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(54) MOBILE SPINE STABILIZATION DEVICE

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(60) Provisional application No. 60/677,699, filed on May 4, 2005.

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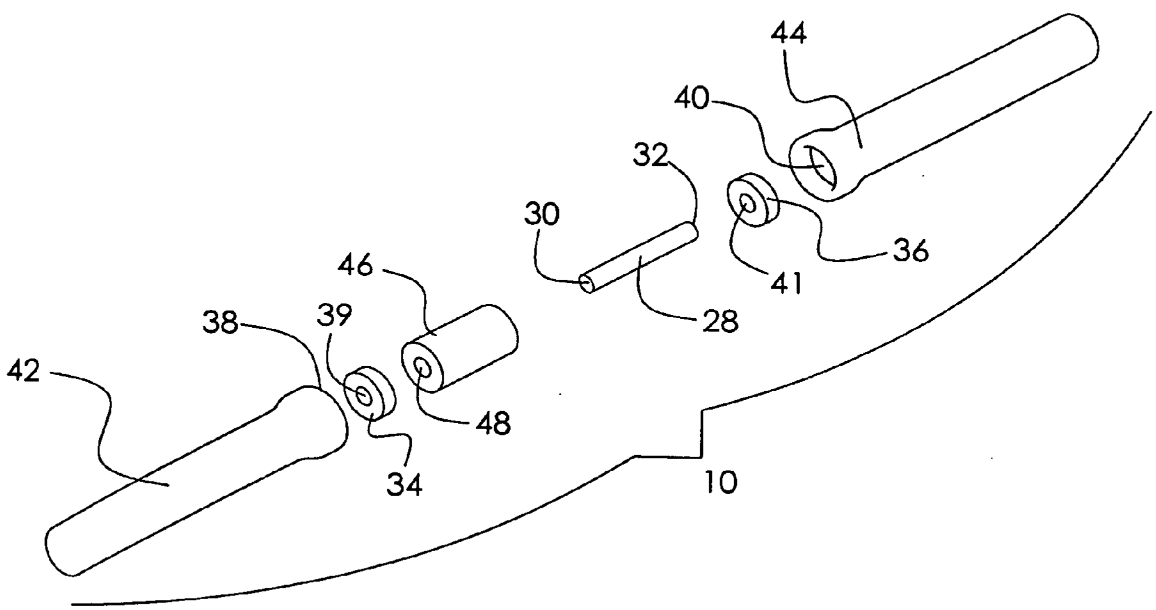
(57) **ABSTRACT**

An orthopedic device is described for stabilizing the spinal column between first and second vertebral bodies. The device has first and second screws adapted for fixation to the first and second vertebral bodies, respectively. The device further includes an elongated ligament with a first end connected to the first screw and the second end operatively connected with the second screw. The ligament is made preferably of a nickel titanium alloy selected to have ductile inelastic properties at body temperature and is capable of continuous plastic deformation to allow relative constrained motion between the vertebral bodies. In a preferred embodiment the second pedicle screw includes a bearing for receiving the ligament in a slideably engageable relationship. The device further includes optional first and second dampening members surrounding the ligament for restraining the spinal column during flexion and extension. Other preferred devices and kits containing such devices are also described.



