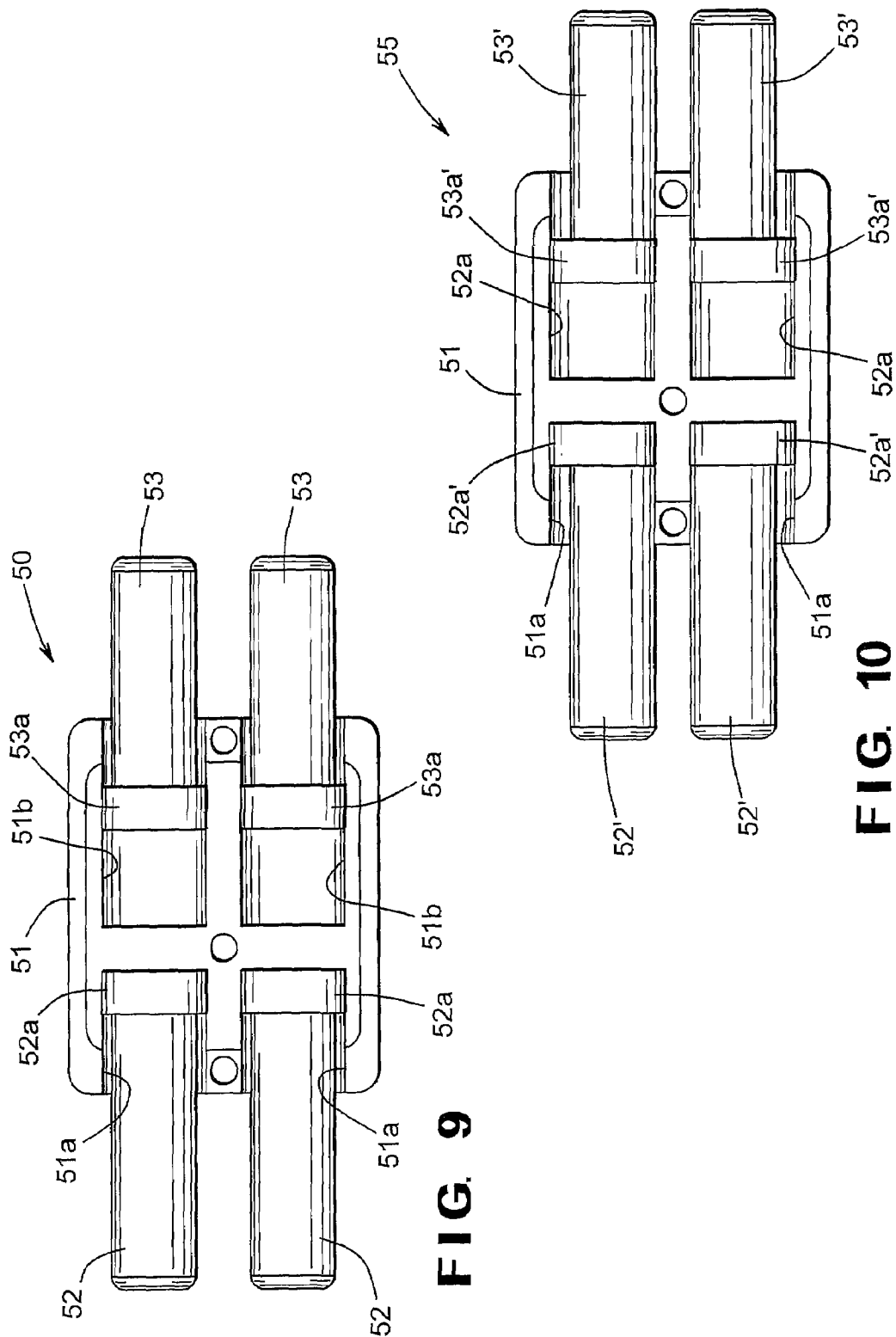


FIG. 8



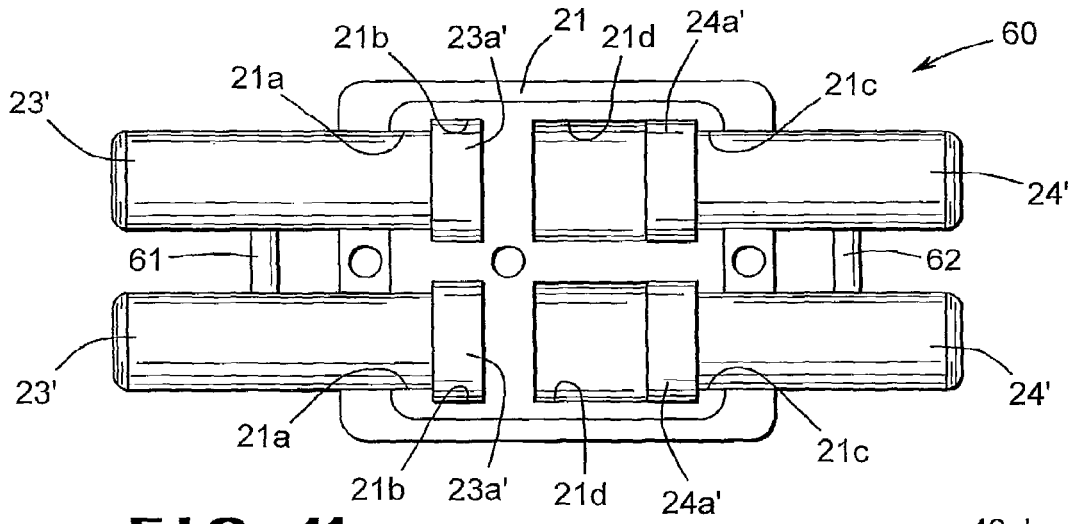


FIG. 11

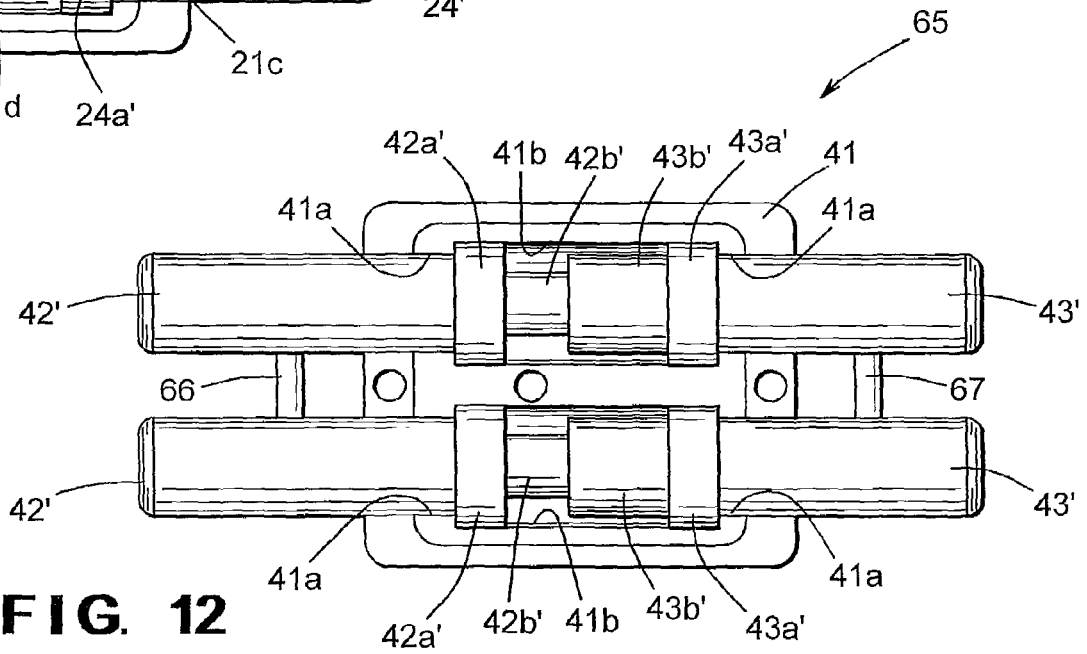


FIG. 12

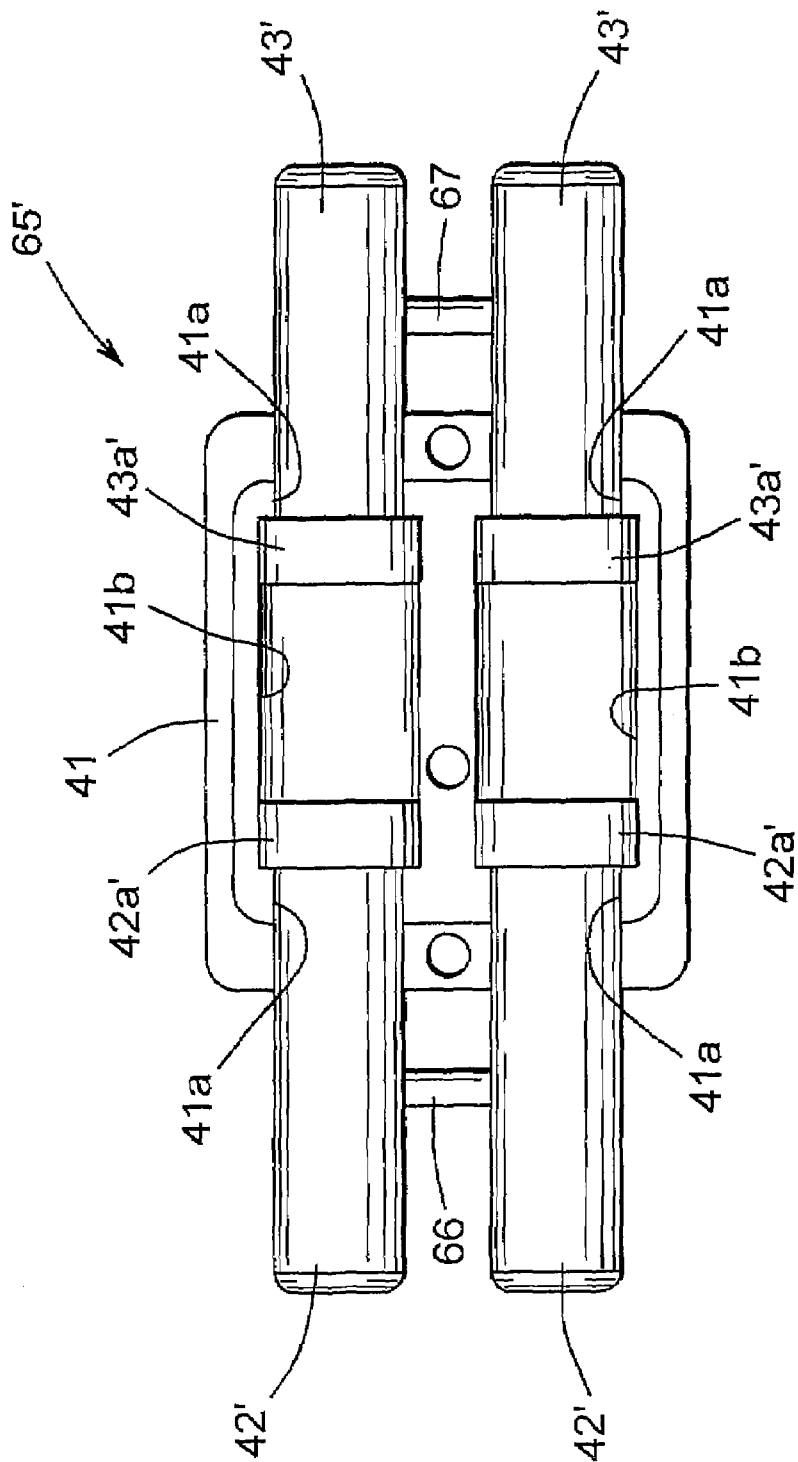


FIG. 13

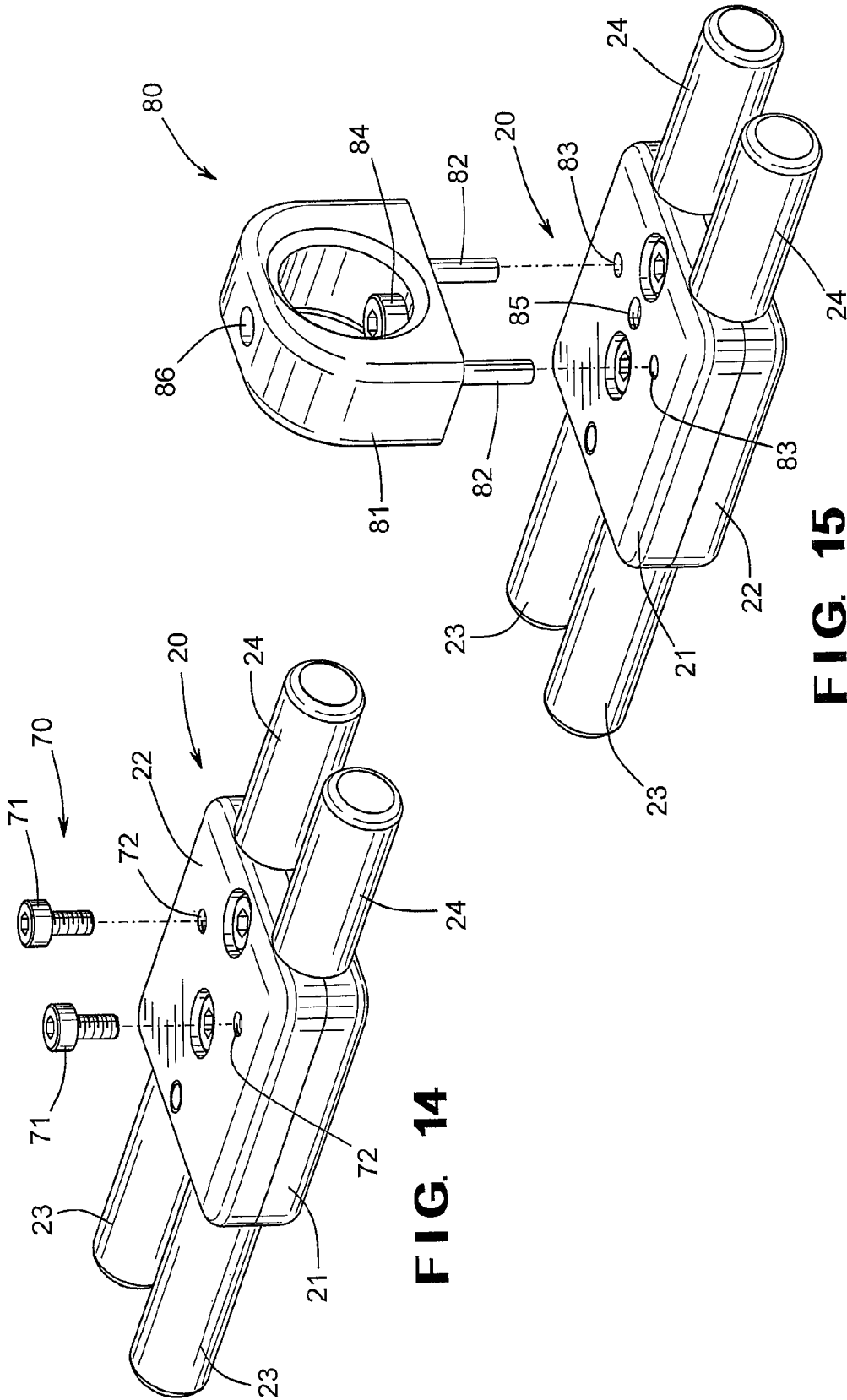


FIG. 14

FIG. 15

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LATERAL FIXATION ASSEMBLY FOR SPINAL COLUMN

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/077,260 filed Jul. 1, 2008, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention relates in general to the field of orthopedic surgery and more particularly to the area of spinal surgery. In particular, this invention relates to an improved structure for a lateral fixation assembly that is adapted to be installed during a spinal surgery to engage two more spinal vertebrae so as to maintain a desired spacing and alignment therebetween.

One example of a spinal surgery is referred to as a corpectomy, which is a procedure that involves the removal of one or more damaged vertebrae. Vertebrae can be damaged by a variety of causes including, but not limited to severe trauma and/or tumors. During a corpectomy procedure, the damaged vertebrae are removed and a replacement structure (such as a cage, for example) can be inserted into the corpectomy defect to restore the anterior column of the spine. Additionally, the replacement structure can be supplemented with other structures, such as for example a lateral fixation assembly. A lateral fixation assembly can be positioned to the side of the corpectomy defect and configured to provide support to the affected spinal region.

Known lateral fixation assemblies are fixed in a vertical direction and do not allow for vertical translation of the lateral fixation assembly. Thus, there is a need for a lateral fixation assembly that allows for vertical translation.

