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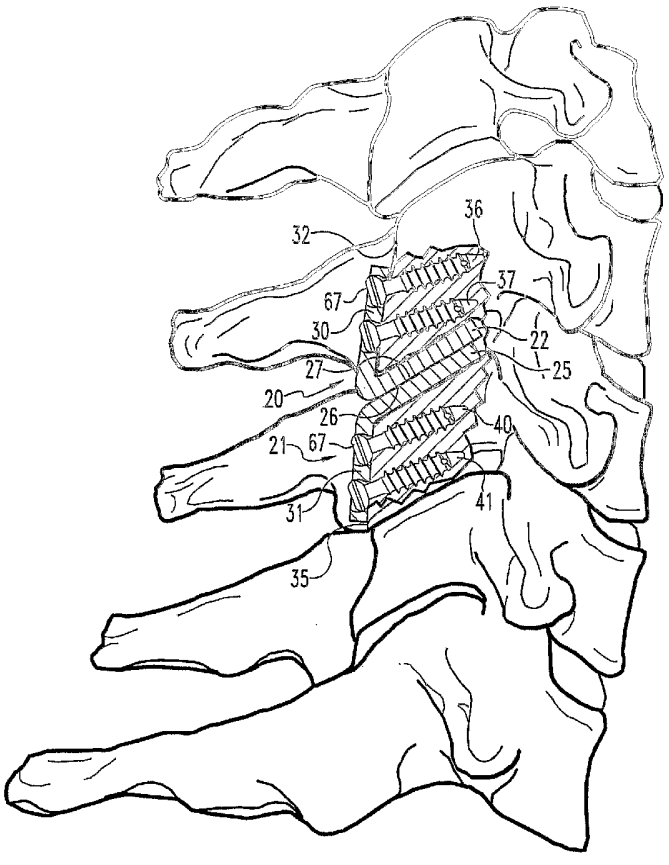
(54) Title: REPLACEMENT FACET JOINT AND METHOD



(57) Abstract: Prostheses and methods for repair of a cervical fact joint. The articulating surfaces of the natural facets of the facet joint are removed only a sufficient amount to allow the insertion of flat or slightly curvilinear portions of protheses therebetween in an overlapping relationship. The portions are so inserted and the prostheses mounted by attachment to adjacent vertebrae. Also, a single natural facet may be similarly repaired with a single prosthesis.

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REPLACEMENT FACET JOINT AND METHOD

Background of the Invention

Field of the Invention

This invention relates to a method and apparatus for replacing and/or repairing a spinal facet joint particularly in the cervical spine.

Description of the Prior Art

Various devices and methods have been proposed for replacing the facet joints of the spine. For example, the U.S. Patent to Fitz, No. RE36,758 discloses an artificial facet joint which includes a superior component that is conical or pyramidical in form and articulates with an inferior component that is also roughly conical or pyramidical in form. The U.S. patent to Gable et al., No. 6,579,319 discloses a prosthesis for the replacement of a vertebral facet joint which does not require attachment to or abutment against the posterior arch. The U.S. Patent to Reiley, No. 6,610,091 discloses facet arthroplasty devices that provide articulating movement between superior and inferior prostheses. It is desirable that improved prostheses and methods be provided for replacement of the facet joints particularly in the cervical spine and particularly in the facet joints of C3 through C7.

One of the surgical operations performed on the spine involves the replacement of one or more intervertebral discs with a disc prosthesis. One of the problems involved in disc replacement is the restoration of spine alignment. It is desirable that improved methods and prostheses be made available for the restoration of spine alignment in various spinal surgeries, including those involving disc replacement.

Summary of the Invention

One embodiment of the invention might involve a prosthesis for the repair of cervical facet joint which includes a superior component having a first flat or slightly curvilinear portion and a mounting portion. Also provided is an inferior component having a second flat or slightly curvilinear portion and a mounting portion. The mounting portions are adapted for connection to adjacent cervical vertebrae with the first and second portions articulating with each other between the facets of the adjacent cervical vertebrae.

Another embodiment of the invention might involve a prosthesis for the repair of a cervical facet joint. There is provided a component having a flat or slightly curvilinear portion and a mounting portion with the flat or slightly curvilinear portion being adapted for replacing the articulating surface of one of the facets of the articulating facet joint between the two adjacent cervical vertebrae.

Still another embodiment of the invention might include a method for repairing a cervical facet joint of adjacent vertebrae. A superior component is provided having a first flat or slightly curvilinear portion and a superior mounting portion. Also provided is an inferior component having a second flat or slightly curvilinear portion and an inferior mounting portion. The articulating surfaces of the facets are removed only a sufficient amount to allow the insertion of the first and second portions therebetween in an overlapping relationship. A further step involves inserting the first and second portions between the facets with the first and second portions in an overlapping relationship. Further, the components are secured to the adjacent vertebrae by attaching the mounting portions to the posterior arches of the adjacent vertebrae.

Still another method forming an embodiment of this invention involves repairing a cervical facet joint between a first vertebra and a second vertebra by providing a component having a first flat or slightly curvilinear portion and a mounting portion. The natural facet surface of the first vertebra is removed only a sufficient amount to allow the insertion of the first portion into overlapping relationship with the natural facet surface of the second vertebra. The first portion is inserted into overlapping relationship with the natural facet surface of the second

vertebra and the component is secured to the first vertebra by attaching the mounting portion to the posterior arch of the first vertebra.

Brief Description of the Drawings

Fig. 1 is a lateral or side view of the human cervical spine with portions broken away showing one embodiment of the invention.

Fig. 2 is a view similar to Fig. 1 showing a further embodiment of the invention.

Fig. 3 is a front elevation of a superior component forming part of Fig. 1.

Fig. 4 is a front elevation of an inferior component forming part of Fig. 1.

Fig. 5 is a sectional view taken in the direction of the arrows 5-5 in Fig. 3.

Fig. 6 is a sectional view taken in the direction of the arrows 6-6 in Fig. 4.

Fig. 7 is a front elevation of a superior component forming part of Fig. 2.

Fig. 8 is a front elevation of an inferior component forming part of Fig. 2.

Fig. 9 is a sectional view taken in the direction of the arrows 9-9 in Fig. 7.

Fig. 10 is a sectional view taken in the direction of the arrows 10-10 in Fig. 8.

Fig. 11 is a view looking down on the facet of a cervical vertebra showing an alternative embodiment of the invention.