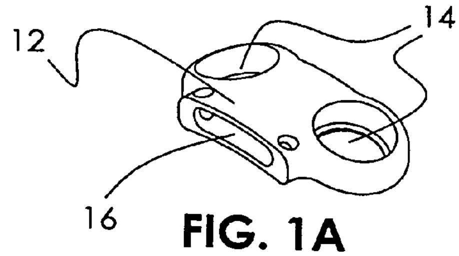


FIG. 1A

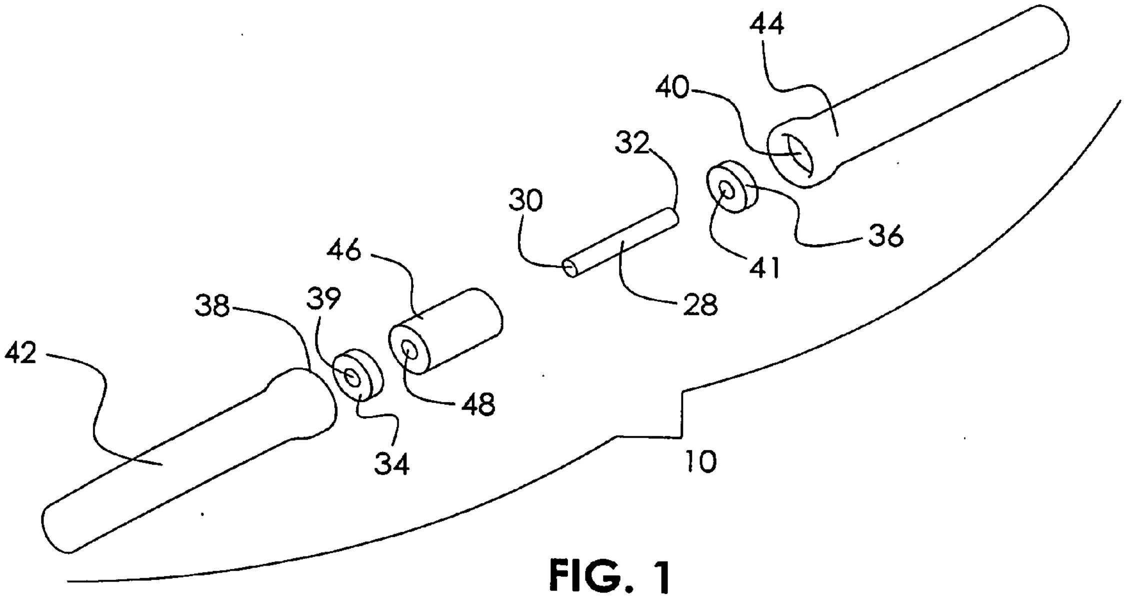


FIG. 1

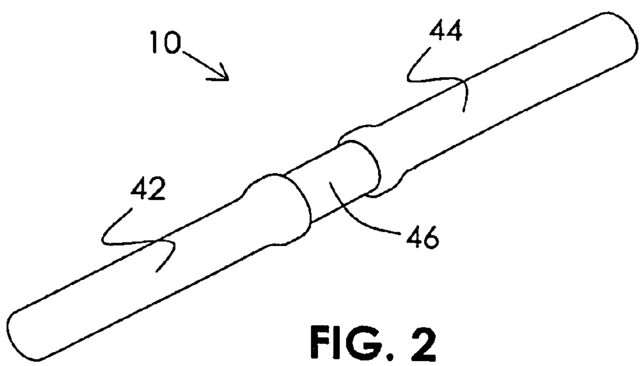


FIG. 2

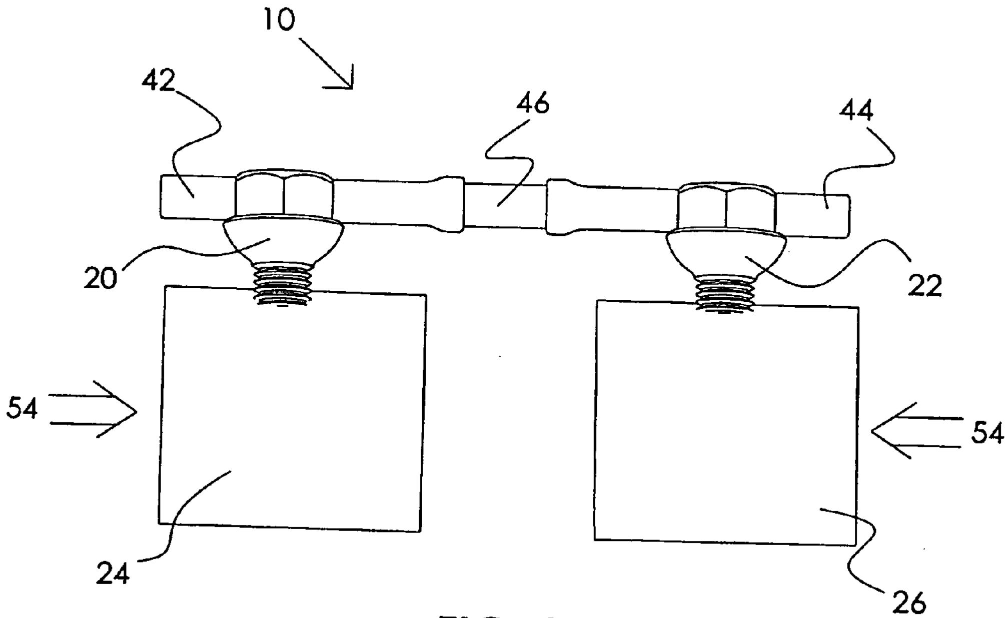