SUMMARY OF THE INVENTION

This invention relates to a lateral fixation assembly for supporting a spinal column. The lateral fixation assembly includes a housing assembly and a plurality of fixed rods connected to one end of the housing assembly. A plurality of movable rods is connected to the end of the housing assembly opposite the plurality of fixed rods. The movable rods have a major axis. The position of the movable rods can vary in a direction along the major axis of the movable rods between a first extended position and a second compressed position.

According to this invention, there is also provided a lateral fixation assembly for attachment to spinal vertebrae positioned above and below a corpectomy defect. The lateral fixation assembly includes a plurality of cleats configured for attachment to vertebrae and a plurality of anchors configured for insertion into the vertebrae and further configured for seating against the cleats. A plurality of fixed rods is attached to the anchors in one of the vertebrae. A plurality of movable rods is attached to the anchors of the other vertebrae, the movable rods having a major axis. A housing assembly is connected to and positioned between the fixed rods and the movable rods. The position of the movable rods can vary in a direction along the major axis of the movable rods between a first extended position and a second compressed position.

According to this invention, there is also provided a method of installing a lateral fixation assembly configured for attachment to spinal vertebrae positioned above and below a corpectomy defect. The method includes the steps of attaching a plurality of cleats to vertebrae located above and below

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the corpectomy defect, inserting a plurality of anchors through the cleats and into vertebrae, seating the anchors against the cleats, attaching a plurality of fixed rods to the anchors of one of the vertebrae, attaching a plurality of movable rods to the anchors of the other vertebrae, the movable rods having a major axes, the fixed rods and the movable rods connected to and positioned on opposite sides of a housing assembly, the movable rods initially in an extended position and releasing the movable rods from the initial extended position. The position of the movable rods can vary in a direction along the major axes between a first extended position and a second compressed position.

Various aspects of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiments, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a first embodiment of a lateral fixation assembly in accordance with this invention, shown installed on a pair of vertebrae in a spinal column.

FIG. 2 is a perspective view of the first embodiment of the lateral fixation assembly illustrated in FIG. 1.

FIG. 3 is a perspective view of a portion of the first embodiment of the lateral fixation assembly illustrated in FIGS. 1 and 2.

FIG. 4 is an exploded perspective view of the first embodiment of the lateral fixation assembly illustrated in FIGS. 1, 2, and 3.

FIG. 5 is a perspective view of an inner side of a staple that can be used with the lateral fixation assembly of this invention.

FIG. 6 is a perspective view of an outer side of the staple illustrated in FIG. 5.

FIG. 7 is a perspective view similar to FIG. 3 of a second embodiment of a lateral fixation assembly in accordance with this invention.

