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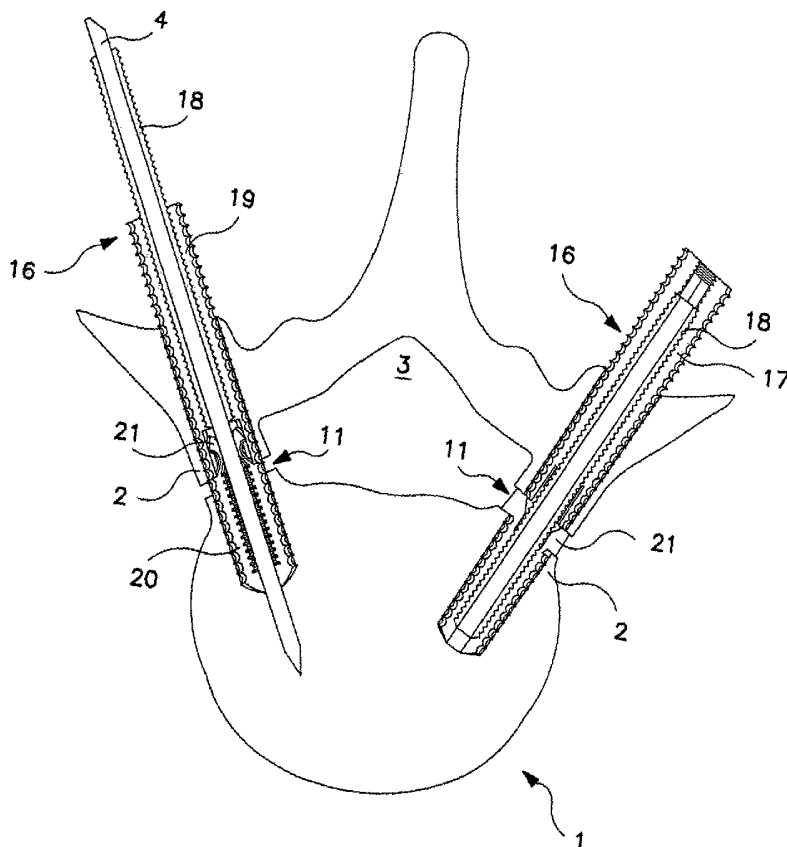
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[Continued on next page]

(54) Title: PERCUTANEOUS TECHNIQUE AND IMPLANT FOR EXPANDING THE SPINAL CANAL



(57) Abstract: The present invention expands a spinal (3) canal by drilling a cylindrical passage (7) in each pedicle (2) of a vertebra (1), making a circumferential pedicle cut (osteotomy) (11) through each pedicle (2) from within the passage (7), separating each pedicle cut (11) by inserting an implant (16) into the passage (7) which distracts the pedicle cut (11) to expand the spinal canal (3), and securing each pedicle cut (11), allowing the vertebra (1) to heal with the spinal canal (3) expanded. The implant (16) includes an outer sleeve (17), an inner bolt (18), and expandable flanges (21). The outer sleeve (17) includes an upper portion (19) and a lower portion (20), with the expandable flanges (21) connected to the lower portion (20) and housed within the upper portion (19). Rotation of the inner bolt (18) causes the upper and lower portions (19, 20) of the outer sleeve (17) to separate, causing the pedicle cut (11) to widen and the expandable flanges (21) to radially extend into and stabilize the widened pedicle cut (11) to effectuate expansion of the spinal canal (3).

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PERCUTANEOUS TECHNIQUE AND IMPLANT FOR EXPANDING THE SPINAL CANAL

Related Inventions

5 This application is a continuation-in-part (CIP) of U.S. Serial No. 09/659,180, filed September 11, 2000 (now U.S. Patent No. 6,358,254), entitled "A Method and Implant for Expanding a Spinal Canal," which is hereby incorporated in its entirety by this reference.

Field Of The Invention

10 The present invention relates generally to spinal surgery, and more particularly to a method and apparatus for expanding a spinal canal to relieve pressure on spinal nerves.

Background Of The Invention

 Spinal Stenosis, or narrowing of the spinal canal, inflicts millions of people
15 with back and leg pain due to compression of spinal nerves. Severe spinal stenosis often leads to surgery in an effort to relieve compressed nerves and lessen back and leg pain. Spinal laminectomy is the traditional operation performed to treat spinal stenosis. In the spinal laminectomy, posterior aspects of the spinal column are removed to "un-roof" the spinal canal to relieve the pressure on the nerves.
20 Specifically, a spinous process, lamina and portions of various facet joints are the posterior aspects of the spinal column surgically excised.