FIG. 3

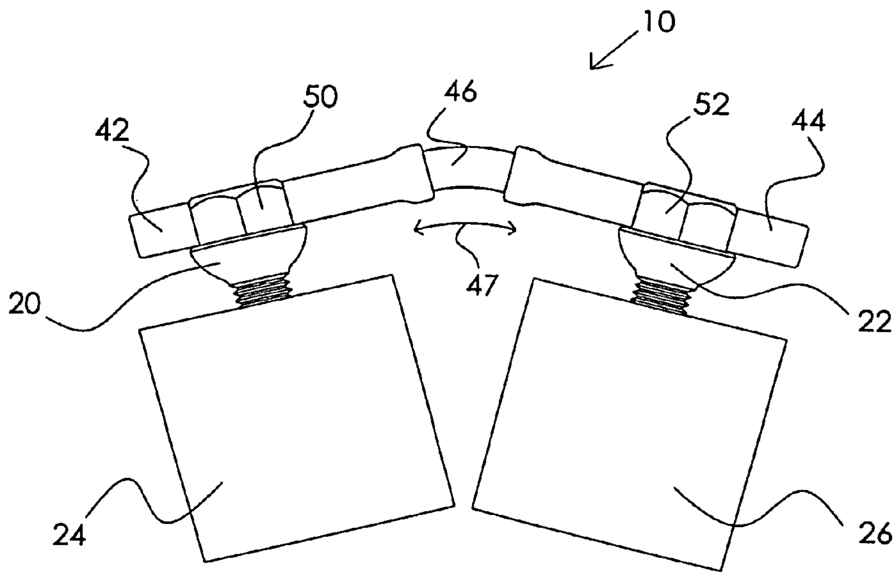


FIG. 4

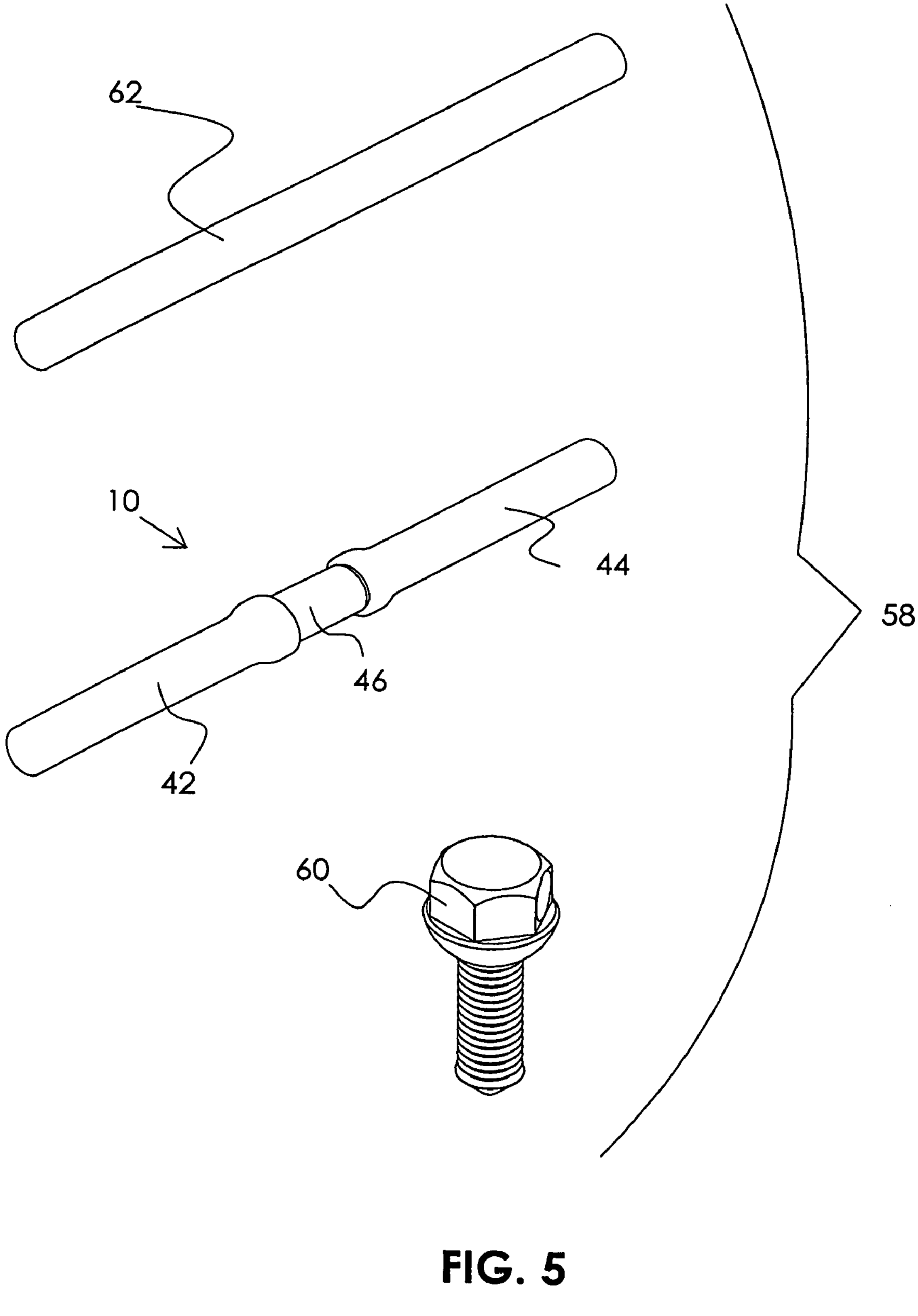


FIG. 5

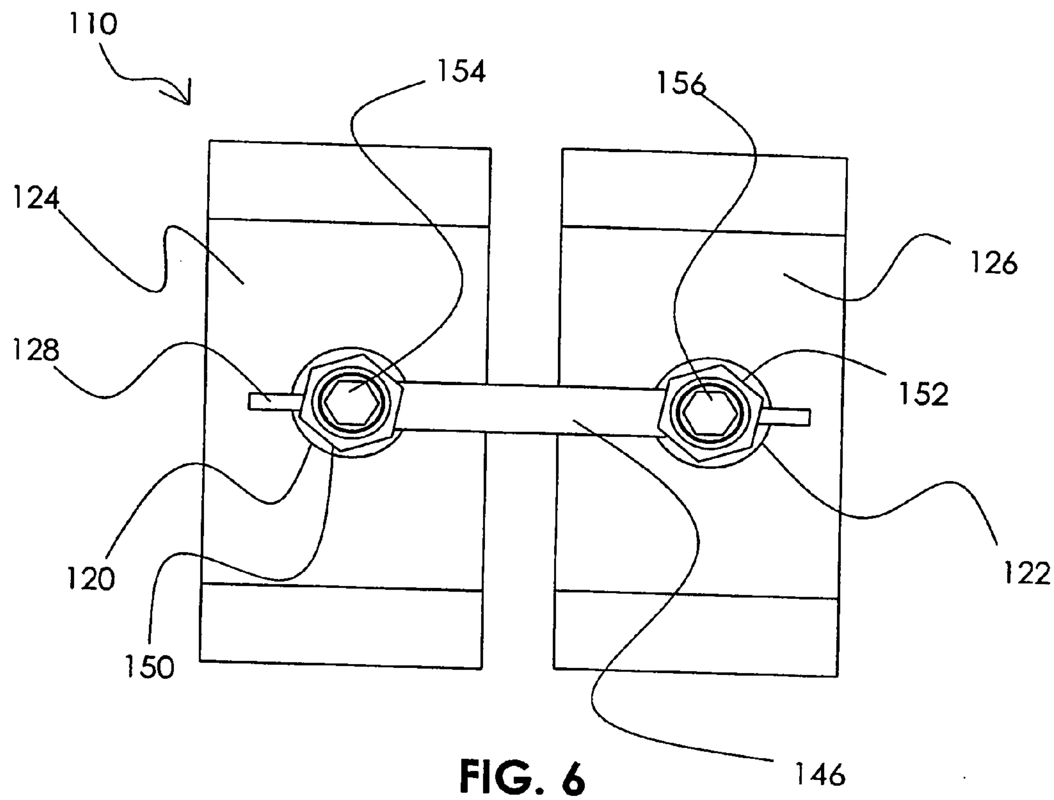
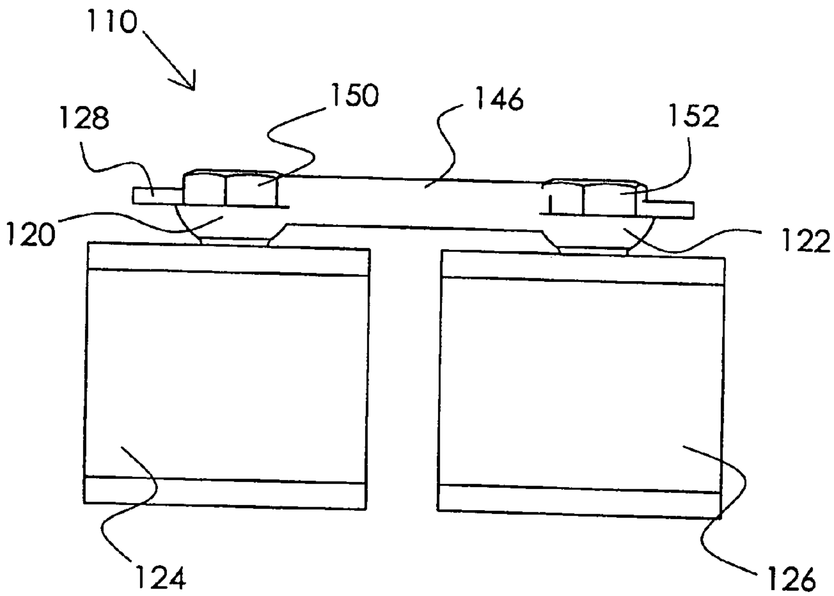