Fig. 12 is a posterior view of the cervical spine showing still another embodiment of the invention.

Detailed Description

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

The invention generally relates to an artificial facet joint that is particularly configured for use in association with the cervical region of the spine. The artificial facet joint preferably includes superior and inferior components that cooperate with one another to substantially mimic normal physiological movement between the adjacent vertebrae. Implantation of the artificial facet joint does not necessarily require the removal of significant portions of the natural facet joint. Instead, the superior and inferior components are preferably configured to replace only the articulating surface portions of the natural facet joint, with the remainder of the natural facet joint remaining intact. Moreover, the artificial facet joint does not have to constitute an interbody-type device, but might instead be mounted outside of the intervertebral disc space. Additionally, the artificial facet joint may be used in association with uni-lateral or bi-lateral treatment of the cervical spine.

Referring to Fig. 1, in one embodiment, the superior component 20 and inferior component 21 each preferably include a substantially flat or slightly curvilinear articulation portion 22 and 25, respectively, defining articulating surfaces, and a mounting flange portion 30 and 31, respectively, extending transversely from the articulation portion for posterior attachment to the lateral mass 32 and 35 of respective vertebra via one or more bone screws 36, 37, 40 and 41. The articulation and mounting portions of the superior/inferior components preferably have a relatively thin, plate-like configuration. The mating articulating surfaces of the superior and inferior components of the artificial facet joint preferably are substantially planar or flat or slightly curvilinear as opposed to defining a ball-and-socket configuration. Some slight curvature in the mating articulating surfaces, while less preferred, is contemplated as within the scope of

the invention. It being understood that in embodiments having both superior and inferior components, such very slight curvature is preferably matched between the two components and that such curvature may limit the extent of articulation possible. In this manner, the interface between the superior and inferior articulation portions can be described as having a "shingle" overlap arrangement.

With regard to the superior prosthetic component 20, the angle between the articulation portion 22 and the mounting flange portion 30 is preferably about 45 degrees to approximate the angular orientation of the natural inferior articular facet relative to the posterior lateral mass. Similarly, the inferior prosthetic component 21 preferably defines an angle between the articulation and mounting portions of about 135 degrees to approximate the angular orientation of the natural superior articular facet relative to the posterior lateral mass. It should be understood that the superior and inferior components of the artificial facet joint can be formed of all materials known to those of ordinary skill in the art as being suitable for this purpose. Such materials include, but are not limited to, metal, a polymer, a ceramic, or any combination thereof. It should further be understood that it is contemplated as within the scope of the invention that portions of each component might be made of one material, and other portions of a different material and/or that portions of the component might be coated with additional materials, particularly the mounting portions that might be subject to greater wear as opposing surfaces rub against one another.

Referring to Fig. 2, in a further aspect of the invention, a flexible tethering system 45 is attached between, for example, the cervical vertebrae 46 and 47 to provide for flexible stabilization of the portion of the cervical spine being treated. In one embodiment, the flexible tethering system 45 might preferably include two Vertex-type screws 50 and 51 that are used to anchor the superior component 52 and inferior component 53 of the artificial facet joint to the upper and lower vertebrae, respectively. The screws 50 and 51 include receiver portions 55 and 56, respectively, that each preferably define a U-shaped channel for receiving a flexible tether 57. Flexible tether 57 is preferably a flexible rope, cable or rod. It should be understood that other types and configurations of flexible tethering systems are contemplated as within the scope of the present invention. The

tethering system may be constructed and include the multi-axial bone screw assembly described and illustrated in detail in U.S. Patent No. 6,280,442 to Barker et al. which is incorporated by reference herein. For use in the present invention, the tether 57 is preferably flexible rather than being rigid as might be required for applications in which a fixed relationship between components is desired.

Fig. 3 is a front elevation and Fig. 5 is a section showing the configuration of the superior component 20. In one specific embodiment, the flat or slightly curvilinear articulation portion 22 and the mounting flange portion 30 are preferably arranged at an angle of 45° relative to one another. Alternatively, the angular relationship may be about 45°. Fig. 4 is a front elevation and Fig. 6 is a section showing the configuration of the inferior component 21. In one specific embodiment, the flat or slightly curvilinear articulation portion 25 and the mounting flange portion 31 are preferably arranged at an angle of 135° relative to one another. Alternatively, the angular relationship may be about 135°. The embodiments of Figs. 1 and 2 are shown, respectively, with two screws per component and one screw per component although the number of screws in each embodiment may vary. Thus, the embodiment of Fig. 1 may use one screw per component and the embodiment of Fig. 2 may use two screws per component. It should be understood that it is contemplated as within the scope of the invention that each component may have a different number of anchors and that the number of anchors might be one, two or more than two anchors for each component.

Fig. 7 is a front elevation and Fig. 9 is a section showing the configuration of the superior component 52. In one specific embodiment the flat or slightly curvilinear articulation portion 60 and the mounting flange portion 61 are preferably arranged at an angle of 45° relative to one another. Alternatively, the angular relationship may be about 45°. Fig. 8 is a front elevation and Fig. 10 is a section showing the configuration of the inferior component 55. In one specific embodiment, the flat or slightly curvilinear articulation portion 62 and the mounting flange portion 65 are preferably arranged at an angle of 135° relative to one another. Alternatively, the angular relationship may be about 135°.

The embodiments of Figs. 1 and 2 are both preferably provided with mounting capabilities that allow the screw (or any other bone anchor that might be

used) to attach the component to extend in the direction desired by the physician installing the component. Referring, for example, to Fig. 1, the bone screws 36, 37, 40 and 41each preferably have rounded heads 67 that rest in rounded holes 70 (Figs. 5 and 6) in the mounting flange portions 30 and 31. This configuration allows the surgeon to orient the screw at a variety of angles so as to place the screw in the strongest portion of the bone. This capability is also true of the multi-axial bone screw assembly of Fig. 2 as described in detail in the U.S. Patent to Barker, No. 6,280,442. Thus, the bone screw holes 70 of Figs. 7-10 are also preferably rounded to receive the heads of their respective bone screws at a range of angles.

