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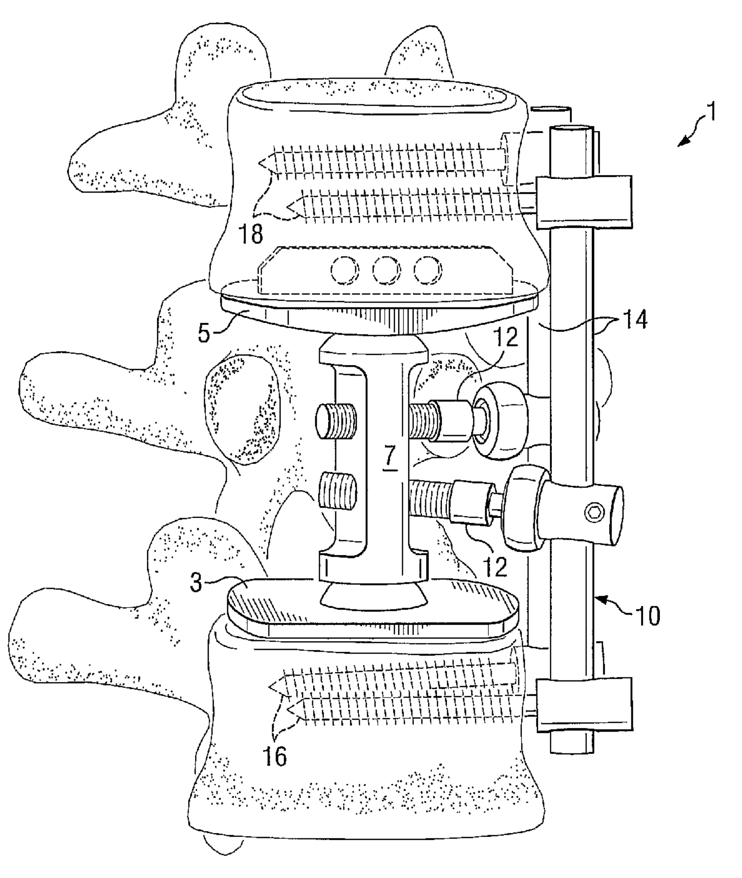
(54) Title: SPINAL IMPLANT SYSTEM



(57) Abstract: Embodiments of the invention include devices and methods for performing a corpectomy or spinal disc replacement. Devices may include an inferior bearing that is implantable in an inferior vertebral body and a superior bearing that is implantable in a superior vertebral body. The bearings of some embodiments have a support member rotatably coupled between the bearings, and a fixation device may attach the vertebral bodies to the support member with a fastener.

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SPINAL IMPLANT SYSTEM

FIELD OF THE INVENTION

The present invention relates generally to the field of spinal implants, and more particularly relates to corpectomy and disc replacement devices and methods for the replacement of one or more vertebral bodies or discs.

BACKGROUND

A corpectomy is the excision of one or more vertebral bodies, usually combined with replacement of the removed body or bodies with a prosthesis or bone graft. A corpectomy may be necessary to correct a degenerative condition, to treat a traumatic injury, to replace vertebral bodies damaged by tumors or other diseases, or in other situations as deemed appropriate by a physician.

Implants and methods useful in performing corpectomy procedures have been known in the art for a number of years. Many of the previous implants and methods sought to create fixed constructs designed to eliminate relative movement between the vertebrae to which the implants were attached. Fixed constructs have been used with some success. However, it is difficult to achieve a securely fixed construct with a corpectomy device because the distance between the fixed vertebrae is relatively large.

Consequently, in practice, some amount of motion typically occurs at the interface of the corpectomy device and the vertebrae. The motion may be very small—sometimes called "micro-motion." Nonetheless, even micro-motion applied through a large number of cycles can cause loosening of an implant. Loosening may necessitate corrective surgery with its associated cost, pain, and inconvenience.

Fixed constructs may also be limited because they fail to provide interfaces with the vertebrae that easily adapt to physiologically unusual, deformed, diseased, or damaged vertebral body surfaces. It is common practice to chisel or machine away portions of a vertebra to make the vertebra conform to an implant. This may cause additional surgical time and expense, and trauma to a patient.

Some of the prior implants and methods provided ball-in-socket or hinged connections rather than fixed constructs. Such flexible joints can be problematic because they may not provide an adequately stable construct to support a patient's weight and activities, especially where the patient has experienced soft tissue damage or degeneration at or near the corpectomy site.

The description herein of certain disadvantages and problems associated with known devices, apparatus, and methods is not intended to limit the scope of the invention to the exclusion of those known devices, apparatus, and methods. Indeed, embodiments of the invention may include some or all of the known devices, apparatus, and methods without suffering from the disadvantages and problems described herein.

SUMMARY

Embodiments of an improved device and method may provide stable but motion tolerant fixation. Improved devices and methods may also be adaptable to the geometry of the vertebrae, including irregular vertebrae, with less or no removal of vertebral tissue. An improved device in some embodiments would have components that, in addition to use in a corpectomy construct, are components of a disc replacement device.

An embodiment of the invention is an implantable corpectomy device having an inferior bearing coupled with an inferior vertebral body. A support member is slidably engaged with the inferior bearing, and the support member is configured to transfer load along its longitudinal axis and into the inferior bearing. A superior bearing is coupled with a superior vertebral body that is slidably engaged with the support member. The support member is configured to transfer load along its longitudinal axis and into the superior bearing. A fixation device is configured to couple with at least one of the inferior vertebral body and the superior vertebral body through a first bone fixation element at one end of the fixation device. The fixation device is configured to couple with the support member.