 Although the spinal laminectomy is often successful in relieving pressure on the nerves of the spinal canal, several problems and disadvantages arise as a result of the laminectomy. First, the laminectomy removes important sites of back muscle
25 attachment leading to back muscle dysfunction and pain. Second, the laminectomy

exposes the nerve sac causing scar tissue to form around the nerves. Scar tissue may prevent normal motion of the nerves, leading to recurrent pain. Third, the laminectomy can destabilize the spine resulting in a forward slippage of one vertebra on another. Vertebral slippage can cause recurrent pain and deformity. Fourth, the
5 laminectomy requires a large surgical exposure and significant blood loss, making the laminectomy dangerous for older patients. Finally, spinal stenosis can recur following the laminectomy, requiring risky revision surgery.

Laminectomy risks have led surgeons to seek an alternative for patients with severe spinal stenosis. Some surgeons choose to treat spinal stenosis with multiple
10 laminotomies. Laminotomies involve removing bone and soft tissue from the posterior aspect of the spine making “windows” into the spinal canal over areas of nerve compression. Multiple laminotomies remove less tissue than the laminectomy, resulting in less scarring, vertebral instability and blood loss.

Multiple laminotomies, however, also suffer from problems and
15 disadvantages. Laminotomies may not adequately relieve nerve compression and the pain may continue. Laminotomies are more difficult to correctly perform than the laminectomy. Laminotomies expose the nerves and may cause nerve scarring. Patients receiving multiple laminotomies also often have recurrent spinal stenosis requiring risky revision surgery.

20 For the foregoing reasons, there is a need for different and better methods for relieving the symptoms of spinal stenosis without the drawbacks of currently available techniques. A method is needed that expands the spinal canal, relieving pressure on the spinal nerves, while being simple, safe and permanent.

An initial invention was submitted by the present inventor entitled, "A Method and Implant for Expanding the Spinal Canal" (now U.S. Patent No. 6,358,254). In the original application, a novel technique was disclosed to expand the spinal canal by lengthening the spinal pedicles on both sides of a vertebra resulting in decompression of compressed nerves while maintaining normal anatomic structures and muscle attachments. This disclosure relies on the same principle, namely that lengthening spinal pedicles can relieve the symptoms of spinal stenosis. This disclosure describes a continuation of the prior disclosure whereby the expansion of the spinal canal can be achieved by a percutaneous technique, thus eliminating the need for a larger incision.

10

Summary of the Invention

The present invention provides a simple, safe, permanent, and minimally invasive method and apparatus for treating spinal stenosis by expanding the spinal canal area to provide additional space for the spinal nerves, relieving pressure on the spinal nerves.

15

An object of the present invention is to maintain the integrity of the spinal canal so that the function of normal tissues is not destroyed or significantly altered, which can occur with a laminectomy or laminotomy.

Another object of the present invention is to avoid scarring around spinal nerves by avoiding an open exposure of the nerves.

20

Another object of the present invention is to avoid a procedure causing spinal instability, which occurs when one vertebra slips forward on another vertebra causing recurrent pain and deformity.

Another object of the present invention is to decompress the spinal nerves with a quick, safe approach resulting in minimal blood loss.

Another object of the present invention is to provide a permanent solution to spinal stenosis, where no tendency exists for recurrence.

Another object of the present invention is to achieve decompression of the spinal canal through small percutaneous incisions, rather than a larger incision.

5 In one aspect of the present invention, a method for correcting spinal stenosis is introduced where a spinal canal is enlarged by cutting a vertebra through one or both pedicles, separating the vertebral cut and then stabilizing the cut, allowing the vertebra to heal with the spinal canal expanded, permanently creating more space for the spinal nerves, thus relieving compression on the nerves.

10 In another aspect of the present invention, the method of expanding the spinal canal includes drilling a passage or hollow tunnel into one or both pedicles of a vertebra, making a pedicle cut (osteotomy) from within the passage through to the spinal canal and to the outside of the vertebra, distracting (elongating) the osteotomy to expand the spinal canal, and then stabilizing the osteotomy.

15 In another aspect of the present invention, the method of expanding the spinal canal includes the following steps: first, a guide wire is inserted into a central portion of the vertebral pedicles on each side of a vertebra. This and other method steps can be accomplished with the assistance of x-rays, fluoroscopy, CAT scan or computer assisted image guidance technology, which are well known in the art of spinal
20 surgery.