In certain applications, such as for example a spinal fracture, it may be appropriate to repair a cervical facet joint by replacing only one of the articulating surfaces of the natural facet joint. Thus, Fig. 11 shows a prosthesis 75 for accomplishing this purpose wherein the inferior portion of the facet joint has been replaced by the prosthesis 75 which is preferably constructed identically to the structure illustrated in Figs. 8 and 10. Fig. 12 is a posterior view of the cervical spine and wherein the superior portion of the facet joint has been replaced by the prosthesis 76 which may preferably be constructed identically to the structure illustrated in Figs 3 and 5. It should be understood, however, that one or more bone screws may be used in the embodiment of Figs. 11 and 12. Also in connection with the embodiment of Figs. 11 and 12, it is important that the surface of the artificial articulating portion such as the surface of the portion 62 which contacts the natural facet should be made out of cartilage or biologic tissue and not be a material which causes wear on the natural facet tissue.

The method of the present invention for repairing a cervical facet joint of adjacent vertebrae involves providing a superior component having a first substantially flat or slightly curvilinear portion and a mounting portion. An inferior component is provided having a second substantially flat or slightly curvilinear portion and a mounting portion. The articulating surfaces of the natural facet joint are removed only a sufficient amount to allow insertion of the first and second portions therebetween in an overlapping relationship. The first and second portions are then inserted between the facets with the first and second portions in an overlapping relationship. The components are preferably secured to the

adjacent vertebrae by attaching the mounting portions to the posterior arches of the adjacent vertebrae.

The step of removing the natural articulating surfaces of the natural facet joint can be accomplished with various surgical instruments or tools. The instrument that is used should be chosen so as to make possible effecting the exact desired dimensions of the joint. The instrument could be an oscillating saw or saws. Also, a high speed burr might be used.

In order to practice the method, preferably a guide or guides is placed into the facet joint. The guide or guides may be a flat spatula-appearing device which is placed into the joint. The guide or guides are cephalad and caudad to the center of the natural facet joint to make room to place the artificial facet joint. The guide is preferably a jig, similar to those used for total knees to cut the total knees or similar to those used in the anterior lumbar spine to cut the end plates. The jig is set up so that either an oscillating saw or a high speed burr is used to make the cuts that allow the placement of the artificial joint. Once the cuts are made, the end plates of the natural facet joint are removed so that the surgeon can look into the area where the cuts are made to make sure there are no osteophytes or any other pieces of bone that are at the tips of the natural facet joint. That is where the nerve is so the surgeon should make sure there are no big bone spurs that are deep so it should be decompressed. Once the cuts have been made preferably the surgeon will place the artificial joint as one piece with the two components married together. The artificial joint will be put in preferably as one piece. It should fit perfectly because by use of the jig to make the cuts there will be exact matching of the dimensions of the facet joint. Preferably it is put in as or similar to a press fit. Then the surgeon places the anchors or screws in to seat the artificial joint preferably with lateral mass screws. In one of the preferred embodiments, there is a tether which provides dynamic stabilization. By using the elastic tether, the facet joint is tensioned perfectly. If the procedure is done with artificial disc replacement, the artificial discs are already placed in front so that has been done first and then the tether is tensioned so that the spine is in the perfect saggittal alignment so that on a lateral x-ray, normal lordosis is achieved and confirmed. Thus, the tether (or soft rod) is used to tension this dynamic stabilizing structure

and actually that will allow sliding articulation of the facet joint so that absolutely normal saggittal alignment is obtained.

In order to practice the method shown in Figs. 11 and 12 wherein only one of the articulating surfaces of the natural facet joint is replaced, the procedure is as follows. A component is provided having a first substantially flat or slightly curvilinear portion and mounting portion. The natural facet surface of a first vertebra is removed only a sufficient amount to allow the insertion of the first portion into overlapping relationship with the natural facet surface of the second vertebra. The first portion is then inserted into overlapping relationship with the natural facet surface of the second vertebra and the component is preferably secured to the first vertebra by attaching the mounting portion to the posterior arch of the first vertebra.

It can be appreciated that the prostheses and procedures described herein make possible improved treatment of the spine. For example, these procedures may be used in combination with disc replacement in order to restore spine alignment. Further in the case of a fracture, the concepts taught herein may be used to repair a facet joint by replacing only one of the natural facet surfaces.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

What is claimed:

1. A prosthesis for the repair of a cervical facet joint comprising:

a superior component having a first substantially flat or slightly curvilinear portion and a mounting portion;

an inferior component having a second substantially flat or slightly curvilinear portion and a mounting portion;

said mounting portions being adapted for connection to adjacent cervical vertebrae with said first and second portions articulating with each other between the facets of the adjacent cervical vertebrae.

2. The prosthesis of claim 1 wherein said first flat or slightly curvilinear portion is joined to said superior mounting portion at an angle of about 45°.

3. The prosthesis of claim 1 wherein said second flat or slightly curvilinear portion is joined to said inferior mounting portion at an angle of about 135°.

4. The prosthesis of claim 3 wherein said first flat or slightly curvilinear portion is joined to said superior mounting portion at an angle of about 45°.

5. The prosthesis of claim 1 wherein said first flat or slightly curvilinear portion is joined to said superior mounting portion at an angle of 45°.

6. The prosthesis of claim 1 wherein said second flat or slightly curvilinear portion is joined to said inferior mounting portion at an angle of 135°.

7. The prosthesis of claim 6 wherein said first flat or slightly curvilinear portion is joined to said superior mounting portion at an angle of 45°.

8. The prosthesis of claim 1 additionally comprising a first bone anchor member for attaching said superior component to a vertebrae, a second bone anchor member for attaching said inferior component to a vertebra and a flexible tethering system connecting said first bone anchor and said second bone anchor.

9. The prosthesis of claim 9 wherein said flexible tethering system comprises a flexible elongated member secured to said first bone anchor member and to said second bone anchor member.

10. The prosthesis of claim 9 wherein said bone anchor members are screws.

11. A prosthesis for the repair of a cervical facet joint comprising:

a component having a substantially flat or slightly curvilinear portion and a mounting portion, said substantially flat or slightly curvilinear portion being adapted for replacing the articulating surface of one of the facets of the articulating facet joint between two adjacent cervical vertebrae.

12. The prosthesis of claim 11 wherein said flat or slightly curvilinear portion is joined to said mounting portion at an angle of about 45°.

13. The prosthesis of claim 11 wherein said flat or slightly curvilinear portion is joined to said mounting portion at an angle of 45°.

14. The prosthesis of claim 11 wherein said flat or slightly curvilinear portion is joined to said mounting portion at an angle of about 135°.