An additional embodiment of the invention includes a spinal implant system having an inferior bearing means for bearing against an inferior vertebral body, and a superior bearing means for bearing against a superior vertebral body. The spinal implant system optionally includes a support means for providing support between the inferior bearing means and superior bearing means, and optionally a fixation means for coupling the inferior and superior vertebral bodies to the support means.

Another embodiment of the invention is a spinal implant system having an inferior bearing coupled with an inferior vertebral body and a support member configured to slidably engage with the inferior bearing through a first joint. The system also has a superior bearing coupled with a superior vertebral body. The superior bearing is configured to slidably engage with the support member through a second joint. The inferior bearing and the superior bearing are configured to slidably engage with each other.

An embodiment of the invention is an implantable corpectomy device with an inferior bearing coupled with an inferior vertebral body and a support member slidably engaged with the inferior bearing. The support member may be configured to transfer load along its longitudinal axis and into the inferior bearing. The implantable corpectomy device may also include a superior bearing coupled with a superior vertebral body and slidably engaged with the support member. The support member may be configured to transfer load along its longitudinal axis and into the superior bearing. The implantable corpectomy device may also have a fixation device configured to couple with at least one of the inferior vertebral body and the superior vertebral body through a first bone fixation element at one end of the fixation device, and the fixation device configured to couple with the support member.

Yet another embodiment of the invention is a method of implanting a corpectomy device that includes implanting an inferior bearing into an inferior vertebra and implanting a superior bearing into a superior vertebra. Embodiments of the method may include placing a support member between the inferior bearing and the superior bearing such that the support member is rotatably coupled to the inferior bearing and rotatably coupled to the superior bearing, coupling a fixation device to at least one of the inferior vertebra and the superior vertebra with a first bone fixation element, and coupling the fixation device to the support member with a fastener.

Still another embodiment of the invention is a method of implanting a corpectomy device. The method includes coupling an inferior bearing with an inferior vertebra, coupling a superior bearing with a superior vertebra, and placing a support member between the inferior bearing and the superior bearing such that the support member is slidably engaged with the inferior bearing and slidably engaged with the superior bearing. The method also includes coupling a fixation device to at least one of the inferior vertebra and the superior vertebra with a first bone fixation element, and coupling the fixation device to the support member.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an isometric view of an embodiment of an implantable corpectomy device implanted between vertebrae of a spine.

Figure 2 is an exploded view of an embodiment of an implantable corpectomy device.

Figure 3 is a perspective view of an embodiment of a support member.

Figure 4 is a perspective view of embodiments of inferior and superior bearings.

Figure 5 is an elevation view of embodiments of inferior and superior bearings coupled together.

Fig. 6a is an exploded view of a corpectomy device according to another embodiment of the present disclosure.

Fig. 6b is a lateral view depicting the corpectomy device of Fig. 6a disposed between a pair of vertebral bodies.

Fig. 6c is a lateral view of the corpectomy device of Fig. 6b connected to a pair of vertebral bodies.

Fig. 6d is a lateral view of the corpectomy device of Fig. 6b connected to a linkage system.

DETAILED DESCRIPTION

Figure 1 illustrates an implantable corpectomy device 1 implanted between vertebrae of the spine. An inferior bearing 3 is implanted into an inferior vertebral body, and a superior bearing 5 is implanted into a superior vertebral body. In the construct illustrated, one vertebral body has been removed and replaced by the corpectomy device 1.

In other embodiments, more than one vertebral body could be replaced by a corpectomy device of the invention, or in some circumstances, the inferior bearing 3 and the superior bearing 5 could be implanted adjacent to one another and interact in a vertebral disc space without the removal of a vertebra. Figure 5 illustrates the inferior bearing 3 adjacent with the superior bearing 5.

Methods of implanting inferior and superior bearings as well as various configurations of bearings adapted for use from a number of surgical approaches are described in U.S. Pat. Appl. Nos. 10/042,589, "Intervertebral Prosthetic Joint," filed January 9, 2002; 10/620,529, "Intervertebral Prosthetic Joint," filed July 16, 2003; 60/446,963, "Articular Disc Prosthesis and Method for Treating Spondylolisthesis ," filed February 12, 2003; 10/744,157, "Articular Disc Prosthesis and Method for Treating Spondylolisthesis," filed February 6, 2004; 10/752,725, "Device For Fusing Two Bone Segments," filed January 7, 2004; 10/752,724, "Instrument and Method for Milling a Path Into Bone," filed January 7, 2004; 10/752,860, "Mobile Bearing Articulating Disc," filed January 7, 2004; 10/773,494, "Articular Disc Prosthesis For Lateral Insertion," filed February 6, 2004; 10/773,814, "Articular Disc Prosthesis For Transforaminal Insertion," filed February 6, 2004; 10/773,815, "Method and Device for Correcting Spondylolisthesis from the Lateral Approach," filed February 6, 2004; 10/774,078, "Instruments and Methods for Aligning Implants for Insertion," filed February 6, 2004; 10/774,157, "Articular Disc Prosthesis for Anterior-Oblique Insertion," filed February 6, 2004 all of which are incorporated by reference herein. Any of the relevant implants, methods, or surgical approaches described in the incorporated references are adaptable for use with components of the present invention and are within the scope of the invention described and claimed herein.