Second, the guide wire is used to direct the position of a cannulated drill (drill with a central barrel or passage to allow introduction over the guide wire) into each of pedicles to form a passage or hollow tunnel in the central portion of each pedicle. At

the conclusion of this step the pedicles comprise a hollow column of bone having a central passage and thin, cylindrical, bony walls.

Next, the vertebral pedicles are cut circumferentially, forming an upper portion and a lower portion. A side-cutting instrument can be introduced into the central passage in each pedicle to perform the circumferential cut. The side-cutting instrument has a cutting surface that projects radially outward so that the bony walls of each pedicle can be circumferentially cut. With both pedicles circumferentially cut, the vertebra is divided into an upper portion (including the spinous process, lamina, transverse process and articular processes) and a lower portion (including the vertebral body). The side-cutting instrument could include a rotating cutting burr or osteotome (chisel) as the cutting surface, both of which are well known in the art.

Next, each osteotomy (site of the circumferential bone cut) is distracted (expanded). A specially designed implant can be used to distract the osteotomy. In one aspect of the present invention, the implant can include an outer sleeve and an inner bolt in communication with the outer sleeve. Movement of the inner bolt in relation to the outer sleeve widens the osteotomy to expand the spinal canal.

In another aspect of the present invention, the implant can be threadably inserted into the central passage in each pedicle, and can include an outer sleeve divided into an upper and a lower portion; the division of the upper and lower portion being positioned at the site of the bone cut. The implant could also include an inner bolt capable of drawing the upper and lower portions of the outer sleeve apart, each part respectively attaching to the upper or lower portion of the pedicle by exterior threads which grip the bony walls of the pedicle.

The lower portion of the outer sleeve could also include expandable flanges which expand by the action of the inner bolt of the implant, resulting in the flanges being positioned between the drawn apart edges of the cut pedicle. The inner bolt of the implant could ultimately span across the separation between and engage the upper and lower portions of the outer sleeve, allowing secure fixation of the upper and lower portions of the outer sleeve by the action of the inner bolt.

Finally, the pedicle cut is secured in the elongated position, which can be accomplished by the action of the expandable flanges interposed between the cut surfaces of the pedicle and the inner bolt, the inner bolt securing the upper and lower portions of the outer sleeve by crossing the junction between the upper and lower portions of the outer sleeve.

The drawing apart of the upper and lower portions of the pedicles on each side of the spine cause expansion of the spinal canal, achieving pressure relief on the spinal nerves. The implants remains in the elongated pedicles until bony healing of the pedicles occurs, thus creating permanent expansion of the spinal canal and preventing recurrence of the spinal stenosis.

In another aspect of the present invention, the expandable flanges include osteogenic material to assist in the healing of the osteotomy site, allowing the pedicles to heal in the elongated position, thereby permanently expanding the spinal canal.

In another aspect of the current invention, the implant includes a central barrel allowing introduction of the implant over a guide wire.

The present invention has the following advantages over current, unrelated techniques for treating spinal stenosis:

- (1) Normal spine structures are not removed and thus normal muscle attachments are maintained.
- (2) There is less chance of spinal instability.
- (3) There is less manipulation of the spinal nerves.
- 5 (4) There is less scaring around the spinal nerves.
- (5) Spinal decompression is more complete.
- (6) The operation is quicker and safer with less blood loss.
- (7) The expanded spinal canal is permanent, preventing recurrent spinal stenosis.
- 10 (8) The procedure can be accomplished in a percutaneous fashion through very small incisions.

Brief Description Of The Drawings

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is
15 not limited to the precise arrangements and instrumentalities shown.

Fig. 1 illustrates a cross-section of a vertebra with a guide wire passing through a central region of a pedicle;

Fig. 2 illustrates the cross-section of the vertebra of Fig. 1, with a cannulated drill passing over the guide wire and drilling a passage into the central region of the
20 pedicle;

Fig. 3 illustrates the cross-section of the vertebra of Fig. 1, showing a passage (hollow tunnel) in the central region of the pedicle following the cannulated drilling of Fig. 2;

Fig. 4 illustrates the cross-section of the vertebra of Fig. 1, with a side-cutting instrument in the passage in the pedicle performing a cut through an outer bony wall of the pedicle;

Fig. 5 illustrates an enlarged view of Fig. 4, showing a cutting surface of the side-cutting instrument penetrating through the outer bony wall of the pedicle;