15. The prosthesis of claim 11 wherein said flat or slightly curvilinear portion is joined to said mounting portion at an angle of 135°.

16. A method for repairing a cervical facet joint of adjacent vertebrae comprising:

(a) providing a superior component having a first substantially flat or slightly curvilinear portion and a mounting portion,

(b) providing an inferior component having a second substantially flat or slightly curvilinear portion and a mounting portion,

(c) removing the articulating surfaces of the facets of the facet joint only a sufficient amount to allow the insertion of said flat or slightly curvilinear portions therebetween in an overlapping relationship,

(d) inserting said flat portions between the facets with the flat or slightly curvilinear portions in an overlapping relationship,

(e) and securing the component to the adjacent vertebrae by attaching the mounting portions to the posterior arches of the adjacent vertebrae.

17. The method of claim 16 wherein said first flat or slightly curvilinear portion is joined to said superior mounting portion at an angle of about 45°.

18. The method of claim 16 wherein said second flat or slightly curvilinear portion is joined to said inferior mounting portion at an angle of about 135°.

19. The method of claim 18 wherein said first flat or slightly curvilinear portion is joined to said inferior mounting portion at an angle of about 45°

20. The method of claim 16 wherein said first flat or slightly curvilinear portion is joined to said superior mounting portion at an angle of 45°.

21. The method of claim 16 wherein said second flat or slightly curvilinear portion is joined to said inferior mounting portion at an angle of 135°.

22. The method of claim 21 wherein said first flat or slightly curvilinear portion is joined to said inferior mounting portion at an angle of 45°.

23. A method for repairing a cervical facet joint between a first vertebra and a second vertebra comprising:

(a) providing a component having a substantially flat or slightly curvilinear portion and a mounting portion,

(b) removing the natural facet surface of the first vertebra only a sufficient amount to allow the insertion of said flat or slightly curvilinear portion into overlapping relationship with the natural facet surface of the second vertebra,

(c) inserting said flat portion into overlapping relationship with the natural facet surface of the second vertebra, and;

(d) securing the component to the first vertebra by attaching the mounting portion to the posterior arch of the first vertebra.

24. The method of claim 23 wherein said flat or slightly curvilinear portion is joined to said mounting portion at an angle of about 45°.

25. The method of claim 23 wherein said flat or slightly curvilinear portion is joined to said mounting portion at an angle of 45°.

26. The method of claim 23 wherein said flat or slightly curvilinear portion is joined to said mounting portion at an angle of about 135°.

27. The method of claim 23 wherein said flat or slightly curvilinear portion is joined to said mounting portion at an angle of 135°.