A support member 7 is shown in Figure 1 slidably engaged between the inferior bearing 3 and the superior bearing 5. As illustrated, there are rotatable couplings between both inferior bearing 3 and support member 7, and the superior bearing 5 and the support member 7. The term slidably engaged includes all engagements or couplings that permit some degree of sliding. For example, longitudinal sliding or rotational sliding would be encompassed by the term. The term rotatable is intended to include any rotational movement between the coupled ends about any of the three axes of rotation. In addition to the embodiments illustrated, rotatable would, for example, describe substantially flat or angular surfaces bearing against one another that are able to rotate about an axis substantially perpendicular to the plane of their surfaces. Hinges or captured ball-in-socket couplings are additional examples of rotatable couplings.

The most significant spinal loads are typically compressive forces applied along the axis of the spine. The corpectomy device 1 illustrated in Figure 1 will provide support for these typical compressive loads. A portion of the loads applied through the spine shown in Figure 1 would be transferred along the longitudinal axis of the support member

7 and though inferior bearing 3 and superior bearing 5. Other portions of the load may be borne by a fixation device 10 or by any posterior spinal processes left intact.

A support member superior articular surface 4 is illustrated in Figure 3. The surface 4 shown is a polished metallic surface designed to bear against a similar or complementary surface that interacts with the support member superior articular surface 4 in a manner that is tolerant of wear. Examples of wear tolerant surfaces include metallic alloys such as polished cobalt chrome or titanium, polymer materials such as ultra high molecular weight polyethylene, ceramic materials, and others. Any biocompatible material able to support the design loads also may be used with embodiments of the invention. The support member 7 may be made of one such material or of a combination of such materials that provides desired design characteristics. The support member superior articular surface 4 couples with a superior bearing articular surface 8 (Fig. 2). In the embodiment illustrated, the coupling between the superior bearing 5 and the support member 7 is a partial ball-in-socket joint. The superior bearing articular surface 8 is a concave surface, and the support member superior articular surface 4 is a convex surface. In other embodiments, the orientation or curvature of the respective surfaces may be altered to any configuration that is able to support the design loads while maintaining a degree of sliding or rotation between the components.

As illustrated in Figure 2, the support member inferior articular surface 2 couples with inferior bearing articular surface 6 (Fig. 4). As shown, the coupling between the inferior bearing 3 and the support member 7 is a partial ball-in-socket joint. The inferior bearing articular surface 6 is a convex surface, and the support member inferior articular surface 2 is a concave surface. In other embodiments, the orientation or curvature of the respective surfaces may be altered to any configuration that is able to support the design loads while maintaining a degree of sliding engagement between the components.

Figure 1 shows a fixation device 10 attached to the inferior vertebral body with a first bone fixation element 16. The first bone fixation element 16 illustrated is a polyaxial bone screw with a mechanism for attaching and locking to a rod 14 from multiple angles. Those skilled in the art will appreciate that any element can be used instead of rod 14 for attaching bone fixation elements to one another, including, for example, flexible or arcuate rods, plates, polymeric materials, and the like. In other embodiments, the bone fixation element may be any device capable of attaching between a fixation device and a vertebral body. The fixation device 10 is coupled to the superior vertebral body with a second bone fixation element 18. A fastener 12 is illustrated coupling the fixation device 10 with the support member 7. As shown, one or more than one bone fixation elements 16, 18, can be used to attach the fixation device 10 to the inferior and superior vertebral bodies, including third and fourth bone fixation elements.

The illustrated fixation device 10 is a rod and screw system commonly used in the art to immobilize vertebrae, although any fixation device 10 can be used in the various embodiments of the invention. Fasteners 12 are multiaxial bolts adapted to engage with the support member 7. The threads applied to the bolt can be machine threads that engage with a tap in the support member 7. In other embodiments, the fasteners 12 may be screws or pins, and may engage with a relatively softer material from which the support member 7 is made or, alternatively, that is embedded in the support member 7. The fasteners 12 of some embodiments engage with a nut that is embedded in the support member 7. Such a nut (not shown) may be permitted to rotate about one or more axes relative to the support member 7. A multiaxial interface between the fixation device 10 and the support member 7 may be beneficial at least because it enables bolt or screw placement from a variety of angles. In some circumstances, approaches to the device may be limited by the anatomy or condition of a patient. The multiaxial embodiment shown and other such embodiments are valuable to enable approaches from a variety of angles.

The inferior bearing 3, the superior bearing 5, and the support member 7 combine to form a spinal implant system. In the spinal implant system, the inferior bearing 3 may be implanted in an inferior vertebral body, as shown in Figure 1. The superior bearing 5 may be implanted in a superior vertebral body. The spinal implant system enables at least two general uses for the bearings 3, 5. In the use shown in Figure 5, the inferior bearing 3 and the superior bearing 5 rotatably couple to each other to form a vertebral disc prosthesis. In this embodiment, a support member 7 and fixation device 10 may not be necessary. In the use shown in Figure 1, the same or similar inferior bearing 3 and superior bearing 5 are rotatably coupled to respective ends of the support member 7 to form a corpectomy device.

The spinal implant system described is advantageous at least because it reduces the types of parts that must be stocked to provide systems that are useful to enable both vertebral disc replacement and vertebral body replacement (i.e. corpectomy).

Embodiments of the invention allow for dual use of the bearings 3, 5. However, other embodiments do not require that an inferior bearing and a superior bearing be configured to both slidably couple with each other and with a support member.

The corpectomy device 1 illustrated in Figure 1 may permit micro-motion at the interfaces of the support member 7 with the inferior bearing 3 and the superior bearing 5.