110
154
156
124
126
128
152
120
122
150
146

FIG. 6


110
150
146
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126

FIG. 7

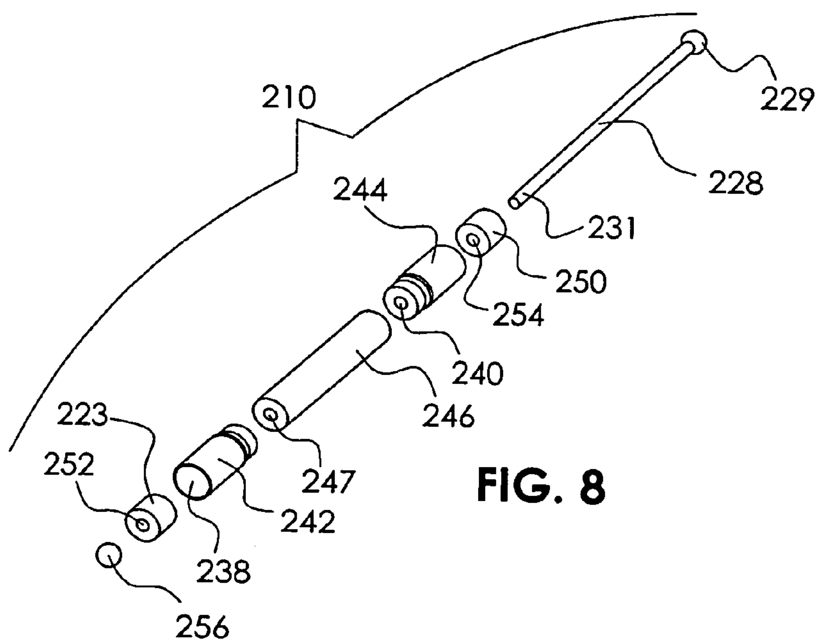

FIG. 8

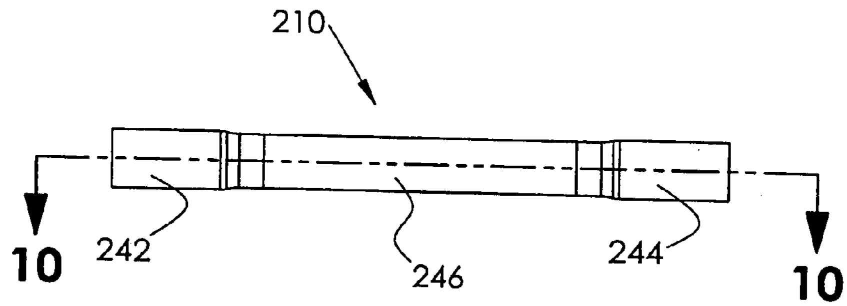

FIG. 9

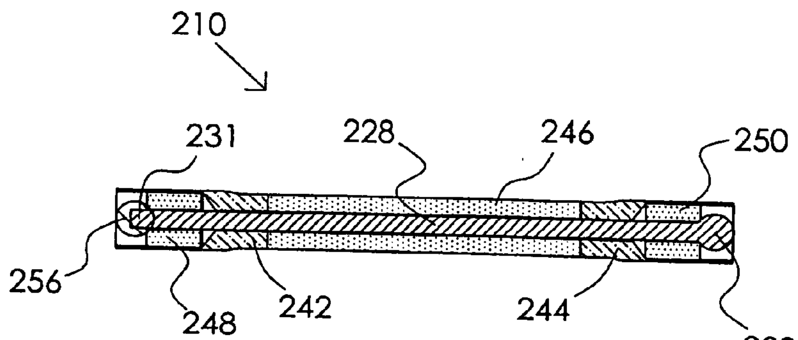

FIG. 10

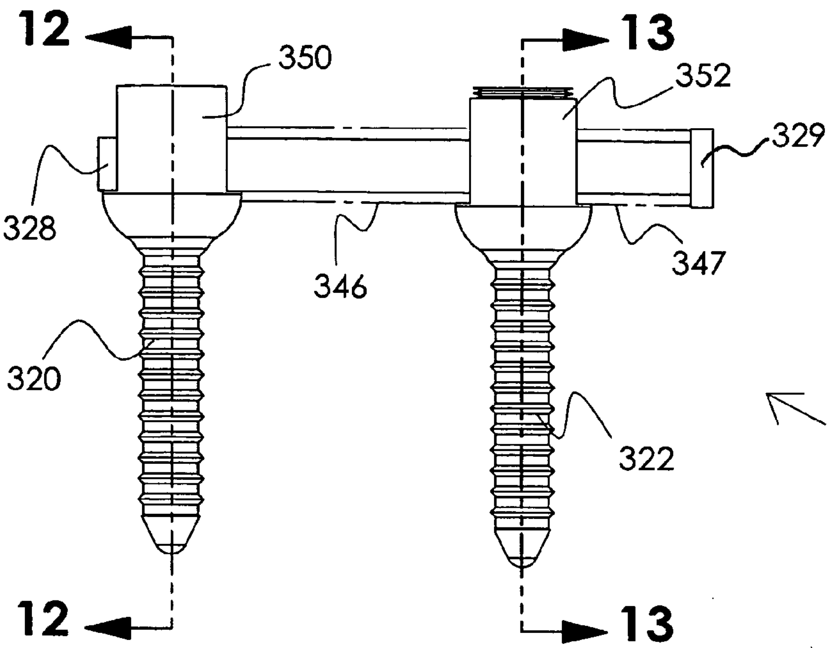

FIG. 11

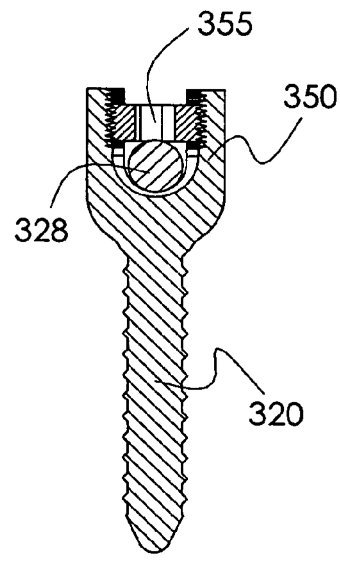

FIG. 12

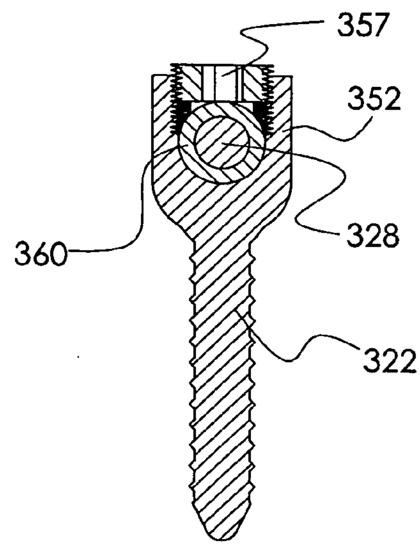

FIG. 13

MOBILE SPINE STABILIZATION DEVICE

RELATED APPLICATION

[0001] This application is a continuation in part of U.S. Ser. No. 11/244,184 filed Oct. 5, 2005.

[0002] The present inventor has previously filed U.S. application Ser. No. 11/244,184 entitled "Orthopedic Stabilization Device" on Oct. 5, 2005 and provisional application 60/677,699 entitled "Dynamic spine stabilization device" on May 4, 2005, the entire disclosures of which are expressly incorporated by reference herein and relied upon.

BACKGROUND OF THE INVENTION

[0003] 1. Technical Field of the Invention

[0004] The present invention relates to orthopedic stabilization devices used to limit the relative motion of at least two vertebral bodies for the relief of pain. These devices can be used to aid osteo-synthesis in combination with fusion devices, supplement other motion restoring devices such as disk implants or used solely to restrict the motion of vertebral bodies without other devices.

[0005] 2. Description of the Related Art

[0006] In the field of spine surgery there have been many attempts to relieve pain associated with spinal injury or illness. Traditionally surgeons have fused the vertebral bodies with a pedicle screw and rod construct or a fusion cage. In attempting to fuse the patient there is a long and painful recovery process. Most rod and screw constructs and fusion cage constructs are very rigid, not allowing transfer of stress into the fusion site that would otherwise aid in a quicker recovery. These approaches defy Wolfe's law stating: bone that is not stressed will degrade. As a corollary, where stress is allowed to transfer through the fusion site while the vertebral bodies are held in a limited range of motion, then fusion can occur much quicker aiding in patient recovery time.

[0007] Many are working to develop devices that allow relative motion, yet these have fallen short in preventing shear forces between the vertebral bodies being stabilized. Another shortcoming is that relative motion has been forcibly channeled through a rather specific location or hinge point in the mechanical construct. The following discussion more particularly summarizes these efforts.

[0008] U.S. Pat. No. 5,092,866 (U.S. Re. 36,221) discloses a pedicle screw system that is banded together with flexible ligaments. While the ligaments allow for relative motion, they do not appear to resist compression or shear loads, instead relying upon tension alone.