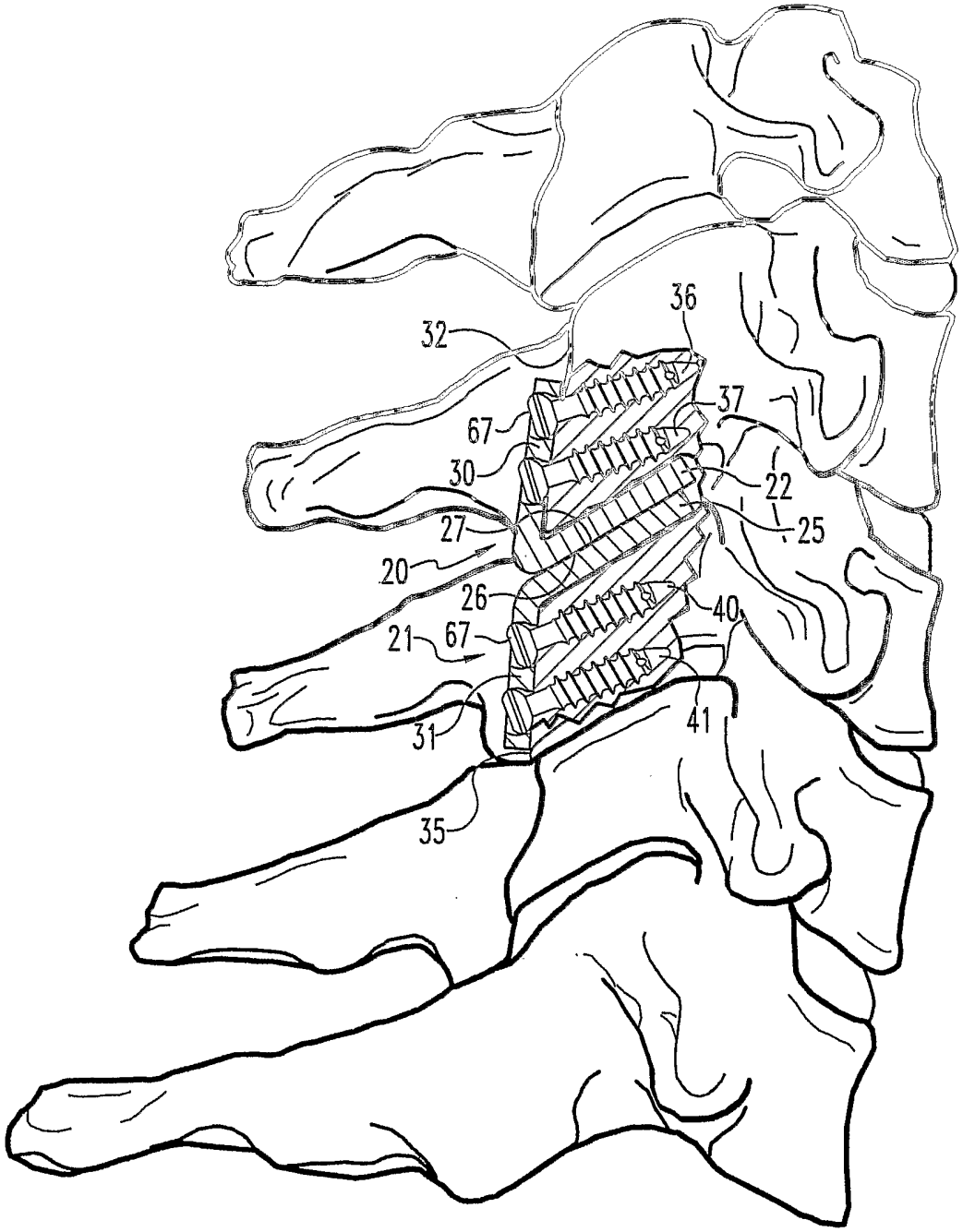

Fig. 1

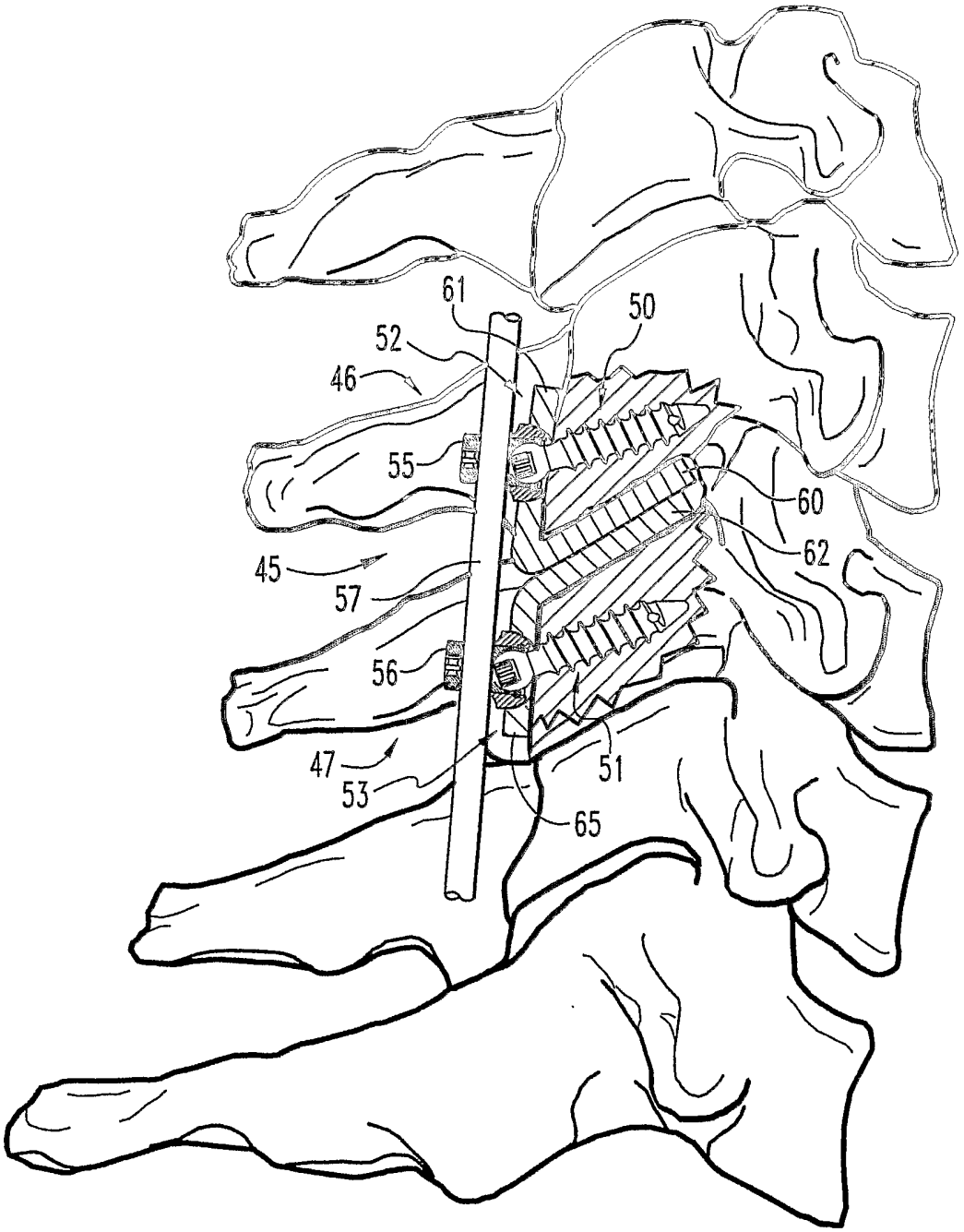

Fig. 2

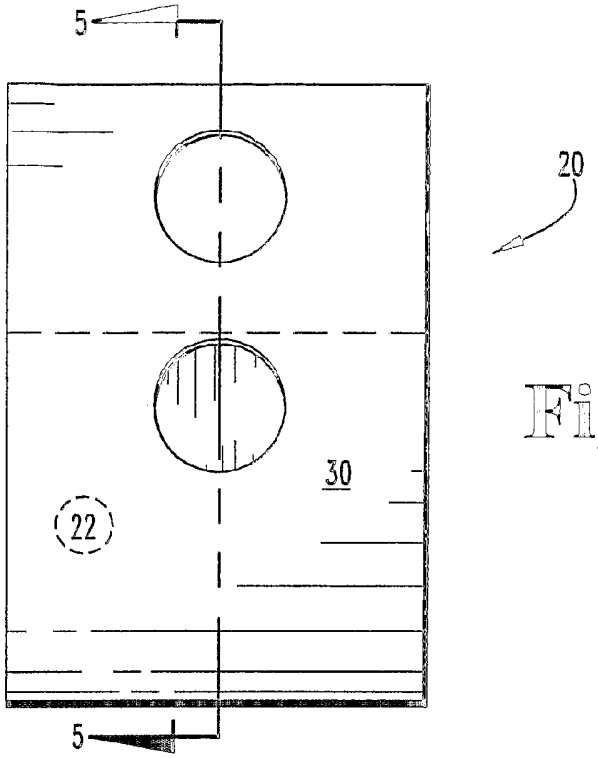

Fig. 3