Allowing controlled micro-motion may be advantageous because it permits an acceptable outlet for strain that does not affect the connection between the corpectomy device 1 and the anatomy. The corpectomy device 1 may not be capable of completely eliminating motion between the inferior vertebra and the superior vertebra. Therefore, if there is no controlled outlet for the strain generated by spinal forces, the strain will be expressed through deformations of components of the corpectomy device 1 and by stress on and potential loosening of the connections of the various components to the anatomy.

For example, the connections of the second fixation elements 18 to the superior vertebral body, the first fixation elements 16 to the inferior vertebral body, the inferior bearing 3 to the inferior vertebral body, and the superior bearing 5 to the superior vertebral body could be loosened in a device without articulating elements. However, allowing micro-motion at the interfaces of the support member 7 with the inferior bearing 3 and the superior bearing 5 assists in reducing the risk of such loosening. An embodiment of the invention therefore permits such micro-motion at these interfaces.

An additional embodiment of the invention includes a spinal implant and/or implantable corpectomy device that has an inferior bearing means for bearing against an inferior vertebral body and a superior bearing means for bearing against a superior vertebral body. The inferior bearing means and superior bearing means are capable of being implanted into the respective vertebral bodies. The spinal implant and/or implantable corpectomy device further may include a support means for providing support between the inferior bearing means and the superior bearing means, and optionally includes a fixation means. The fixation means may be a mechanism for coupling an inferior vertebral body and/or superior vertebral body to the support means, or a mechanism for coupling one or both inferior and superior bearing means.

The inferior bearing means, and the superior bearing means may be any device capable of bearing against a vertebral body, either by implanting directly into or onto the surface of the vertebral body, or by attachment using an external attachment mechanism such as adhesive, screw, bolt, or other attachment mechanism. The inferior bearing means and superior bearing means may be the same or similar to the inferior bearing 3 and superior bearing 5, as well as all known equivalents and equivalents later developed. The inferior and superior bearing means may be configured in any manner to permit bearing against an inferior and superior vertebral body. In one embodiment, the inferior bearing means is rotatably coupled to the superior bearing means. In this embodiment, a support means and a fixation means may or may not be employed.

The support means may be a supporting member capable of providing a support between the inferior bearing means and the superior bearing means. Any supporting member can be used, and the support means may be rotatably coupled to the inferior and superior bearing means. The support means may be the same or similar to the support member 7, as well as all known equivalents and equivalents later developed. The support means may include convex and concave shaped opposing ends to permit a rotatable coupling to the inferior and superior bearing means 3, 5.

The fixation means may be a device capable of fixing an inferior vertebral body and a superior vertebral body together, and may be used to couple the vertebral bodies to the support means, if utilized. Any vertebral fixation device now known or later discovered can be used as the fixation means. The fixation means can be the same or different from the fixation device 10, including its respective component parts, as well as all known equivalents and equivalents later developed.

Referring to Fig. 6a, in an alternative embodiment, socket and ball components 400, 402 each include a keel 404, 406, respectively, for engaging the vertebral bodies V_1, V_2 (Fig. 6b), respectively. A spacer device 410 is provided between the socket and ball components 400, 402 and includes a projection 412 corresponding to a recess 414 formed in the socket component 400. The spacer device 410 also includes a recess 416 corresponding to projection 418 extending from the ball component 402.

Referring to Fig. 6b, the socket and ball components 400, 402 are shown laterally engaged with the vertebral bodies V_1, V_2, respectively, and the spacer device 410 is shown engaged with the socket and ball components. It is understood that the socket and ball components 400, 402 may be inserted into the vertebral bodies V_1, V_2 from a variety of approaches other than the lateral approach, such as the anterior, transforaminal or anterior-oblique approaches. As is also illustrated, the spacer device 410 is positioned adjacent to a floating arch 420, the floating arch being the portion of vertebral body that remains after a vertebrectomy. The length of the spacer device 410 allows the spacer device to span between the socket and ball components 400, 402, thereby allowing articulating motion at both vertebral bodies V_1, V_2.

In some instances, it may be desirable to revise the arrangement of Fig. 6b in order to obtain a more stable interaction between the vertebral bodies V_1, V_2 and the prosthetic devices 400, 402, 410. Referring to Fig. 6c, in one embodiment, either of the socket and ball components 400, 402 can be secured to an adjacent vertebral bone, such as an arch 422, via a linkage 424. In another embodiment, and referring to Fig. 6d, the linkage 424 may also be secured to a posterior plate 428, which, is secured to another linkage 430.

The linkage 430 can be configured to engage the spacer device 410. In either arrangement, motion is provided at only one of the vertebral bodies V_1, V_2, which provides for a more stable arrangement. It is understood that the linkages 424 and 430 and the posterior plate 428 can be formed of any bio-compatible material and that the various connections between the linkages and the posterior plate and between the linkages and the prosthetic devices can be accomplished by way of threaded, slotted or any other type of conventional connection means. Furthermore, it is understood that any number of fixation systems are contemplated for use with the embodiments of Figs. 12c and 12d, such as ANTARES®, Z-PLATE™ and CD HORIZON® fixation systems sold by Medtronic Sofamor Danek, Inc.

Although not depicted, in another embodiment, stabilization can be achieved by removing the spacer device 410 and elongating either of the socket and ball components 400, 402 such that the socket and ball components engage one another in an articulating arrangement. Thus, motion would again only be provided at one of the vertebral bodies V_1, V_2, which would result in a relatively stable arrangement.