FIG. 8 is a sectional elevational view of a portion of the second embodiment of the lateral fixation assembly illustrated in FIG. 7.

FIG. 9 is a top plan view of a third embodiment of a lateral fixation assembly in accordance with this invention having axially centered rods.

FIG. 10 is a top plan view of a fourth embodiment of a lateral fixation assembly in accordance with this invention having axially offset rods.

FIG. 11 is a top plan view of a fifth embodiment of a lateral fixation assembly in accordance with this invention having external stops.

FIG. 12 is a top plan view of a sixth embodiment of a lateral fixation assembly in accordance with this invention having external stops.

FIG. 13 is a top plan view of a seventh embodiment of a lateral fixation assembly in accordance with this invention having external stops.

FIG. 14 is a perspective view of a first embodiment of a temporary blocking device that can be used to facilitate the installation of the lateral fixation assembly of this invention.

FIG. 15 is a perspective view of a second embodiment of a temporary blocking device that can be used to facilitate the installation of the lateral fixation assembly of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, there is illustrated in FIG. 1 a pair of vertebrae, indicated generally at 10 and 11, that form

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a portion of a human spinal column. In the illustrated embodiment, the vertebrae **10** and **11** are located in the lumbar region of the spinal column. However, the vertebrae **10** and **11** can be located in other regions of the spinal column.

As shown in FIG. 1, the upper vertebra **10** includes an upper end plate **10a**, a lower end plate **10b**, and a body **10c** that extends between the upper end plate **10a** and the lower end plate **10b**. The body **10c** of the first vertebra **10** includes a concavely-shaped waist region **10d** that is located between the upper end plate **10a** and the lower end plate **10b**. Similarly, the lower vertebra **11** includes an upper end plate **11a**, a lower end plate **11b**, and a body **11c** that extends between the upper end plate **11a** and the lower end plate **11b**. The body **11c** of the vertebra **11** includes a concavely-shaped waist region **11d** that is located between the upper end plate **11a** and the lower end plate **11b**. The vertebrae **10** and **11** define respective widths that can vary in accordance with the region of the spinal column in which the vertebrae **10** and **11** are located.

In the illustrated embodiment, the vertebrae **10** and **11** are separated by a defect region, which may be a corpectomy defect. The defect region may be formed during a surgical procedure when one or more damaged vertebrae (not shown) and adjacent fibro-cartilaginous structures commonly referred to as “discs” (not shown) are removed from the spinal column. As shown in FIG. 1, a replacement structure **12** can be inserted into the defect region, extending between the lower end plate **10b** of the upper vertebra **10** and the upper end plate **11a** of the lower vertebra **11**. The replacement structure **12** is adapted to maintain a desired spacing and alignment between the vertebrae **10** and **11**. The replacement structure **12** may be embodied as any structure that is suitable to restore and maintain the desired height within the defect region. In some embodiments, the replacement structure **12** can be packed with bone graft to facilitate fusion with the vertebrae **10** and **11**. While the embodiment shown in FIG. 1 illustrates a single replacement structure **12**, it should be understood that more than one replacement structure **12** can be used in the defect region.

A first embodiment of a lateral fixation assembly, indicated generally at **20**, in accordance with this invention is secured to each of the vertebrae **10** and **11** and spans the defect region therebetween. The lateral fixation assembly **20** is adapted to supplement the support to the spinal column provided by the replacement structure **12**, while allowing a limited amount of compression of the defect region after the lateral fixation assembly **20** has been installed. Such compression (which is manifested as a shortening of the distance between the lower end plate **10b** of the upper vertebra **10** and the upper end plate **11a** of the lower vertebra **11**) can occur following the installation of the replacement structure **12**.

The structure of the lateral fixation assembly **20** is illustrated in detail in FIGS. 2, 3, and 4. As shown therein, the lateral fixation assembly **20** includes a housing that, in the illustrated embodiment, is formed from a first housing portion **21** and a second housing portion **22**. However, if desired, the housing of the lateral fixation assembly **20** may be formed from a greater or lesser number of pieces. In the illustrated embodiment, the first housing portion **21** is located adjacent to the vertebrae **10** and **11** when the lateral fixation assembly **20** is secured to each of the vertebrae **10** and **11**, while the second housing portion **22** is located remote therefrom. However, the first and second housing portions **21** and **22** may be arranged in any desired relative locations.

The illustrated first housing portion **21** has a pair of first recesses **21a** provided therein. It will be appreciated, however, that the first housing portion **21** may have a greater or lesser number of such first recesses **21a** provided therein. In

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the illustrated embodiment, each of the first recesses **21a** is generally semi-cylindrical in shape. However, the first recesses **21a** may have any desired shape or combination of shapes. Each of the illustrated first recesses **21a** has an enlarged region **21b**, although such is not required. In the illustrated embodiment, each of the enlarged regions **21b** is generally semi-square in shape. However, the enlarged regions **21b** may have any desired shape or combination of shapes. The purposes for the first recesses **21a** and the associated enlarged regions **21b** will be explained below.

The illustrated first housing portion **21** also has a pair of second recesses **21c** provided therein. It will be appreciated, however, that the first housing portion **21** may have a greater or lesser number of such second recesses **21c** provided therein. In the illustrated embodiment, each of the second recesses **21c** is generally semi-cylindrical in shape. However, the second recesses **21c** may have any desired shape or combination of shapes. Each of the illustrated second recesses **21c** has an enlarged region **21d**, although such is not required. In the illustrated embodiment, each of the enlarged regions **21d** is generally semi-square in shape. However, the enlarged regions **21d** may have any desired shape or combination of shapes. The purposes for the second recesses **21c** and the associated enlarged regions **21d** will be explained below.

The illustrated second housing portion **22** may be shaped complementary to the first housing portion **21**, having similar first recesses (not shown) having associated enlarged regions (not shown) and similar second recesses **22c** having associated enlarged regions (not shown). When the first and second housing portions **21** and **22** are secured together as shown in FIGS. 1 and 2, the first recesses **21a** and the associated enlarged regions **21b** provided in the first housing portion **21** are aligned with the first recesses and the associated enlarged regions provided in the second housing portion **22**. Similarly, the second recesses **21c** and the associated enlarged regions **21d** provided in the first housing portion **21** are aligned with the second recesses **22c** and the associated enlarged regions provided in the second housing portion **22**.