[0009] European Patent No. EP 06691091 A1/B1 and the "DYNESYS" product brochure disclose a polycarbonate/urethane supporting element, compressed between two adjacent pedicle screws and passing over an elastic strap that acts as a flexible internal ligament. The flexible internal ligament is in the form of a nylon cord, which is pre-tensioned and fastened to the screw heads. This design provides flexural degrees of freedom, allows relative motion between the vertebral bodies but does little to inhibit or prevent shearing between the vertebral bodies. While flexibility is desirable, the "DYNASES" ligament would appear to lack rigidity and rely on proper tensioning inter-operatively to gain its balance.

[0010] U.S. Pat. No. 6,267,764 discloses a pedicle screw and rod system wherein the rod is flexible in translation. A dampening ball is not separate from the rods and has cutouts to allow bending, with no ligament passing through the centers of the rods. While flexibility in translation can be helpful, the spine loads in several planes at the same time and the translation spoken of in this patent would appear to inadequately redistribute stresses through the fusion site. As a result motion is forcibly limited to one location, i.e., motion is constrained through a hinge point, which undesirably stresses the assembly construct.

[0011] U.S. Pat. No. 6,241,730 discloses a construction that lacks a ligament element, particularly a ligament extending through the center of rod members. There is a compressible dampening element. The '730 design attempts to accomplish a multidirectional redistribution of force for aiding in quicker fusion rates, however its constructs were not designed for use in conjunction with a disk implant. The '730 approach overly limits motion of the vertebral bodies to one location, i.e., forces motion unnaturally through a hinge point.

[0012] U.S. Pat. Nos. 6,293,949 and 6,761,719 disclose embodiments seeking to elastically constrain range of motion using a continuous super-elastic nitinol rod and pedicle screw system. Due to the super-elastic state of the rod, motion is always pushed-back to a neutral, pre-set position. This constrains force through the rod in a manner causing early fatigue failure. In order to provide the correct elasticity of the rod, its diameter must be so small that it cannot withstand the continuous loads. Further, the rod cannot be bent at the time of surgery to a preformed shape holding the vertebral bodies in a desired relative position while also limiting their relative motion.

[0013] Accordingly there exists a need for assemblies and devices that effectively resist torsion as well as shear forces while providing flexible spine stabilization. More specifically, it would be desirable to provide kits with such assemblies and devices, which work with existing pedicle screw arrangements.

[0014] There is another need for flexible assemblies and devices having rigid portions deformable to fit a patient's anatomical contours while maintaining flexibility of the orthopedic construct.

[0015] There is yet another need for assemblies and devices to stabilize vertebrae while providing multi-directional flexibility, without imparting elastic stresses to the bone.

[0016] There is a further need yet to provide a spine stabilization device that can allow natural flexion and extension motion while effectively restraining torsional and shear forces.

[0017] There is a further need to provide spine stabilization assemblies and devices manufactured from a shape memory material such as an alloy or other flexible polymer, which can withstand repeated loading of the spine without fatiguing yet still maintain its flexibility.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0018] According to one embodiment of the present invention, there is provided an orthopedic device for stabilizing the spinal column between anchorage locations on respective first and second vertebral bodies. The device includes an elongated bridge having first and second ends operatively connected at the respective anchorage locations. The bridge contains an implantable ligament selected to be inelastic at body temperature. The ligament is further capable of continuous plastic deformation to allow relative constrained motion while resisting forces exerted upon the vertebral bodies. In a preferred embodiment, the bridge contains an implantable nickel titanium alloy. In another preferred embodiment the device further includes a dampening member surrounding at least a portion of the ligament. In yet another preferred embodiment, the ligament is in the form of a wire, tube, or band. In still another preferred embodiment the device includes rigid rod members each correspondingly retained with either end of the ligament, and independently attached to the vertebral bodies with anchors. The rigid rod members are correspondingly connected to either end of the ligament. In still yet another preferred embodiment, the device includes a plate segment retained with an end of the ligament and independently attached to a vertebral body with the plurality of anchors; more preferably, a plurality of plate segments are correspondingly connected to either end of the ligament.

[0019] In another embodiment of the present invention, an orthopedic device for stabilizing the spinal column includes an elongated implantable ligament with two ends, the ligament partially formed of an implantable nickel titanium alloy capable of continuous plastic in-elastic deformation at body temperature. Either end of the ligament is attached to a vertebral body with a screw at an anchor location. A compression-dampening member surrounds the ligament and is sandwiched between the screws. Plastic deformation in the ligament allows relative constrained motion between the vertebral bodies.

[0020] In yet another embodiment of the present invention, an orthopedic device for stabilizing the spinal column is disclosed. The device includes an implantable elongated ligament with two enlarged end portions. The ligament is partially formed of a nickel titanium alloy capable of continuous plastic in-elastic deformation at body temperature. Two rigid rod members each contain a bore sized for the ligament, the rigid rod members being retained with either end of the ligament and engageable with two vertebral bodies by a plurality of anchors. A compression-dampening member surrounds the ligament and is sandwiched between the rods. Two tension-dampening members are captured within the rigid rod bores, surround the ligament and abut the enlarged end portions respectively. Plastic deformation in the ligament allows relative constrained motion between the vertebral bodies.

[0021] In still another embodiment of the present invention, a surgical kit is disclosed. The kit includes at least one bone anchor and a flexible spine stabilization device. The device includes a ligament partially formed of an implantable nickel titanium alloy capable of continuous plastic in-elastic deformation at body temperature. In a preferred embodiment, the surgical kit includes at least one rigid fusion rod. The anchor, ligament and rigid fusion rod mentioned above are provided in various sizes to accommodate a given patient's anatomy.

[0022] An orthopedic device for stabilizing first and second vertebral bodies of the spinal column, the device comprising:

[0023] In a further embodiment an orthopedic spine stabilization device is disclosed having an elongated ligament with two ends. The ligament is manufactured to exhibit inelastic characteristics at body temperature while further being capable of continuous plastic deformation and can be in the form of a wire, rod, tube, cable, band or plate. The device includes a first screw adapted to securely fasten one end of the ligament to a vertebral body and a second screw with a bearing for receiving the opposite end of the ligament securing it in a mobile fashion to another vertebral body. Plastic deformation in the ligament allows relative constrained motion between the vertebral bodies.

[0024] In still yet a further embodiment of a spine stabilization device is disclosed with an elongated shape memory nickel titanium ligament having a transformation temperature above body temperature. The nickel titanium ligament in the form of a rod exhibits a ductile characteristic during use allowing motion. One end of the rod is fixed to one vertebral body with a first screw. The other end of the rod is secured to a second vertebral body with a second screw containing a plastic linear bearing. As the body moves the ductile nature of the ligament resists bending and shear motions in the vertebral column while at the same time the rod slides in a translational relationship to the second screw further allowing flexion and extension motions.