In other instances, it may be desirable to revise the arrangement of Fig. 6b in order to obtain a more mobile interaction between the vertebral bodies V_1, V_2 and the prosthetic devices 400, 402, 410. Although not depicted, it is contemplated that the spacer device 410 may be provided with a socket and ball arrangement to provide a third articulating segment between the vertebral bodies V_1, V_2.

Another embodiment of the invention is a method of implanting a corpectomy device. The method may include implanting an inferior bearing 3 into an inferior vertebra and implanting a superior bearing 5 into a superior vertebra. The bearings placed may be similar to the bearings illustrated in Figure 5, or may be similar to any of the embodiments disclosed in the applications incorporated by reference herein. The bearings may be of any configuration that provides an interface for coupling with a vertebral body and may be constructed of any structurally capable biocompatible material.

In some methods of the invention, a support member, such as support member 7, is placed between the inferior bearing and the superior bearing. The support member may be rotatably coupled to the inferior bearing and rotatably coupled to the superior bearing.

The order of placement of the bearings and the support member may vary among various embodiments of the invention.

A fixation device may be included with certain embodiments of the invention to provide additional stability to the corpectomy device. The fixation device may be coupled to the inferior vertebra with one or more bone fixation elements, and/or to the superior vertebra with one or more bone fixation elements. In some embodiments, the rigidity of the corpectomy device is increased by coupling the fixation device to the support member.

Coupling the fixation device to the support member with a fastener may include the use of one or more multiaxial fasteners as are shown in the illustrated embodiments. Multiaxial fasteners may enable easier positioning of a fastener to align the fastener with a connection point in the support member. Once aligned, connection of the multiaxial fastener to the fixation device may be made. The illustrated multiaxial fastener has an engaging element that can be tightened to restrict multiaxial rotational movement of the fastener. Tightening of the engaging element provides additional rigidity to the corpectomy device.

In still a further embodiment, bearings such as inferior bearing 3 and superior bearing 5 may be implanted to achieve either a disc replacement or a corpectomy. A revision to repair or replace implanted devices sometimes becomes medically necessary. In such an embodiment, one of the inferior bearing or the superior bearing is removed. A replacement for the removed bearing is implanted. Because of the cooperating characteristics of the bearings and support members of the invention, a bearing originally implanted for use in a disc replacement may be employed as part of a corpectomy construct. Similarly, a bearing originally implanted as a part of a single level corpectomy may be employed as part of a two level corpectomy construct.

Various embodiments of the invention have been described in detail with reference to particularly preferred embodiments and figures. Those skilled in the art will appreciate that various modifications may be made to the invention without departing from the spirit and scope thereof.

CLAIMS

What is claimed is:

1. An implantable corpectomy device comprising:
an inferior bearing coupled with an inferior vertebral body;
a support member slidably engaged with the inferior bearing, wherein the support member is configured to transfer load along its longitudinal axis and into the inferior bearing;
a superior bearing coupled with a superior vertebral body and slidably engaged with the support member, wherein the support member is configured to transfer load along its longitudinal axis and into the superior bearing; and
a fixation device configured to couple with the inferior vertebral body through a first bone fixation element at one end of the fixation device, the fixation device configured to couple with the superior vertebral body through a second bone fixation element at the opposite end of the fixation device, and the fixation device configured to couple with the support member.

2. The implantable corpectomy device of claim 1 wherein the engagement between the inferior bearing and the support member is at least a partial ball-in-socket joint.

3. The implantable corpectomy device of claim 2 wherein a convex portion of the joint is a part of the inferior bearing and a concave portion of the joint is a part of the support member.

4. The implantable corpectomy device of claim 2 wherein a concave portion of the joint is a part of the inferior bearing and a convex portion of the joint is a part of the support member.

5. The implantable corpectomy device of claim 1 wherein the engagement between the superior bearing and the support member is at least a partial ball-in-socket joint.

6. The implantable corpectomy device of claim 5 wherein a convex portion of the joint is a part of the superior bearing and a concave portion of the joint is a part of the support member.

7. The implantable corpectomy device of claim 5 wherein a concave portion of the joint is a part of the superior bearing and a convex portion of the joint is a part of the support member.

8. The implantable corpectomy device of claim 1 wherein the fixation device is a rod and screw system.

9. The implantable corpectomy device of claim 1, wherein the fixation device is a screw and plate system.

10. The implantable corpectomy device of claim 1 wherein the fixation device is coupled with the support member with a fastener comprising at least one multiaxial bolt that is configured to extend between the fixation device and the support member at multiple angles.