The lateral fixation assembly **20** also includes a pair of fixed rods **23**. In the illustrated embodiment, each of the fixed rods **23** is shaped in correspondence with the shapes of the aligned first recesses **21a** respectively provided in the first and second housing portions **21** and **22**. However, the fixed rods **23** may have any desired shape or combination of shapes. Each of the illustrated fixed rods **23** also has an enlarged head portion **23a**, although such is not required. In the illustrated embodiment, each of the enlarged head portions **23a** is shaped in correspondence with the shapes of the aligned enlarged regions **21b** respectively provided in the first and second housing portions **21** and **22**, respectively. However, the enlarged head portions **23a** may have any desired shape or combination of shapes.

The lateral fixation assembly **20** further includes a pair of movable rods **24**. In the illustrated embodiment, each of the movable rods **24** is shaped in correspondence with the shapes of the aligned first recesses **21c** and **22c** respectively provided in the first and second housing portions **21** and **22**. However, the movable rods **24** may have any desired shape or combination of shapes. Each of the illustrated movable rods **24** also has an enlarged head portion **24a**, although such is not required. In the illustrated embodiment, each of the enlarged head portions **24a** is shaped in correspondence with the shapes of the aligned enlarged regions **21d** respectively provided in the first and second housing portions **21** and **22**, respectively. However, the enlarged head portions **24a** may have any desired shape or combination of shapes.

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To assemble the lateral fixation assembly **20**, the fixed rods **23** and their associated enlarged head portions **23a** are respectively received within the first recesses **21a** and their associated enlarged regions **21b** provided on the first housing portion **21**, as best shown in FIG. 3. Similarly, the movable rods **24** and their associated enlarged head portions **24a** are respectively received within the second recesses **21c** and their associated enlarged regions **21d** provided on the first housing portion **21**, as also best shown in FIG. 3. Then, the second housing portion **22** is secured to the first housing portion **21**, as shown in FIGS. 1 and 2. This can be accomplished in any desired manner, such as by a plurality of threaded fasteners **25** extending through respective non-threaded apertures **26** into engagement with respective threaded apertures **27**. If desired, one or more conventional dowel pins (not shown) may be disposed within dowel apertures **28** provided in both of the first and second housing portions **21** and **22** to securely retain such first and second housing portions **21** and **22** in alignment with one another.

As best shown in FIGS. 3 and 4, the axial lengths of the enlarged head portions **23a** of the fixed rods **23** are approximately the same as the axial lengths of the enlarged regions **21b** of the first recesses **21a**. As a result, the fixed rods **23** are fixed in position relative to the first and second housing portions **21** and **22** and, therefore, cannot move axially relative thereto. However, the axial lengths of the enlarged head portions **24a** of the movable rods **24** are somewhat smaller than the axial lengths of the enlarged regions **21d** of the second recesses **21c**. As a result, the movable rods **24** are not fixed in position relative to the first and second housing portions **21** and **22** and, therefore, can move axially relative thereto. The ability of the movable rods **24** to move axially relative to the first and second housing portions **21** and **22** accommodates a limited amount of compression of the defect region after the lateral fixation assembly **20** has been installed, as described above.

Once the lateral fixation assembly **20** has been assembled, it can be secured to the vertebrae **10** and **11** by means of staples, indicated generally at **30**. The structure of one of the staples **30** is illustrated in detail in FIGS. 5 and 6. As shown therein, the staple **30** includes a body having an inner surface **31** and an outer surface **32**. As will be explained below, the thickness of the staple **30** (as defined by the distance between the inner surface **31** and the outer surface **32**) varies throughout the body thereof from a relatively thicker portion **33** to a relatively thinner portion **34**. The purpose for the varying thickness of the staple **30** will be explained below.

The staple **30** also includes one or more cleats **35** that are provided on the inner surface **31** thereof. The cleats **35** are configured for insertion into the vertebrae **10** and **11**. In the illustrated embodiment, the cleats **35** have a generally triangular cross sectional shape that tapers to a point. However, the cleats **35** can have any other desired shape or combination of shapes. Although three cleats **35** are shown in the illustrated embodiment, it will be understood that the staple **30** may have a greater or lesser number of such cleats **35**. Additionally, one or more apertures **36** are formed through the staple **30**. Any desired number of such apertures **36** having any desired shape or combination of shapes may be provided in the staple **30**. The staples **30** can be formed from titanium or any other desired material and may have any desired surface, finish, or coating. The staples **30** may be formed either from a single piece of material or from a plurality of pieces of material.

Referring back to FIG. 1, the staple **30** can be connected to the upper vertebra **10** by initially aligning the relatively thicker portion **33** of the staple **30** with the waist region **10d** of the upper vertebra **10**, and further by aligning the relatively

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thinner portion **34** of the staple **30** adjacent to the lower end plate **10b** of the upper vertebra **10**. As mentioned above, the waist region **10d** of the upper vertebra **10** is concavely-shaped between the upper end plate **10a** and the lower end plate **10b**. By aligning the relatively thicker portion **33** of the staple **30** in the manner described above, the outer surface **32** of the staple **30** presents a generally flat and vertical surface that can be used to facilitate the securement of the fixed rods **23** of the lateral fixation device **20** thereto. Once the staple **30** has been aligned on the vertebra **10**, it is moved toward the vertebra **10** such that the cleats **38** penetrate within the vertebra body **10c** until the inner surface **31** of the staple **30** engages the surface of the waist region **10d** of the vertebra **10**. Similarly, the staple **30** can be connected to the lower vertebra **11** by aligning the relatively thicker portion **33** thereof with the waist region **11d** of the lower vertebra **11**, and by aligning the relatively thinner portion **34** of the staple **30** adjacent to the upper end plate **11a** of the lower vertebra **11**. Such alignment also presents a generally flat and vertical surface that can be used to facilitate the securement of the movable rods **24** of the lateral fixation device **20** thereto.

The staple **30** is preferably attached close to the lower end plate **10b** of the vertebra **10** such that the triangular apical portion of the staple **30** (which is thicker than the rest thereof) sits generally flush with the waist **10d** of the vertebra **10**, thereby providing a stable surface. The inner surface **31** of the staple **30** is contoured such that it accommodates the transition from the end plate **10b** to the waist region **10d** and, therefore, is thicker toward the waist **10d**. The thinner portion **34** of the staple **30** is placed close to the lower end plate **10b** of the vertebra **10**. The other staple **30** can be installed in a similar manner on the other vertebra **11**.