[0025] In another preferred embodiment of the present invention an orthopedic device for stabilizing the spinal column is shown. The device includes an elongated shape memory nickel titanium ligament having a transformation temperature above body temperature and exhibiting ductile characteristics during use. The ligament is formed in the shape of a rod with first and second ends and the second end includes an abutment. The device also includes a first screw adapted to securely fasten the first end of the rod to a vertebral body and a second screw presenting a plastic linear bearing for receiving the second end of the rod and securing it in a slideably constrained fashion to the other vertebral body. Surrounding the rod and sandwiched between the first and second screw is one dampening member and a second dampening member is found surrounding the rod and sandwiched between the second screw and the abutment. As the body moves the ductile nature of the ligament resists bending and shear motion in the vertebral column while at the same time the rod can slideably translate in relationship to the second screw allowing flexion and extension motion. The dampening members act as cushions for flexion and extension motions and controllably resist the sliding motion between the ligament and the bearing.

[0026] An advantage of the present invention is a device that limits the range of relative motion between two vertebral bodies and works with existing pedicle screw assemblies.

[0027] Another advantage of the invention is to constrain the motion between vertebral bodies in a ductile manor.

[0028] In still another advantage is to allow controlled flexion and extension motions of the spine while constraining bending and shear forces.

[0029] Another advantage of the invention is to provide a kit to the surgeon that has a variety of pedicle screws, rigid fusion rods and elongated implantable ductile ligaments. Further it is desirable that the ligaments provide a variety of stiffness and flexibility options so the surgeon can select the appropriate stiffness and range of motion to achieve the desired surgical result whether it is for aiding fusion or restoring normal range of motion to a patient.

[0030] Other objects and advantages will become apparent to a reader skilled in the art, with reference to the following Figures and accompanying Detailed Description wherein textual reference characters correspond to those denoted on the Drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] In the accompanying drawings:

[0032] **FIG. 1** is an exploded perspective view of a flexible inelastic spine stabilization device, according to the present invention;

[0033] **FIG. 1A** is a perspective view of a representative plate segment for securing the device of **FIG. 1**;

[0034] **FIG. 2** is a perspective view of the device of **FIG. 1**, shown in its assembled state;

[0035] **FIG. 3** is an elevational view of the device of **FIGS. 1 and 2**, further including pedicle screws for attaching the device to adjacent vertebral bodies as schematically shown;

[0036] **FIG. 4** is an elevational view of the device of **FIG. 3**, upon application of load;

[0037] **FIG. 5** is a kit of spinal implant components including a pedicle screw, a rigid fusion rod, and a ligament of the present invention, selected from among various ranges of flexibility;

[0038] **FIG. 6** is a top view of a device employing an elongated implantable ligament attached to vertebral bodies (schematically shown) with pedicle screws that directly secure the ligament between the screws;

[0039] **FIG. 7** is an elevational view of the device of **FIG. 6**;

[0040] **FIG. 8** is an exploded perspective view of another device of the present invention, employing a ligament surrounded by compression and tension-damping members;

[0041] **FIG. 9** is an elevational view of the assembled structures shown in **FIG. 8** prior to application of a load; and

[0042] **FIG. 10** is a sectional view taken longitudinally along Lines **10-10** of **FIG. 9**.

[0043] **FIG. 11** is an elevation view of the present invention employing a ligament which is slideably constrained using a pedicle screw and bearing.

[0044] **FIG. 12** is a sectional view taken longitudinally along Lines **12-12** of **FIG. 11**.

[0045] **FIG. 13** is a sectional view taken longitudinally along Lines **13-13** of **FIG. 11** showing a pedicle screw with a bearing sleeve.

DETAILED DESCRIPTION OF THE INVENTION

[0046] With reference generally to **FIGS. 1-13**, the Applicant's invention provides flexible spinal stabilization allowing controlled relative vertebral motion for the relief of pain, while preventing intervertebral shear forces. Moreover, the invention evenly distributes mechanical stresses throughout its structure rather than constraining motion within a limited portion of its structure, by virtue of its distinctive design.

[0047] Referring to **FIGS. 1 and 2-4**, an elongated bridge member is generally shown as an assembly at **10**. Assembly **10** includes a ligament **28** shown in the form of a wire. It will be understood that the ligament **28** may also take the form of a tube, solid rod or a band, having different cross sectional shapes and sizes. The ligament **28** is made of an implantable material selected to be inelastic at body temperature and allows relative constrained motion while resisting bodily shear forces. The ligament **28** has opposed first **30** and second **32** ends received within washer type connectors **34**, **36** that engage counter-bores **38**, **40** formed within rigid rod members **42**, **44**, respectively. Those in the art will appreciate that the rigid rod members **42**, **44** could have differing sizes and/or lengths. Washer-shaped connectors **34**, **36** are preferably made of a shape-memory alloy in its super-elastic state at body temperature. Alternatively other means for attaching the in-elastic ligament **28** to rigid rod potions **42**, **44** may include welding, threading, gluing or crimping instead of using connectors **34**, **36**. Thus, assembly **10** operatively functions as a bridge between a first anchor **20** and a second anchor **22**, respectively. Ligament **28** is preferably made of an implantable shape memory alloy, more preferably a nickel titanium alloy, which is selected to be inelastic at body temperature. That is, ligament **28** is not in a super-elastic state. Preferably, assembly **10** may include a dampening member **46** that has an inner diameter **48** surrounding ligament **28**. Referring to **FIGS. 3-4**, first and second screw anchors **20**, **22** are adapted for respectively affixing assembly **10** to first and second vertebral bodies **24**, **26**.

[0048] Referring to **FIG. 1A**, a representative plate segment **12** has openings **14** that receive anchoring screws for attachment to a vertebral body not shown. Each plate segment **12** has a passageway **16** configured to receive one end of a ligament not shown. It will be understood that the ligament used in conjunction with the plate **12** could have a variety of forms as elucidated in the above discussion of **FIGS. 1 and 2-4**. Passageway **16** could have a rectangular cross section as shown, or could have a variety of forms for receiving the ligament. Preferably a plurality of plates **12** can be employed with the ligament, across a corresponding plurality of vertebral bodies to form a bridge similar to assembly **10** in **FIGS. 1 and 24**.

[0049] Referring to **FIGS. 3-4**, plastic deformation in ligament **28** is in response to external stimulus indicated by arrows **54**, **54**, which for the sake of illustration is shown as direct uniform axial compression. However, as will be appreciated, the external stimulus often consists of combined bending and twisting motions of a patient's body.

[0050] With continuing reference to **FIGS. 1-4**, the present assembly **10** resists shear forces exerted between vertebral bodies **24**, **26** during the bending and twisting motions of a patient without creating elastic forces that otherwise would exert unnatural stresses forcing the vertebral bodies back into some prior position. The present invention instead allows the body's own motion to return it to the natural position without undue elastic impetus. This natural return to body position is therefore distinct from prior approaches that rely upon super-elastic members such as those discussed above; moreover, the present invention is distinct from prior approaches that do not resist both shear and direct torsional movements while yet bending themselves. The present assembly **10** does not exert resultant forces that are opposite to the motion input **54**, **54** and yet the assembly is repetitively plastically deformable due to the material and design employed herein.