Fig. 6 illustrates the cross-section of the vertebra of Fig. 1, with the cutting surface of the side-cutting instrument completing a cut through an inner bony wall of the pedicle to the spinal canal;

Fig. 7 illustrates an enlarged view of Fig. 6, showing the cutting surface of the side-cutting instrument penetrating through the inner bony wall of the pedicle to the spinal canal;

Fig. 8 illustrates the cross-section of the vertebra of Fig. 1, with a completed circumferential cut through the pedicle, separating the pedicle into upper and lower portions;

Fig. 9 illustrates the cross-section of the vertebra of Fig. 1, with completed circumferential cuts through both pedicles, separating the vertebra into upper and lower portions;

Fig. 10 illustrates a cross-section of an implant used to elongate and stabilize the pedicles, the implant shown in an extended, pre-elongating position;

Fig. 11 illustrates a cross-section of the implant of Fig. 10 in a pedicle elongating position;

Fig. 12 illustrates the cross-section of the vertebra of Fig. 1, with the implant inserted into the passage of each pedicle, the implant inserted in the left pedicle

shown in the extended, pre-elongating position and the implant inserted in the right pedicle shown in the pedicle elongating position;

Fig. 13 illustrates an enlarged view of the left pedicle of Fig. 12, showing the implant inserted in the passage in an extended, pre-elongating position and aligned in
5 the passage to begin pedicle elongation;

Fig. 14 illustrates an enlarged view of the right pedicle of Fig. 12, showing the implant inserted in the passage in a pedicle elongating position, with expandable flanges of the implant filling and securing a widened circumferential cut in the pedicle after pedicle elongation.

10

Detailed Description of the Invention

Referring now to the drawings, where like numeral indicate like elements, there is shown in Fig. 1 a cross section of a vertebra 1 having a vertebral body 5, spinal canal 3 and pedicles 2. Also shown is a guide wire 4 inserted into a central portion of the left pedicle 2 to enter the vertebral body 5.

15

Fig. 2 illustrates the cross section of the vertebra 1 of Fig. 1, showing a cannulated drill 6 passing over the guide wire 4, drilling a passage in the central portion of the left pedicle 2 but leaving intact outer wall 23 of the left pedicle 2.

20

Fig. 3 illustrates the cross section of the vertebra 1 of Fig. 1 following completion of the drilling procedure of Fig. 2, showing a passage 7, or hollow tunnel, spanning the central portion of the left pedicle 2, leaving intact an outer bony wall 23 of the left pedicle 2.

Fig. 4 illustrates the cross section of the vertebra 1 of Fig. 1 with a side-cutting instrument 8 within the passage 7 of the left pedicle 2. The side-cutting instrument 8 has an opening 9 which allows a cutting surface 10 to pass radially outward from a

longitudinal center of the side-cutting instrument 8. The cutting surface 10 is seen penetrating the outer bony wall 23 of the left pedicle 2.

Fig. 5 illustrates an enlarged view of the cross section of the vertebra 1 of Fig. 1, showing the side-cutting instrument 8 within the passage 7 of the left pedicle 2. The cutting surface 10 is passing radially outward from the side-cutting instrument 8 and penetrating the outer wall 23 of the left pedicle 2. The cutting surface 10 of the side-cutting instrument 8 is capable of extended and withdrawing in such a way that it can penetrate through the bony wall 23 of the left pedicle 2. By extending and withdrawing the cutting surface 10, and turning the side-cutting instrument 8 within the passage 7, exposing the opening 9 and the cutting surface 10 to pedicle wall material, the side-cutting instrument 8 can create a circumferential cut (an osteotomy) through the left pedicle 2, separating the left pedicle into two portions, an upper portion and a lower portion.

Fig. 6 illustrates a cross-section of the vertebra 1 of Fig. 1 with the cutting surface 10 of the side-cutting instrument 8 extended and penetrating an inner wall 24 (along the spinal canal 3) of the left pedicle 2, creating a cut through to the spinal canal 3.

Fig. 7 illustrates an enlarged view of the cross section of the vertebra 1 of Fig. 1, showing the side-cutting instrument 8 within the passage 7 of the left pedicle 2. The cutting surface 10 is passing radially outward from the side-cutting instrument 8, penetrating the inner bony wall 24 of the left pedicle 2 through to the spinal canal 3.

Fig. 8 illustrates a cross section of the vertebra 1 of Fig. 1 with a completed circumferential cut (an osteotomy) 11 through the left pedicle 2, separating the left pedicle 2 into an upper portion 12 and a lower portion 13.