In general, bone quality is better close to the end plates **10a** and **10b** of the vertebra **10** because there is more cortical bone in that region, as opposed to the cancellous bone in the region of the waist **10d** of the vertebra **10**. As a result, when the staple **30** and the vertebral anchors (described below) are placed close to the end plates **10a** and **10b**, stiffness and pull out strength are improved. In certain situations, when additional posterior fixation is anticipated as being necessary, it may be preferable to place both staples **30** close to the lower end plates **10b** and **11b** of the respective vertebra **10** and **11**. With this arrangement, the screws placed through the staples **30** will be out of the path of vertebral anchors that are placed during subsequent posterior surgery.

When installed on the vertebrae **10** and **11**, the staples **30** are adapted to engage and support one or more vertebral anchors, each indicated generally at **39**. In the illustrated embodiment, the vertebral anchors **39** are conventional pedicle screws. Each of the illustrated pedicle screws **39** includes a head portion and a threaded shank portion. The shank portion of each pedicle screw **39** is initially threaded into engagement with one of the vertebrae **10** and **11**. As shown in FIG. 1, the anchors **39** can be inserted through the apertures **36** of the staples **30** and into the vertebrae **10** and **11**. The anchors **39** are inserted until the head portions thereof seat against the outer surfaces **32** of the staples **30**. Thereafter, the head portion of each pedicle screw **39** is secured to one of the fixed and movable rods **23** and **24**, respectively, of the lateral fixation assembly **20**. In this or any other conventional manner, the lateral fixation assembly **20** can be secured to the vertebrae **10** and **11** for use.

FIGS. 7 and 8 illustrate portions of a second embodiment of a lateral fixation assembly, indicated generally at **40**, in accordance with this invention. The second embodiment of the lateral fixation device **40** includes a housing that, in the illustrated embodiment, is formed from a first housing portion

41 and a second housing portion (not shown). The illustrated first housing portion 41 has a pair of first recesses 41a provided therein. If desired, the first housing portion 41 may have a greater or lesser number of such first recesses 41a provided therein. In the illustrated embodiment, each of the first recesses 41a is generally semi-cylindrical in shape. However, the first recesses 41a may have any desired shape or combination of shapes. Each of the illustrated first recesses 41a has an enlarged central region 41b, although such is not required. In the illustrated embodiment, each of the enlarged central regions 41b is generally semi-square in shape. However, the enlarged central regions 41b may have any desired shape or combination of shapes. The purposes for the first recesses 41a and the associated enlarged central regions 41b will be explained below.

The second embodiment of the lateral fixation assembly 40 also includes a first pair of rods 42. In the illustrated embodiment, each of the first pair of rods 42 is shaped in correspondence with the shapes of the aligned first recesses 41a respectively provided in the first and second housing portions 41. However, the first pair of rods 42 may have any desired shape or combination of shapes. Each of the illustrated first pair of rods 42 also has an enlarged head portion 42a and an axially extending journal portion 42b, although such is not required. In the illustrated embodiment, each of the enlarged head portions 42a is shaped in correspondence with the shapes of the aligned enlarged central regions 41b respectively provided in the first and second housing portions 41, respectively. However, the enlarged head portions 42a may have any desired shape or combination of shapes. The illustrated journal portions 42b are cylindrical in shape, although such is not required.

The second embodiment of the lateral fixation assembly 40 further includes a second pair of rods 43. In the illustrated embodiment, each of the second pair of rods 43 is shaped in correspondence with the shapes of the aligned first recesses 41a respectively provided in the first and second housing portions 41. However, the second pair of rods 43 may have any desired shape or combination of shapes. Each of the illustrated second pair of rods 43 also has an enlarged head portion 43a and an axially extending receiving portion 43b, although such is not required. In the illustrated embodiment, each of the enlarged head portions 43a is shaped in correspondence with the shapes of the aligned enlarged regions 41b respectively provided in the first and second housing portions 41, respectively. However, the enlarged head portions 43a may have any desired shape or combination of shapes. The illustrated receiving portions 43b have bores provided therein that are cylindrical in shape, although such is not required.

To assemble the second embodiment of the lateral fixation assembly 40, the journal portions 42b of the first rods 42 are inserted axially within the bores provided in the receiving portions 43b of the second rods 43, as best shown in FIG. 8. Then, the assembled first and second rods 42 and 43 (along with their associated enlarged head portions 42a and 43a) are respectively disposed within the first recesses 41a and their associated enlarged regions 41b provided on the first housing portion 41, as shown in FIG. 7. Thereafter, the second housing portion (not shown) is secured to the first housing portion 41 as described above. When so assembled, the first and second rods 42 and 43 are journaled on one another for axial movement relative to one another and relative to the housing of the second embodiment of the lateral fixation assembly 40. If desired, one or more of the first and second rods 42 and 43 can be fixed in position relative to the housing of the second embodiment of the lateral fixation assembly 40. This can be

accomplished in the manner described above in connection with the embodiment of the invention illustrated in FIGS. 1 through 4.

FIG. 9 illustrates a portion of a third embodiment of a lateral fixation assembly, indicated generally at 50, in accordance with this invention. The third embodiment of the lateral fixation device 50 includes a housing that, in the illustrated embodiment, is formed from a first housing portion 51 and a second housing portion (not shown). The illustrated first housing portion 51 has a pair of first recesses 51a provided therein. If desired, however, the first housing portion 51 may have a greater or lesser number of such first recesses 51a provided therein. In the illustrated embodiment, each of the first recesses 51a is generally semi-cylindrical in shape. However, the first recesses 51a may have any desired shape or combination of shapes. The illustrated first housing portion 51 also has a pair of second recesses 51b provided therein. As described above, the first housing portion 51 may have a greater or lesser number of such second recesses 51b provided therein. In the illustrated embodiment, each of the second recesses 51b is generally semi-cylindrical in shape. However, the second recesses 51b may have any desired shape or combination of shapes. The purposes for the first recesses 51a and the second recesses 51b will be explained below.

The third embodiment of the lateral fixation assembly 50 also includes a first pair of rods 52. In the illustrated embodiment, each of the first pair of rods 52 is shaped in correspondence with the shapes of the aligned first recesses 51a respectively provided in the first and second housing portions 51. However, the first pair of rods 52 may have any desired shape or combination of shapes. Each of the illustrated first pair of rods 52 also has an enlarged head portion 52a, although such is not required. In the illustrated embodiment, each of the enlarged head portions 52a is shaped in correspondence with the shapes of the first recesses 51a respectively provided in the first and second housing portions 51, respectively. However, the enlarged head portions 52a may have any desired shape or combination of shapes. In this third embodiment of the lateral fixation assembly 50, the enlarged head portions 52a are axially centered relative to the remainder of respective first rods 52.