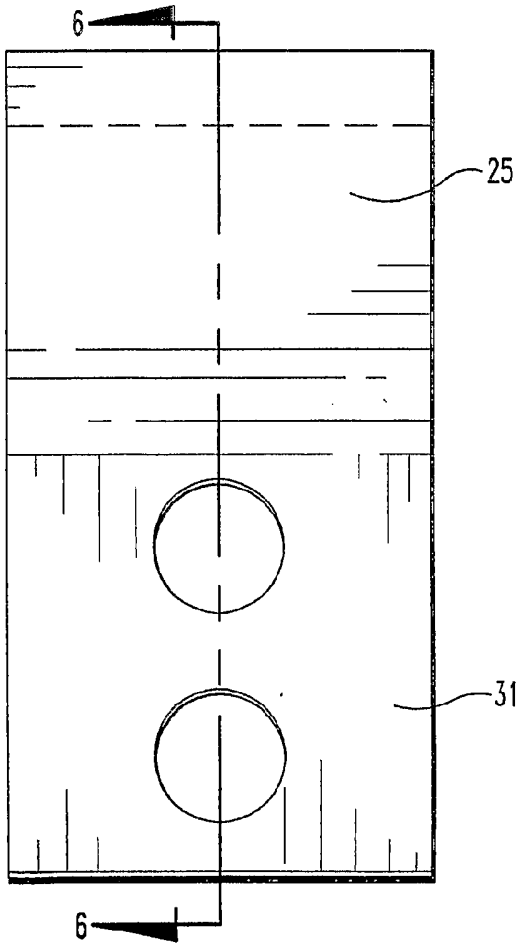

Fig. 4

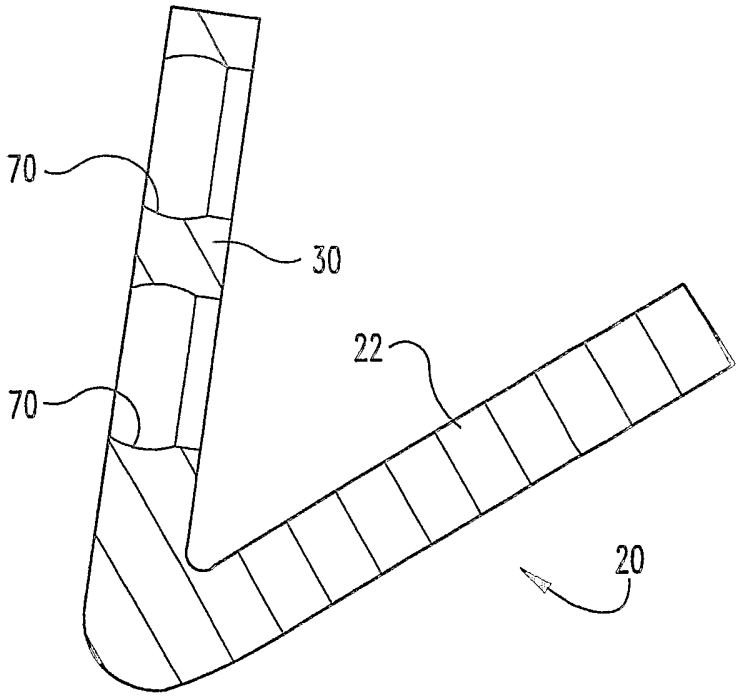

Fig. 5

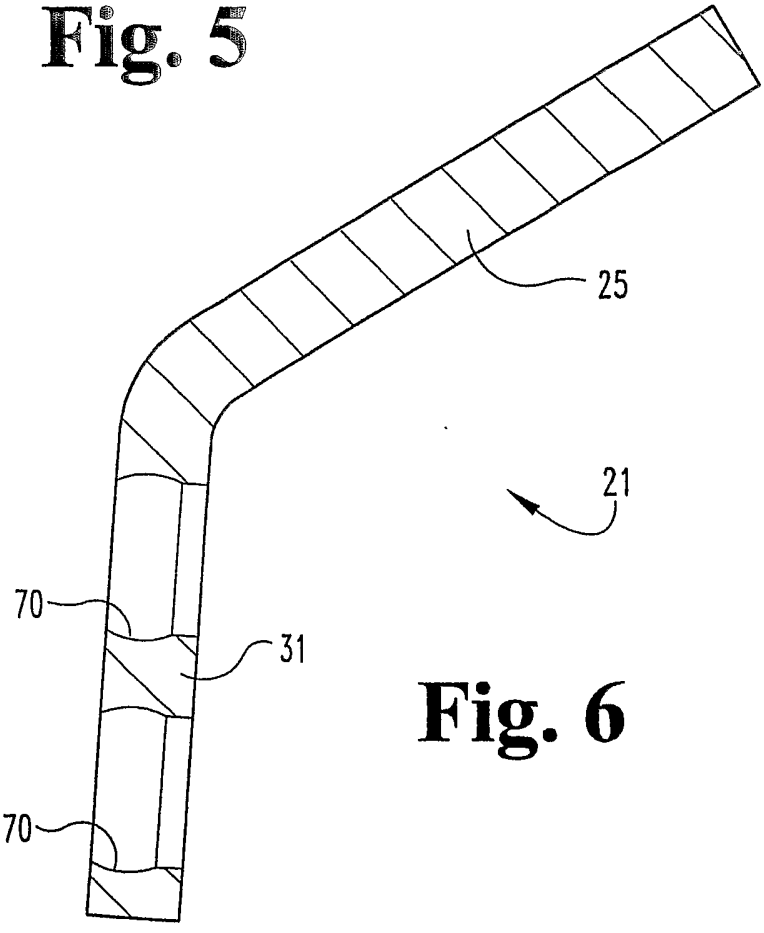

Fig. 6