Fig. 9 illustrates a cross section of the vertebra 1 of Fig. 1, with passages 7 drilled in both the left and right pedicles 2 and circumferential cuts 11 in the midportions of both pedicles 2. The circumferential cuts 11 divide the pedicles 2 into upper portions 12 and lower portions 13 in such a way that upper portion 14 and
5 lower portion 15 of the vertebra 1 are completely detached.

Fig. 10 illustrates a cross section of an implant 16 used to elongate the pedicles 2, thereby widening the circumferential cut 11 and expanding the spinal canal 3. The implant 16 also secures the pedicles 2 in an elongated position. The implant 16 is shown in an extended, pre-elongating position.

10 The implant 16 includes an outer sleeve 17 and an inner bolt 18. The outer sleeve 17 is both externally and internally threaded. The inner bolt 18 is externally threaded to engage the internal threads of the outer sleeve 18. The outer sleeve 17 is divided into an upper portion 19 and a lower portion 20. The upper portion 19 and lower portion 20 of the outer sleeve 17 are divided at separation point 25.

15 The lower portion 20 contains expandable flanges 21 which fit into the upper portion 19 of the outer sleeve 17 (as shown in Fig. 10) when in an extended, pre-elongating position. The inner bolt 18 includes a central barrel 22, allowing pass-through of a guide wire 4 (shown in Fig. 10) to assist in correctly aligning the implant 16 within the passage 7 in the pedicle 2. In the extended, pre-elongating position, the
20 inner bolt 18 of the implant 16 is partially housed within the outer sleeve 17. A proximal end 26 of the inner bolt 18 contacts the expandable flanges 21 of the lower portion 20 of the outer sleeve 17. The proximal end 26 of the inner bolt 18 is designed to not only contact the expandable flanges, but also to wedge itself under a

reveal 27 formed due to the flared designed of an upper tip of the expandable flanges 21.

Fig. 11 illustrates the implant 16 of Fig. 10 in a pedicle elongating position. The inner bolt 18 is fully inserted into the outer sleeve 17. By fully and threadably inserting the inner bolt 18 into the outer sleeve 17, the lower portion 20 of the outer sleeve 17 moves away from the upper portion 19 of the outer sleeve 17, at separation point 25, causing overall elongation of the outer sleeve 17. The expandable flanges 21 of the lower portion 20 of the outer sleeve 17 are opened (expanded) to extend beyond the outer diameter of the outer sleeve 17. In the pedicle elongating position, the expandable flanges 21 lie within the separation between the upper 19 and lower 20 portions of the outer sleeve 17. The upper 19 and lower 20 portions of the outer sleeve 17 are secured in the elongated position by the inner bolt 18, which is threaded across the junction (separation) between the upper 19 and lower 20 portions of the outer sleeve 17, securing the upper 19 and lower 20 portions in the pedicle elongating position.

Fig. 12 illustrates a cross section of the vertebra 1 of Fig. 1, showing the implant 16 inserted into the right and left pedicles 2. The right pedicle 2 includes an implant 16 in a pedicle elongating position, while the left pedicle 2 includes an implant in an extended, pre-elongating position. Note that Fig. 12 shows the right pedicle 2 elongated and the left pedicle in a pre-elongating state. The right, elongated pedicle 2 causes an asymmetrical tilt to the upper portion 14 of the vertebra 1 in the Fig. 12 view, which is balanced upon elongation of the right pedicle 2. Also note the alignment of the separation point 25, in relation to the circumferential cut 11, of the extended implant 16 in the left pedicle 2.

Fig. 13 illustrates an enlarged view of the vertebra 1 of Fig. 1, showing the implant 16 of Fig. 12 inserted into the left pedicle 2 in an extended, pre-elongating position. The implant 16 is inserted over the guide wire 4 to ensure correct alignment of the implant 16 within the passage 7. In the extended, pre-elongating position, the expandable flanges 21 are housed within the upper portion 19 of the outer sleeve 17. The proximal end 26 of the inner bolt 18 contacts the upper tip of the expandable flanges 21. The separation point 25 is positioned adjacent to an upper edge 28 of the circumferential cut (osteotomy) 11.