The third embodiment of the lateral fixation assembly 50 further includes a second pair of rods 53. In the illustrated embodiment, each of the second pair of rods 53 is shaped in correspondence with the shapes of the aligned second recesses 51b respectively provided in the first and second housing portions 51. However, the second pair of rods 53 may have any desired shape or combination of shapes. Each of the illustrated second pair of rods 53 also has an enlarged head portion 53a, although such is not required. In the illustrated embodiment, each of the enlarged head portions 53a is shaped in correspondence with the shapes of the second recesses 51b respectively provided in the first and second housing portions 51, respectively. However, the enlarged head portions 53a may have any desired shape or combination of shapes. In this third embodiment of the lateral fixation assembly 50, the enlarged head portions 53a are axially centered relative to the remainder of respective second rods 53.

To assemble the third embodiment of the lateral fixation assembly 50, the first and second rods 52 and 53 (along with their associated enlarged head portions 52a and 53a) are respectively disposed within the first and second recesses 51a and 51b provided on the first housing portion 51, as shown in FIG. 9. Thereafter, the second housing portion (not shown) is secured to the first housing portion 51 as described above. When so assembled, the first and second rods 52 and 53 are

supported for axial movement relative to the housing of the third embodiment of the lateral fixation assembly 50. If desired, one or more of the first and second rods 52 and 53 can be fixed in position relative to the housing of the third embodiment of the lateral fixation assembly 50. This can be accomplished in the manner described above in connection with the embodiment of the invention illustrated in FIGS. 1 through 4.

FIG. 10 illustrates a portion of a fourth embodiment of a lateral fixation assembly, indicated generally at 55, in accordance with this invention. The fourth embodiment of the lateral fixation device 55 is, in large measure, similar to the third embodiment 50 described above, and like reference numbers are used to indicate similar components. In the fourth embodiment of the lateral fixation assembly 55, the first and second housing portions 51 are the same as described above. However, the first pair of rods 52' have enlarged head portions 52a' that are axially offset relative to the remainder of respective first rods 52'. Similarly, the second pair of rods 53' have enlarged head portions 53a' that are axially offset relative to the remainder of respective second rods 53'.

The third and fourth embodiments of the lateral fixation device 50 and 55, respectively, illustrate how the distance between the adjacent ones of either (or both) of the first rods 52 and 52' and the second rods 53 and 53' can be quickly and easily adjusted to accommodate the dimensional characteristics of the vertebrae 10 and 11 that are being supported thereby. For example, in some instances, it may be desirable that such distance be relatively large. In those instances, the use of the first rods 52 having the axially centered enlarged head portions 52a would be desirable. In other instances, it may be desirable that such distance be relatively small. In those other instances, the use of the first rods 52' having the axially offset enlarged head portions 52a' would be desirable. It will be appreciated that any combination of the first rods 52 and 52' and the second rods 53 and 53' may be used as desired.

FIG. 11 illustrates a portion of a fifth embodiment of a lateral fixation assembly, indicated generally at 60, in accordance with this invention. The fifth embodiment of the lateral fixation device 60 is, in large measure, similar to the first embodiment 20 described above, and like reference numbers are used to indicate similar components. In the fifth embodiment of the lateral fixation assembly 60, the first and second housing portions 21 are the same as described above. However, the pair of fixed rods 23' have a first external support rod 61 extending transversely therebetween. Similarly, the pair of movable rods 24' have a second external support rod 62 extending transversely therebetween. The support rods 61 and 62 provide increased support between the fixed rods 23' and the movable rods 24', respectively, and minimize any undesirable flexing thereof. Additionally, the support rods 61 and 62 function as external stops to limit the movements of the fixed rods 23' and the movable rods 24' inwardly toward one another. Although the illustrated support rods 61 and 62 are provided on both of the fixed rods 23' and the movable rods 24' in FIG. 11, it will be appreciated that this invention may be practiced with either only the first support rod 61 extending between the fixed rods 23' or only the second support rod 62 extending between the movable rods 24' as desired.

FIG. 12 illustrates a portion of a sixth embodiment of a lateral fixation assembly, indicated generally at 65, in accordance with this invention. The sixth embodiment of the lateral fixation device 65 is, in large measure, similar to the second embodiment 40 described above, and like reference numbers are used to indicate similar components. In the sixth embodiment of the lateral fixation device 65, the first and second housing portions 41 are the same as described above. However, the first pair of rods 42' have a first external support rod 66 extending transversely therebetween. Similarly, the second pair of rods 43' have a second external support rod 67

extending transversely therebetween. The support rods 66 and 67 can be provided in the same manner and perform the same function as described above in connection with the support rods 61 and 62.

FIG. 13 illustrates a portion of a seventh embodiment of a lateral fixation assembly, indicated generally at 65', in accordance with this invention. The seventh embodiment of the lateral fixation device 65' is, in large measure, similar to the sixth embodiment 65 described above, and like reference numbers are used to indicate similar components. In the seventh embodiment of the lateral fixation device 65', the journal portions 42b' and the receiving portions 43b' have been omitted from the rods 42 and 43, respectively. Otherwise, the seventh embodiment of the lateral fixation device 65' is the same as the sixth embodiment 65 described above.

FIG. 14 illustrates a first embodiment of a temporary blocking device, indicated generally at 70, that can be used to facilitate the installation of the lateral fixation assembly of this invention on the vertebrae 10 and 11. Although the first embodiment of the temporary blocking device 70 will be described and illustrated in the context of the first embodiment of the lateral fixation assembly 20 of this invention, it will be appreciated that the first embodiment of the temporary blocking device 70 can be used in conjunction with any of the lateral fixation assemblies described and illustrated herein or with any other lateral fixation assembly having movable rods.

The first embodiment of the temporary blocking device 70 includes a pair of threaded fasteners 71 that are threaded into respective threaded apertures 72 formed through the second housing portion 22 of the lateral fixation assembly 20. The threaded apertures 72 extend through the second housing portion 22 of the lateral fixation assembly 20 into the enlarged regions 21d of the second recesses 21c, where the enlarged head portions 24a of the movable rods 24 are located. When the threaded fasteners 71 are so positioned, the inner ends thereof engage the enlarged head portions 24a of the movable rods 24, thereby preventing them from moving relative to the housing of the lateral fixation assembly 20. The threaded fasteners 71 of the first embodiment of the temporary blocking device 70 can be installed on the lateral fixation assembly 20 prior to installation on the vertebrae 10 and 11 to prevent any undesired movement of the movable rods 24 until after such installation has been completed. Once the installation of the lateral fixation assembly 20 has been completed, the threaded fasteners 71 of the first embodiment of the temporary blocking device 70 can be removed from the lateral fixation assembly 20 to allow movement of the movable rods 24 relative to the first and second housing portions 21 and 22 as described above.