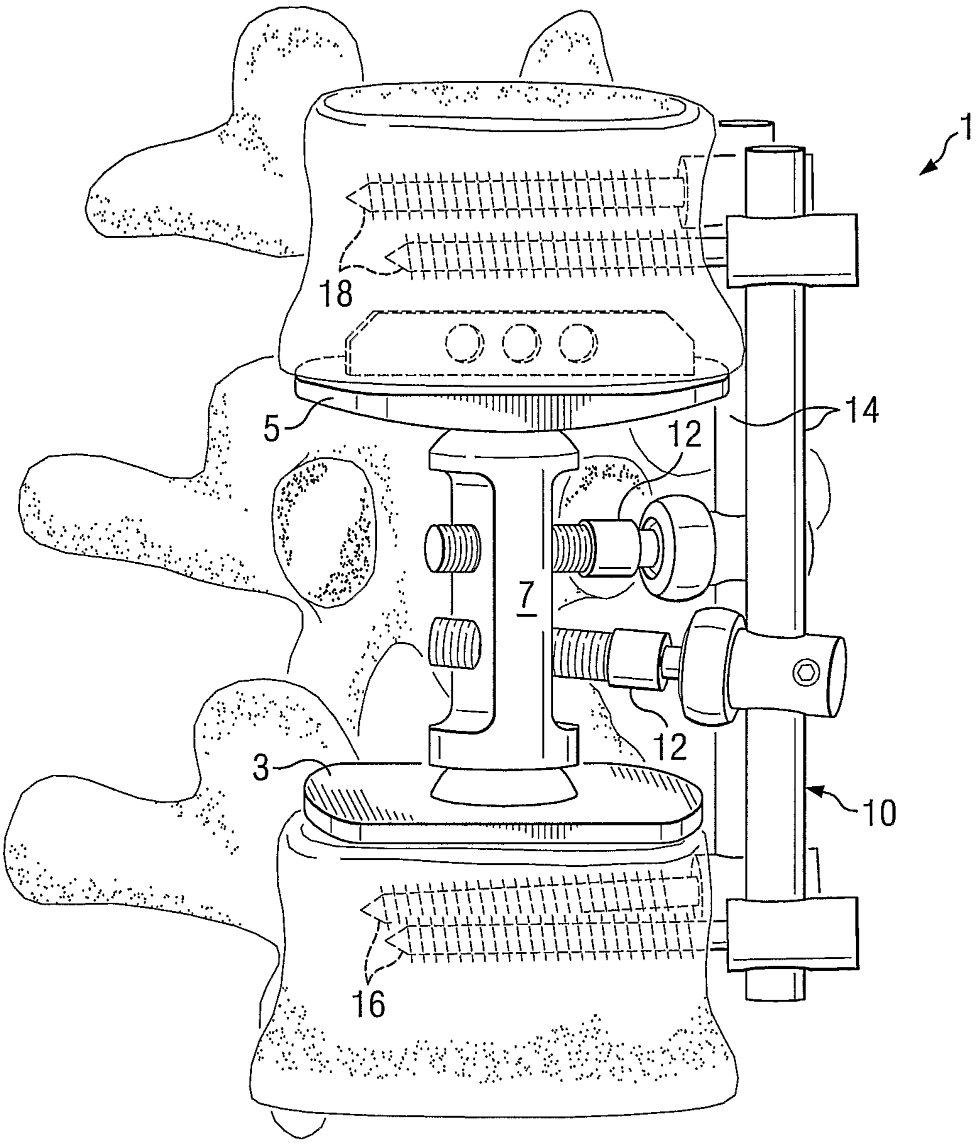

Fig. 1

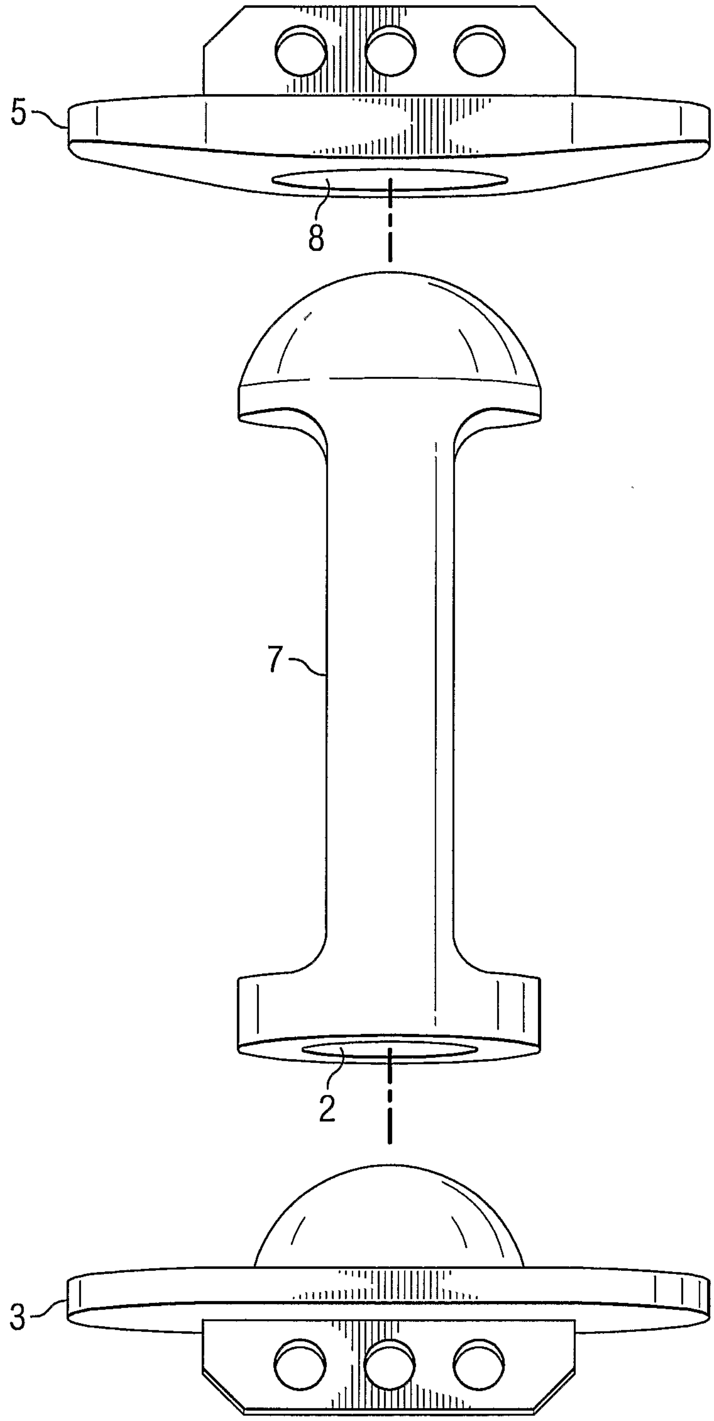

Fig. 2

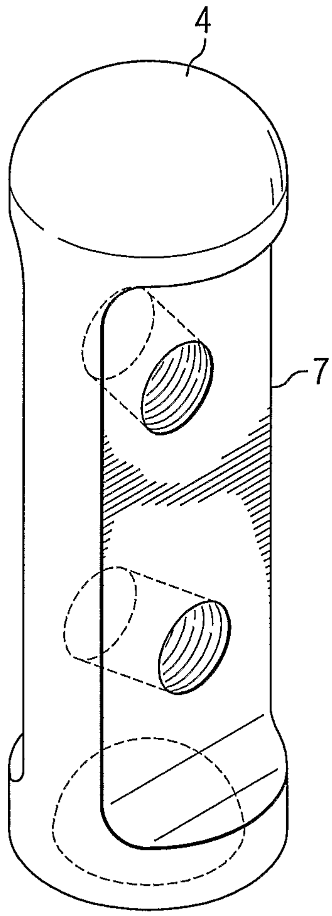

Fig. 3

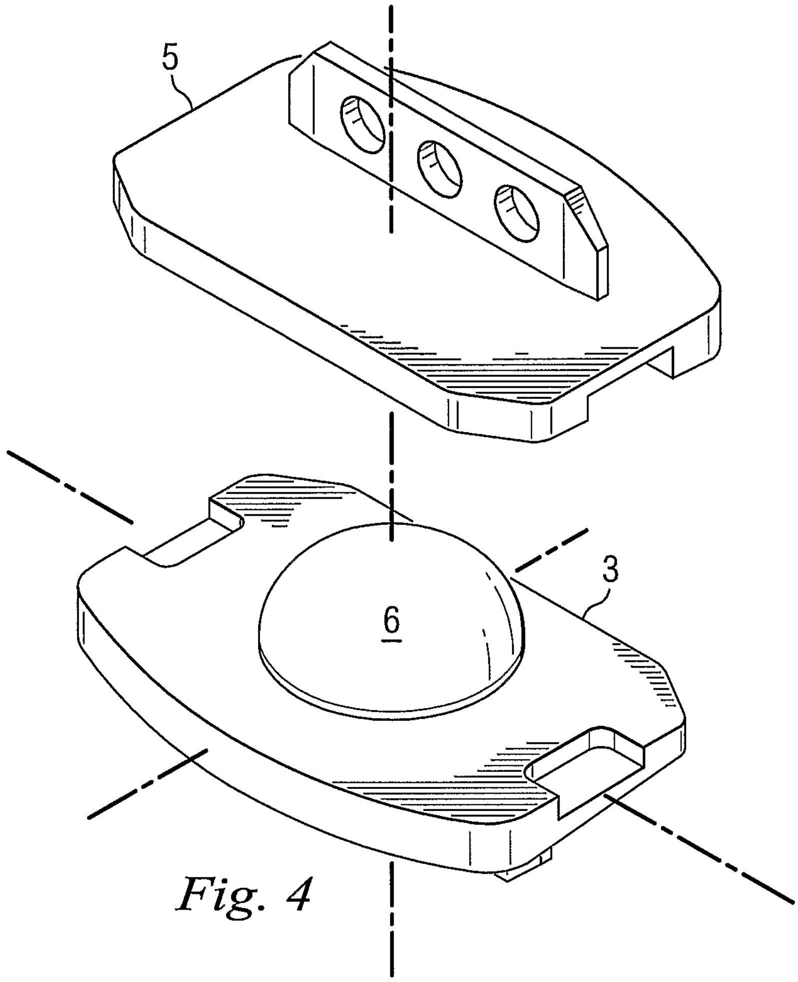

Fig. 4

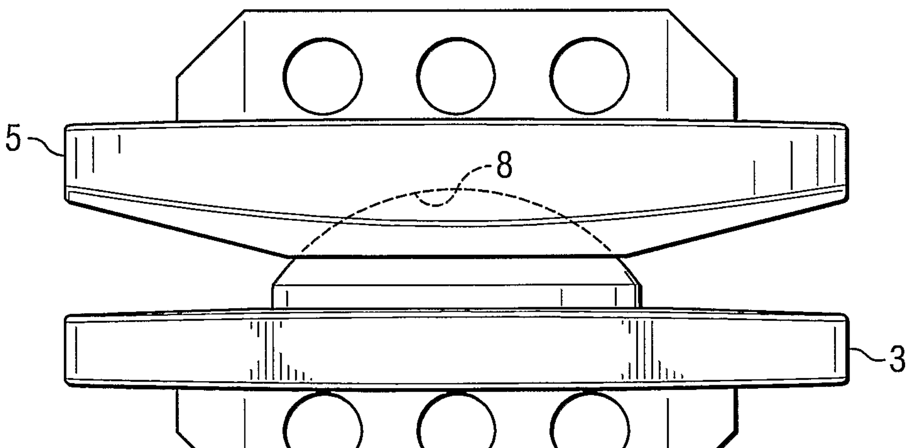

Fig. 5

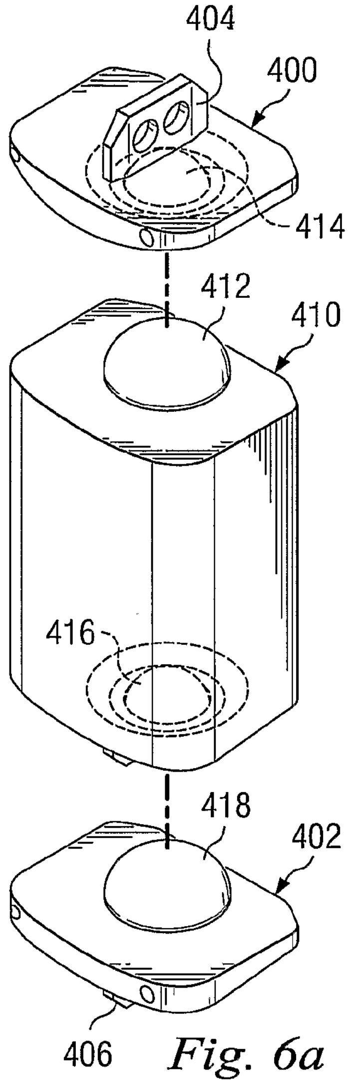

Fig. 6a

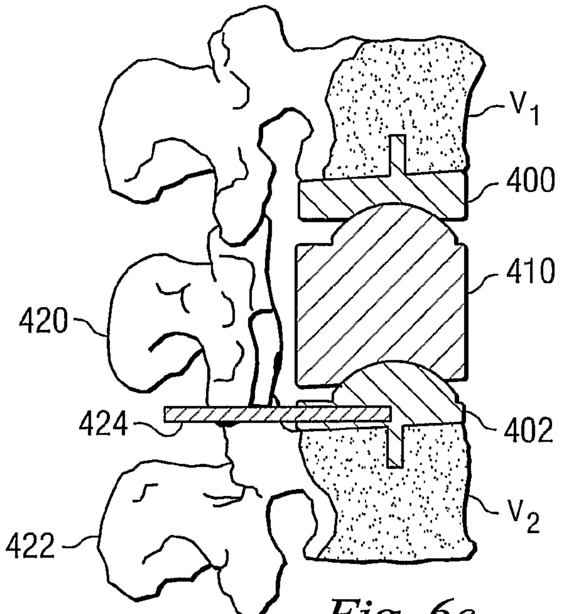

Fig. 6c

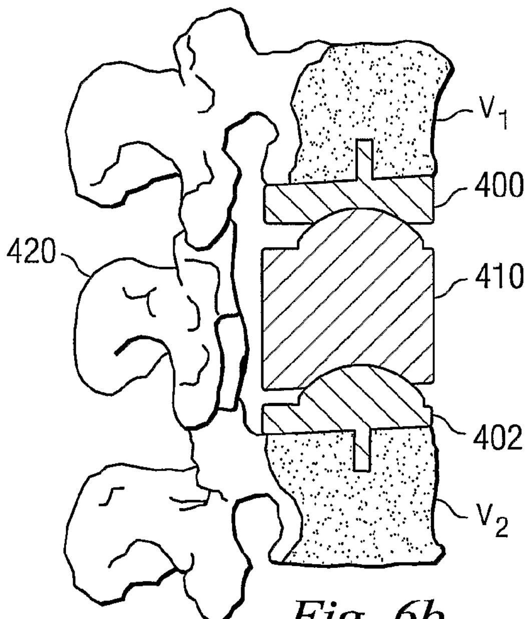

Fig. 6b

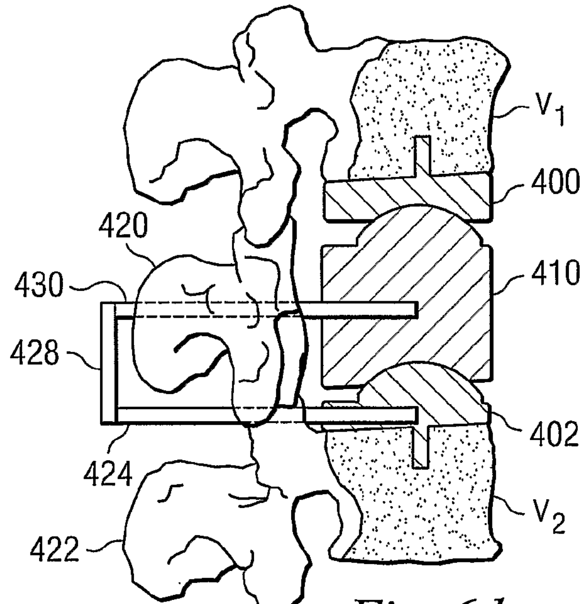

Fig. 6d

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/012184

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/70 A61F2/44

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B A61F

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/060034 A1 (BERRY BRET M ET AL) 17 March 2005 (2005-03-17) paragraph [0083] - paragraph [0085] figure 12	1-10
A	US 2004/176843 A1 (ZUBOK RAFAIL ET AL) 9 September 2004 (2004-09-09) figures	1-10
A	US 6 063 121 A (XAVIER ET AL) 16 May 2000 (2000-05-16) figure 3	1-10

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

☒ See patent family annex.

* Special categories of cited documents :

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 August 2006	24/08/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Held, G

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/012184

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