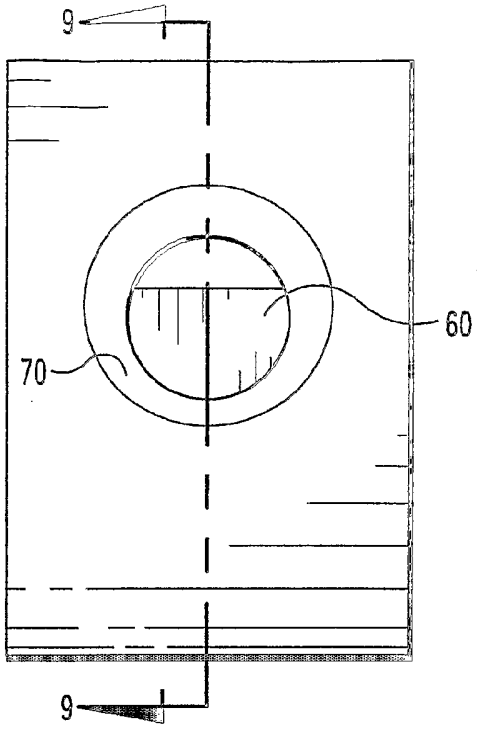

Fig. 7

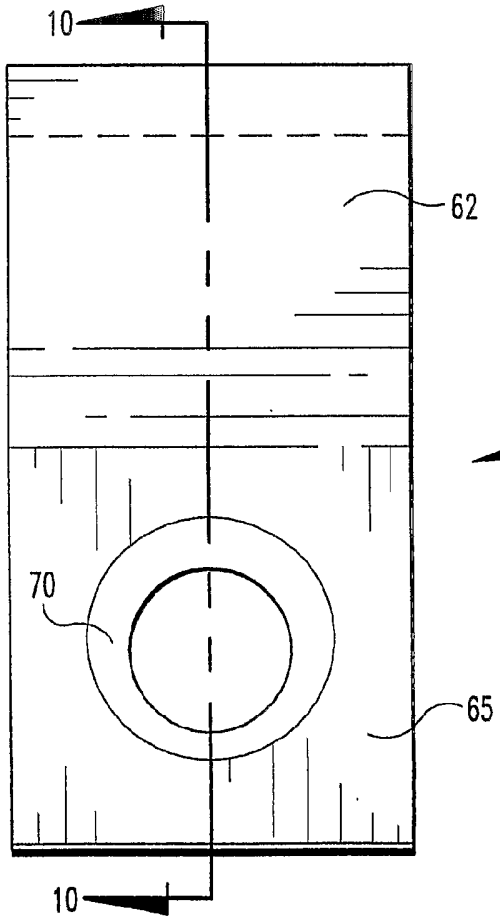

Fig. 8

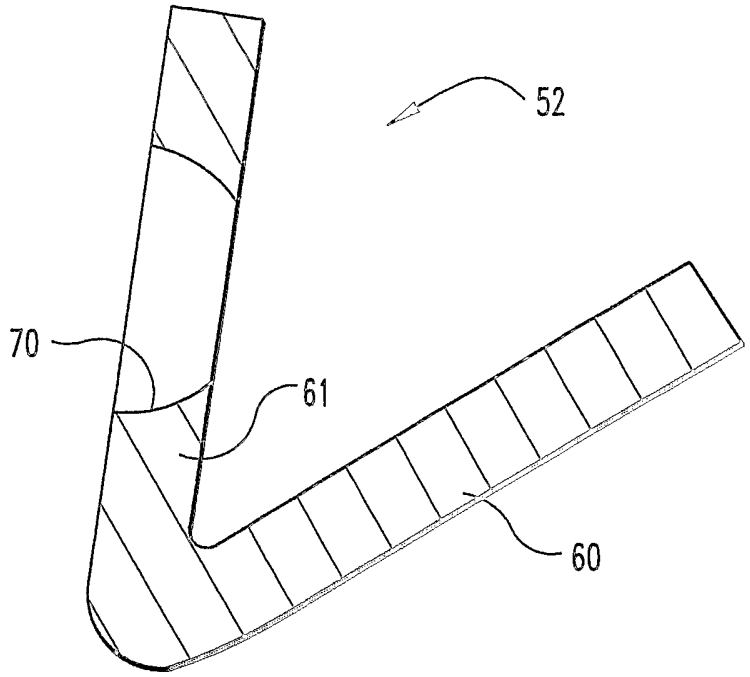

Fig. 9