FIG. 15 illustrates a second embodiment of a temporary blocking device, indicated generally at 80, that can be used to facilitate the installation of the lateral fixation assembly of this invention. Although the second embodiment of the temporary blocking device 80 will be described and illustrated in the context of the first embodiment of the lateral fixation assembly 20 of this invention, it will be appreciated that the second embodiment of the temporary blocking device 80 can be used in conjunction with any of the lateral fixation assemblies described and illustrated herein or with any other lateral fixation assembly having movable rods.

The second embodiment of the temporary blocking device 80 includes a body 81 having a pair of stops 82 extending therefrom. When the second embodiment of the temporary blocking device 80 is installed on the lateral fixation assembly 20, the stops 82 extend through respective apertures 83 formed through the second housing portion 22 of the lateral fixation assembly 20 and into the enlarged regions 21d of the second recesses 21c, where the enlarged head portions 24a of

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the movable rods **24** are located. When the stops **82** are so positioned, the inner ends thereof engage the enlarged head portions **24a** of the movable rods **24**, thereby preventing them from moving relative to the housing of the lateral fixation assembly **20**.

The second embodiment of the temporary blocking device **80** can be installed on the lateral fixation assembly **20** prior to installation on the vertebrae **10** and **11** to prevent any undesired movement of the movable rods **24** until after such installation has been completed. To accomplish this, a threaded retaining fastener **84** can extend into engagement with a threaded aperture **85** provided in the second housing portion **22**. If desired, an aperture **86** can be formed through a portion of the body **81** of the second embodiment of the temporary blocking device **80** to facilitate the installation and removal of the threaded retaining fastener **84**. However, it will be appreciated that the second embodiment of the temporary blocking device **80** can be installed on the lateral fixation assembly **20** using any desired retaining structure. Once the installation of the lateral fixation assembly **20** has been completed, the second embodiment of the temporary blocking device **80** can be removed from the lateral fixation assembly **20** to allow movement of the movable rods **24** relative to the first and second housing portions **21** and **22** as described above.

In practice, the lateral fixation assembly **20** of this invention is installed following a corpectomy or other surgical procedure and the installation of the replacement structure **12** between the lower end plate **10b** of the upper vertebra **10** and the upper end plate **11a** of the lower vertebra **11**. This is done by initially positioning the staples **30** on the vertebrae **10** and **11** and causing the cleats **35** to penetrate into such vertebrae **10** and **11**. As a result, the staples **30** are secured to the vertebrae **10** and **11**. Then, one or more of the pedicle screws **39** are inserted through the apertures **36** formed in the staples **30** and driven into the vertebrae **10** and **11** in a known manner. Next, the fixed rods **23** and the movable rods **24** of the lateral fixation assembly **20** are secured to the head portions of the pedicle screws **39** in a known manner. During this securement of the lateral fixation assembly **20** to the head portions of the pedicle screws **39**, the temporary blocking device **70** or **80** may be installed on the lateral fixation assembly **20** to prevent any undesired relative movement of the movable rods **24**. Lastly, however, after the lateral fixation assembly **20** has been secured to the head portions of the pedicle screws **39**, the temporary blocking device **70** or **80** is removed from the lateral fixation assembly **20** to allow relative movement of the movable rods **24**, as described above.

The principle and mode of operation of this invention have been explained and illustrated in its preferred embodiments. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

What is claimed is:

1. A lateral fixation assembly for engaging vertebrae in a spinal column comprising:

a housing;

a first rod supported on the housing and adapted to be secured to a first vertebra in a spinal column, the first rod being fixed in position relative to the housing; and

a second rod supported on the housing and adapted to be secured to a second vertebra in a spinal column, the second rod being freely movable relative to the housing without the use of a tool and after engaging vertebrae in a spinal column.

2. The lateral fixation assembly defined in claim 1 wherein a plurality of first rods is supported on the housing and the first rods being fixed in position relative to the housing and

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wherein a plurality of second rods is supported on the housing, each of the second rods being movable relative to the housing.

3. The lateral fixation assembly defined in claim 1 wherein the housing has first and second recesses formed therein, and wherein the first rod is received within the first recess and the second rod is received within the second recess.

4. The lateral fixation assembly defined in claim 3 wherein the first rod has an enlarged head portion, and wherein the first recess has an enlarged region that receives the enlarged head portion of the first rod.

5. The lateral fixation assembly defined in claim 4 wherein the size of the enlarged head portion of the first rod is approximately the same as the size of the enlarged region of the first recess.

6. The lateral fixation assembly defined in claim 4 wherein the second rod has an enlarged head portion, and wherein the second recess has an enlarged region that receives the enlarged head portion of the second rod.

7. The lateral fixation assembly defined in claim 6 wherein the size of the enlarged head portion of the second rod is smaller than the size of the enlarged region of the second recess.

8. The lateral fixation assembly defined in claim 1 wherein the first and second rods are journaled on one another.

9. The lateral fixation assembly defined in claim 8 wherein the first rod has a journal portion provided therein, and wherein the second rod has a receiving portion provided therein that receives the journal of the first rod.

10. The lateral fixation assembly defined in claim 1 wherein the first rod has an enlarged head portion that is axially centered on the first rod.

11. The lateral fixation assembly defined in claim 10 wherein the first rod has an enlarged head portion that is axially centered on the first rod, and wherein the second rod has an enlarged head portion that is axially centered on the second rod.

12. The lateral fixation assembly defined in claim 1 wherein the first rod has an enlarged head portion that is axially offset on the first rod.

13. The lateral fixation assembly defined in claim 12 wherein the first rod has an enlarged head portion that is axially offset on the first rod, and wherein the second rod has an enlarged head portion that is axially offset on the second rod.

14. The lateral fixation assembly defined in claim 1 wherein a pair of first rods is supported on the housing, and wherein a first support rod extends transversely between the pair of first rods.

15. The lateral fixation assembly defined in claim 14 wherein a pair of second rods is supported on the housing, and wherein a second support rod extends transversely between the pair of second rods.

16. The lateral fixation assembly defined in claim 1 further including a temporary blocking device secured to the housing that prevents the second rod from moving relative to the housing.

17. The lateral fixation assembly defined in claim 16 wherein the temporary blocking device includes at least one threaded fastener that extends into a recess that receives the second rod.

18. The lateral fixation assembly defined in claim 16 wherein the temporary blocking device includes a body having a stop extending therefrom that extends into a recess that receives the second rod.