[0051] **FIG. 5** depicts still another embodiment of the present invention, that is, a surgical kit generally shown at **58**. Kit **58** includes an array of bone anchors **60** and an elongated bridge assembly **10** preferably of the type shown in **FIGS. 1-4** although it will be appreciated that an array of assemblies having various sizes and stiffness can be provided. The assembly **10** is capable of continuous plastic in-elastic deformation at body temperature. In a preferred embodiment, the surgical kit **58** includes an array of semi-rigid fusion rods such as the representative rod shown at **62**. In another preferred embodiment, an alternative surgical kit not shown may include an array of plates similar to those described in conjunction with **FIG. 1A**. The arrays mentioned above are provided in various sizes to accommodate a given patient's anatomy.

[0052] Referring to **FIGS. 6-7**, an orthopedic device **110** for stabilizing the spinal column includes an elongated bridge member that takes the form of ligament **128** instead of the assembly **10** as previously discussed in conjunction with **FIGS. 1 and 2-4**. It will be understood that the ligament **128** may also take the form of a tube, solid rod or a band, having different cross sectional shapes and sizes. The ligament **128** is at least partially made of an implantable material that is preferably a nickel titanium alloy capable of continuous plastic in-elastic deformation at body temperature in similar fashion as ligament **28** (**FIG. 1**). Device **110** has no distinct rigid rod members as depicted, for example, at **42** and **44** in **FIGS. 1 and 2-4**. Nor are there any plate segments as at **12** in **FIG. 1A** to operatively anchor ligament **28**. Instead, ligament **128** extends between and directly interconnects screws **120**, **122**, which affix it to vertebral bodies **124** and **126**. An optional compression-dampening member **146** is shown surrounding ligament **126** and is sandwiched between the screw heads **150**, **152** in **FIGS. 6-7**. Plastic deformation in the ligament **128** allows relative motion while preventing shear stresses between vertebral bodies **124**, **126**. **FIGS. 6-7** show a tubular dampening member **146** preferably made of an in implantable elastomer such as silicone or polycarbonate urethane, through which elongated ligament **128** passes.

[0053] Referring to **FIGS. 8-10** there is yet another embodiment of the present invention. An elongated bridge member is shown in the form of an assembly **210**, for stabilizing the spinal column. Assembly **210** includes an elongated ligament **228** with an enlarged fixed end portion **229** and a free end **231**. Ligament **228** is at least partially formed of an implantable inelastic material, preferably nickel titanium alloy capable of continuous plastic in-elastic deformation at body temperature, i.e., not in a super-elastic state. Bore **240** of rigid rod member **244** is sized for passage of ligament **228**, the rod members **242**, **244** are retained with ends **229**, **231** of the ligament for attachment at respective anchorage locations to vertebral bodies (not shown). Those in the art will appreciate that the rigid rod members **242**, **244** could have differing sizes and/or lengths. A compression-dampening member **246** has a bore **247** that surrounds ligament **228** and is sandwiched between proximally chamfered rigid rod members **242**, **244**. Tension-dampening members **248**, **250** have respective bores **252**, **254** sized to allow passage of ligament **228** housed within the bores of the rigid rods **242**, **244**. Tension-dampening members **248**, **250** surround ligament **228** and are respectively captured by rigid rods **242**, **244** along with enlarged ends **229**, **256** as shown in **FIG. 10**. Plastic deformation in ligament **228** allows relative constrained motion between, while resisting shear forces exerted upon the vertebral bodies. Motion is transmitted along the entire length of ligament **228** from its enlarged fixed ends **229**, **256**. Dampening members **246**, **248**, **250** are preferably made of an implantable elastomer such as silicone or polycarbonate urethane.

[0054] Inelastic ligament **28**, **128**, **228** is preferably manufactured from a nickel titanium alloy preferably having a diameter in the range of 3-6 mm. Other cross sectional shapes and sizes of ligament **28**, **128**, **228** may be made available for different surgical applications. Nickel Titanium can be alloyed to have varying properties, some alloys exhibiting super-elastic behavior at body temperature while other alloys are continuously in-elastic at body temperature. These inelastic alloys are commonly referred to as shape memory alloys by those skilled in the art. Shape memory alloys may further have transition temperatures either above or below body temperature; however, the applicable transition temperature for the present invention is selected to be higher than body temperature. The present inventor has determined that within the operative size range, in-elastic ligaments **28**, **128**, **228** made from shape memory alloys having a transition temperature above body temperature, exhibit acceptable fatigue resistance. This is because there are no elastic forces exerted by the ligament **28**, **128**, **228** of the present invention, against the body. It is intended that a surgeon determine how much in-elastic resistance is necessary for each individual patient's needs and then pre-selects an assembly or device **10**, **110**, **210** at the time of surgery to ensure the best resistance. Preferably the ligament **28**, **128**, **228** is non-braided and is formed as a unitary contiguous member enabling the ligament to resist shear forces. In the instance where a surgeon may be supplementing fixation of two vertebral bodies **24**, **26** and **124**, **126** with a fusion cage (not shown), a flexible inelastic assembly or device **10**, **110**, **210** with pedicle screws **20**, **22** and **120**, **122** is preferable to limit motion and allow stress transfer through the fusion site in accordance to Wolfe's law. In this instance the surgeon would select a less flexible assembly or device **10**, **110**, **210** with a larger inelastic ligament **28**, **128**, **228** such as 5-6 mm in diameter. The diameter and length of the inelastic ligament **28**, **128**, **228** determine the flexibility of the surgical construct. In another instance a surgeon may selectively remove the facia from two adjacent vertebral bodies **24**, **26** and **124**, **126** to eliminate arthritis caused by bony contact at the facia. To replace the support for the vertebral bodies after the faciaectomy the surgeon would use a flexible inelastic assembly or device **10**, **110**, **210** with pedicle screws **20**, **22** and **120**, **122** to ensure that axial spacing between posterior segments (not shown) of vertebral bodies **24**, **26** and **124**, **126** is maintained. In this instance it would be preferable for the surgeon to select a more flexible assembly or device **10**, **110**, **210** that has an inelastic ligament **28**, **128**, **228** with a diameter closer to 3-4 mm. This surgical construct would allow a patient to have constrained motion but would limit contact between the facia of the two vertebral bodies **24**, **26** and **124**, **126**. The rigid rod portions **42**, **44** and **242**, **244** are typically manufactured from stainless steel or titanium and are preferably in the diameter range of 4-7 mm. This size range is typical of other commercially available spinal implant hardware so that flexible inelastic assembly or device **10**, **110**, **210** of the present type is universally received by existing pedicle screws **20**, **22** and **120**, **122**.

[**0055**] **FIGS. 3-7** illustrate use of pedicle screws **20**, **22** and **120**, **122** to fasten the flexible assembly **10** or device **110** to vertebral bodies **24**, **26** or **124**, **126**. However, other attachment means are possible as well as a variety of alternate locations for mounting. In a traditional spinal stabilization system the rods are placed posterior to and on either side of the spinous process. Depending on the pathology observed, a surgeon might select a unitary flexible ligament **128** or assembly **10** to mount posterior to the theoretical centerline of a patient between two spinous processes. Or alternatively a flexible inelastic ligament **128** or assembly **10** may be placed on the anterior side of the vertebral bodies **24**, **26**; **124**, **126**.