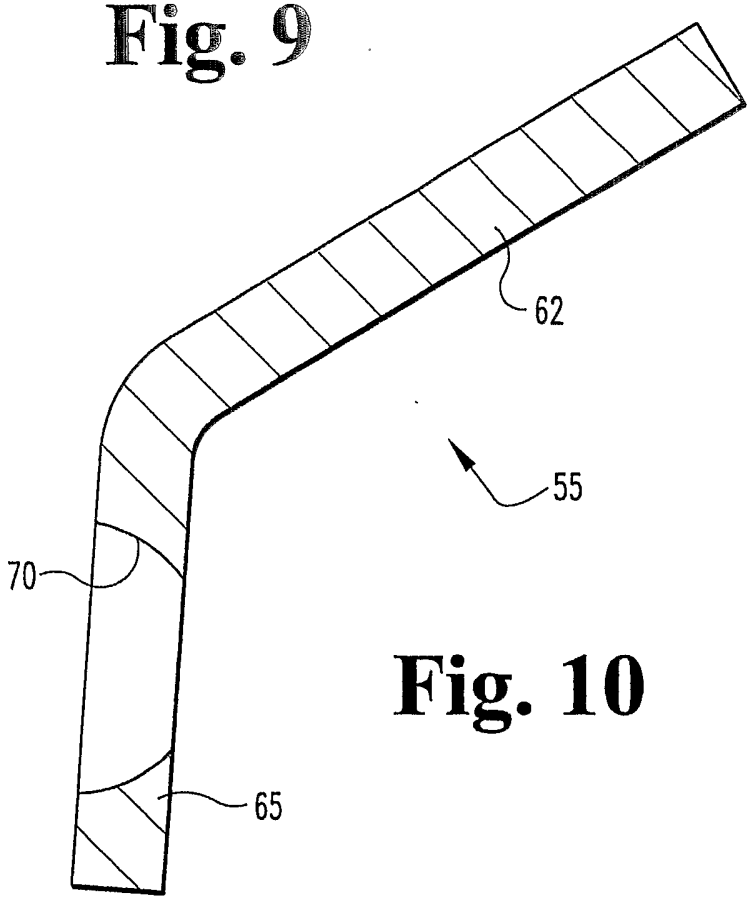

Fig. 10

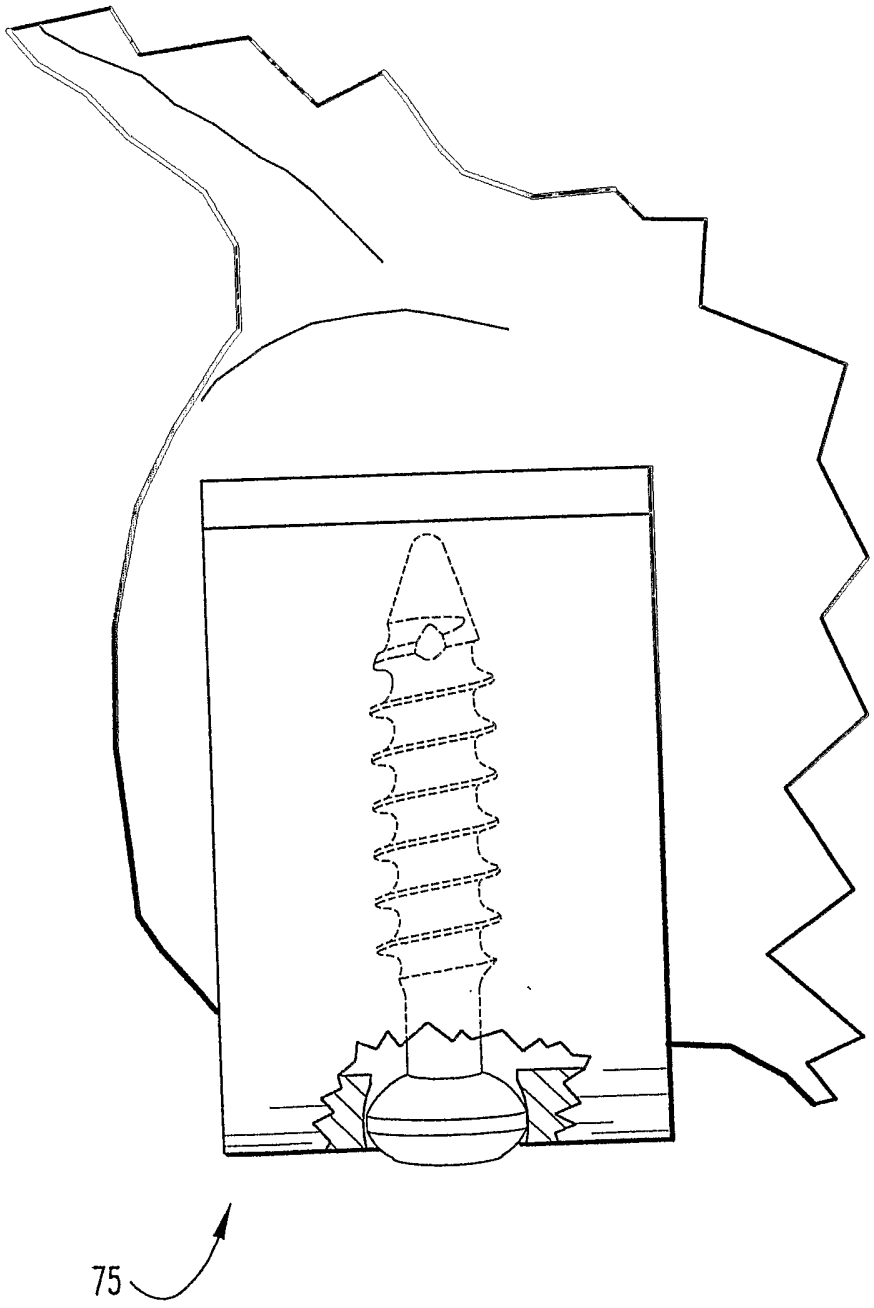

Fig. 11

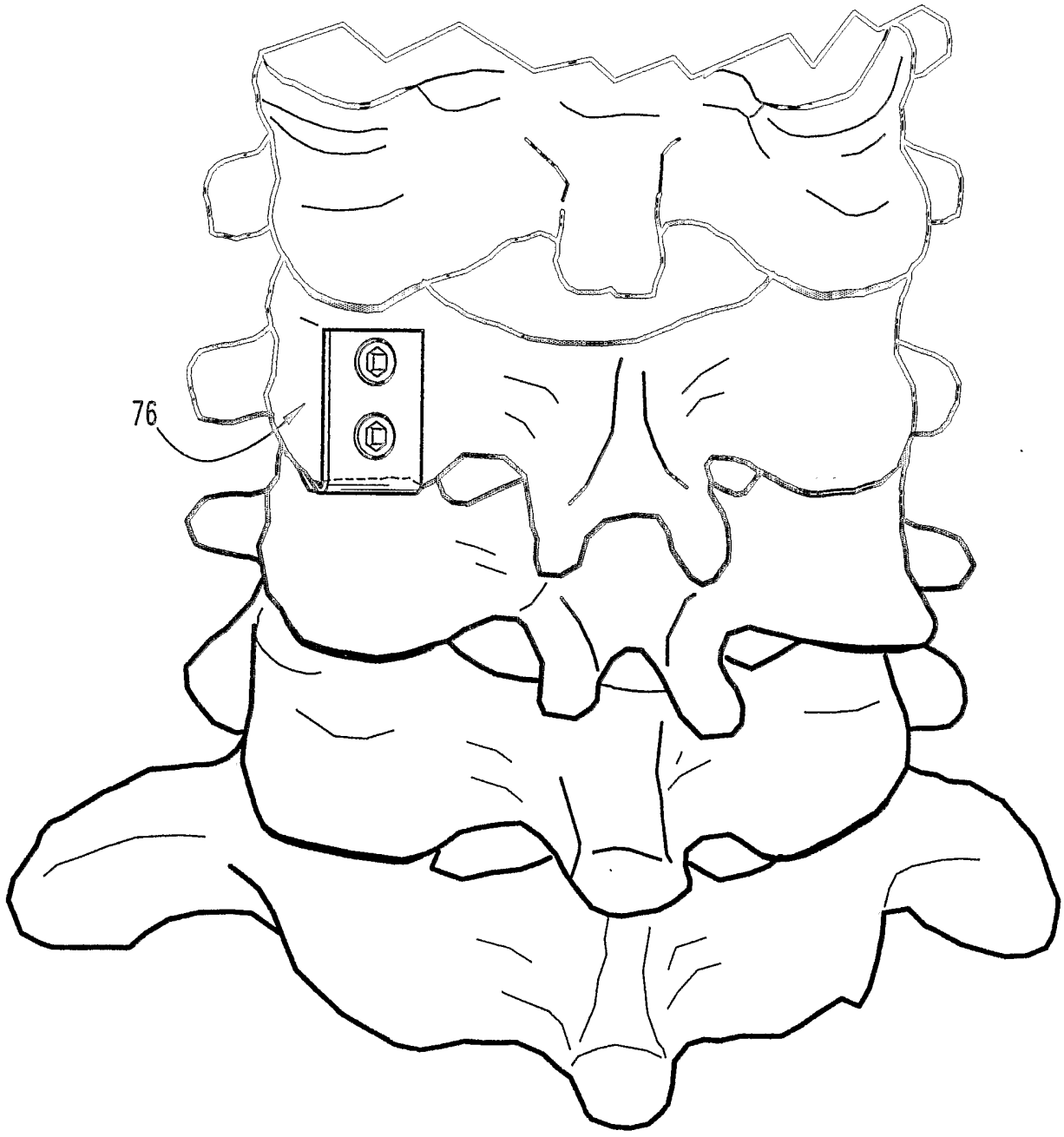

Fig. 12