[**0056**] Referring to **FIGS. 11-13** an embodiment is shown with a device **310** allowing the spine to bend under dynamic constraint. As seen in **FIGS. 11-12** a first pedicle screw **320** is designed to be mounted in a first vertebral body (not shown). The pedicle screw **320** has a head portion **350** which is designed to receive the ligament **328** securely with a set screw **355** or any other locking mechanisms that lock the ligament **328** to the screw **320**. The ligament **328** is being shown in the form of a rod, however it is important to realize that the form of the ligament is not as important as its' mechanical characteristics and could be made in the shape of wire, tube, cable, band or plate. Preferably the ligament **328** should be made from a material that can withstand repeated cyclical loading without failing and should have a ductile nature while at body temperature. Nickel and Titanium or Nickel Titanium as it is referred to can be alloyed to result in a material property that has this ductility which can also be classified as having an in-elastic behavior with continuous plastic deformation. Nickel Titanium is known to be manufactured in two general categories. The first is superelastic; these alloys have an elastic behavior at body temperature but for this application reapply unwanted stresses into the vertebral column during motion and are undesirable. The additional stresses also lead to lower fatigue resistance during use. The second category of Nickel Titanium is classified as having a shape memory characteristic. The temperature at which the material will exhibit the memory characteristics is set during the manufacturing process and this temperature is often referred to as the transition temperature at which a phase transformation between martensite and austenite occur. For this application it is desirable to set the transition temperature above body temperature. It is known that the higher the transition temperature of the material the higher the fatigue resistance. So, below the transition temperature the ligament **328** can be bent with restraint and takes on a ductile nature allowing it to be reshaped on a continuous basis without fatiguing allowing it to support the mobile spinal column. In **FIGS. 11 and 13** a second pedicle screw **322** is shown for adaptation to another vertebral body (not shown), however both pedicle screws **320**, **322** could also be used to treat a fracture within one vertebral body when the bone is fractured or cut into two or more fragments. The second pedicle screw **322** is adapted with a bearing **360** which can be manufactured from any known implantable bearing material such as plastic, metal or ceramic. If a plastic were selected polyethylene or polyetheretherketone materials have shown good characteristics as a bearing material in orthopedic devices. The bearing **360** can be manufactured as an integral part of the pedicle screw **322** for instance as a simple hole (not shown) drilled through the head **352**, or the bearing can be mounted with a set screw **357** as shown. The bearing **360** can be in the form of a ring, washer, ball or any other bearing that will allow the ligament **328** to be received and allow relative movement between the ligament and the pedicle screw **322** during use. As can be appreciated the bearing **360** could be fully closed or split to accommodate the relative motion and could be used to receive other rods known in the art. For instance titanium alloy rods **62** shown in the kit **58** in **FIG. 5** used for fusion could be received within the bearing **360** to allow slight relative movement between the pedicle screws **320**, **322**. It is contemplated that other bridge members such as plastic rods currently under development could also be used in conjunction with the bearings **360** and this description should not be limiting in nature. The ligament **328** can be manufactured to have an abutment **329** and the ligament can receive optional dampening members **346**, **347**. While the bearing **360** allows relative movement between the pedicle screws **320**, **322** in flexion and extension of the spinal column the optional dampening members **346**, **347** are useful for additional constraint. The first dampening member **346** can be sandwiched between the head **350** of the first pedicle screw **320** and the second head **352** of pedicle screw **322**. This first dampening member **346** is used to constrain motion while the spinal column is in extension. The second dampening member **347** surrounds the ligament **328** and is sandwiched between the second head **352** of the pedicle screw **322** and the abutment **329**. The second dampening member **347** can be used to constrain motion in flexion.

[**0057**] The present invention is by no means restricted to the above described preferred embodiments, but covers all variations that might be implemented by using equivalent functional elements or devices that would be apparent to a person skilled in the art, or modifications that fall within the spirit and scope of the appended claims.

What is claimed is:

1. An orthopedic device for stabilizing a first and second bone of the spinal column, the device comprising:

an elongated ligament having first and second ends, the ligament selected to exhibit inelastic characteristics at body temperature and further capable of continuous plastic deformation;

a first screw adapted to securely fasten the first end of the ligament to the first bone;

a second screw presenting a bearing for receiving the second end of the ligament and securing it in a mobily constrained fashion to the second bone, wherein

plastic deformation in the ligament allows relative constrained motion between the bones.

2. The orthopedic device of claim 1 wherein the implantable ligament is in the form of at least one wire, rod, tube, cable, band or plate.

3. The orthopedic device of claim 1 further comprising a dampening member surrounding the ligament and sandwiched between the first and second screw.

4. The orthopedic device of claim 1 wherein the second end of the ligament has an abutment.

5. The orthopedic device of claim 4 further comprising a dampening member oriented around the ligament and sandwiched between the second screw and the abutment.

6. The orthopedic device of claim 1 wherein the bearing further comprises a plastic material selected from polyethylene or polyetheretherketone.

7. The orthopedic device of claim of claim 1 wherein the ligament further comprises a nickel titanium alloy.

8. The orthopedic device of claim 7 wherein the ligament exhibits shape memory characteristics with a transition temperature above body temperature.

9. An orthopedic device for stabilizing first and second vertebral bodies of the spinal column, the device comprising:

an elongated shape memory nickel titanium ligament having a transformation temperature above body temperature and exhibiting ductile characteristics during use, the ligament formed in the shape of a rod with first and second ends;

a first screw adapted to securely fasten the first end of the rod to the first vertebral body;

a second screw presenting a plastic linear bearing for receiving the second end of the rod and securing it in a slideably constrained fashion to the second vertebral body, wherein

ductile deformation in the ligament allows slideably constrained motion between the vertebral bodies.

10. The orthopedic device of claim 9 further comprising a dampening member surrounding the rod and sandwiched between the first and second screw.

11. The orthopedic device of claim 9 wherein the second end of the rod has an abutment.

12. The orthopedic device of claim 11 further comprising a dampening member oriented around the ligament and sandwiched between the second screw and the abutment.

13. The orthopedic device of claim 9 wherein the bearing further comprises a plastic material selected from polyethylene or polyetheretherketone.

14. An orthopedic device for stabilizing first and second vertebral bodies of the spinal column, the device comprising:

an elongated shape memory nickel titanium ligament having a transformation temperature above body temperature and exhibiting ductile characteristics during use, the ligament formed in the shape of a rod with first and second end, the second end including an abutment;

a first screw adapted to securely fasten the first end of the rod to the first vertebral body;

a second screw presenting a plastic linear bearing for receiving the second end of the rod and securing it in a slideably constrained fashion to the second vertebral body,

a first dampening member surrounding the rod and sandwiched between the first screw and the second screw,

a second dampening member surrounding the rod and sandwiched between the second screw and the abutment, wherein

ductile deformation in the ligament allows slideably constrained motion between the vertebral bodies.

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