Fig. 14 illustrates an enlarged view of the vertebra 1 of Fig. 1, showing the implant 16 of Fig. 12 inserted into the right pedicle 2 in a pedicle elongating position. The inner bolt 18 has been threadably inserted completely into the outer sleeve 17, causing the upper portion 19 and the lower portion 20 of the outer sleeve 17 to separate, further causing the expandable flanges 21 to open, extending beyond the confines of the outer sleeve 17 and into the circumferential cut 11 of the pedicle 2. The expandable flanges 21, projecting into the circumferential cut 11, prevents the upper portion 12 and the lower portion 13 of the pedicle 2 from moving (shortening) back to their original, non-elongated position.

In operation, one method for expanding the spinal canal is summarized as follows: first, the guide wire 4 is placed into the central portion of the pedicle 2 of the vertebra 1 (Fig. 1). Assistance with the entire procedure (operation) could be obtained through fluoroscopy, x-ray, CAT scan or computerized image guided technology, which are all well known in the art of spinal surgery.

Next, the guide wire 4 is over drilled with a cannulated drill 6, leaving a passage (hollow tunnel) 7 through the central portion of the pedicle 2 but leaving the

outer walls 23 intact (Fig. 2). The cannulated drill 6 is then withdrawn, leaving the guide wire 4 in place (Fig. 3).

Next, a circumferential cut (osteotomy) 11 is placed in the pedicle 2 (Fig's. 4-7), using a side-cutting instrument 8 inserted into the passage 7 in the pedicle 2. The side-cutting instrument 8 includes a cutting surface 10, which is extended and withdrawn from a side opening 9 in the side-cutting instrument 8. By extending the cutting surface 10 through the side opening 9 in the side-cutting instrument 8 and turning the side-cutting instrument 8 within the passage 7 of the pedicle 2, the entire pedicle 2 is divided in a circumferential fashion, creating the circumferential cut (osteotomy) 11 (Fig. 8). With both pedicles 2 cut, the upper portion 14 and the lower portion 15 of the vertebra 1 are separated, with no bony material left holding the upper 14 and lower 15 portions together (Fig. 9).

Next, the pedicles 2 are elongated at the site of the circumferential cut 11 using the implant 16 (Fig's. 10-14). The implant 16, in an extended, pre-elongating state, is first threadably inserted into the pedicle 2 using the guide wire 4 to assist the implant 16 into the correct position (left pedicle 2 of Fig. 12). Following insertion of the extended implant 16, the guide wire 4 is removed.

The extended implant 16 is positioned within the passage 7 of the pedicle 2 to align the upper edge 28 of the circumferential cut 11 with the demarcation (separation point 25) between the upper 19 and the lower 20 portions of the outer sleeve 17 (Fig. 13). This precise alignment is not critical, however, as placement of the separation point 25 of the outer sleeve 17 within the boundaries of the circumferential cut 11 is sufficient.

The inner bolt 18 of the implant 16 is then threaded into the outer sleeve 17 causing the upper 19 and the lower 20 portions of the outer sleeve 17 to move apart. Because the exterior threads of the upper 19 and the lower 20 portions of the outer sleeve 17 have a good mechanical purchase of the bone of the upper 12 and the lower 13 portions of the pedicle 2, the pedicle is elongated a few millimeters (by a widening of the circumferential cut 11) as the upper 19 and the lower 20 portions of the outer sleeve 17 are drawn apart. The upper portion 19 of the outer sleeve 17 may need to be held motionless to assure that the upper 19 and the lower 20 portions of the outer sleeve 17 begin moving apart.

During rotation of the inner bolt 18, the proximal end 26 of the inner bolt 18 pushes against the upper tip of the expandable flanges 21, causing the upper 19 and the lower portions 20 of the outer sleeve 17 to separate until the expandable flanges 21 clear the lower edge of the upper portion 19 of the outer sleeve 17. When the expandable flanges 21 are no longer contained within the upper portion 19 of the outer sleeve 17, the proximal end 26 of the inner bolt 18 wedges itself under the reveal 27 (Fig's 10 –11) formed by the upper tip of the expandable flanges 21, pushing the expandable flanges 21 radially outward due to the force exerted by the inner bolt 18. The radial expansion of the expandable flanges 21 allows the inner bolt 18 to travel behind the radially extended expandable flanges 21 and threadably engage the internal threads of the lower portion 20 of the outer sleeve 17 (Fig. 14). The inner bolt is now threadably attached to the upper 19 and the lower 20 portions of the outer sleeve 17, thereby mechanically holding the expandable flanges 21 in an open, radially extended position within the circumferential cut 11, locking the upper 19 and the lower 20 portions of the outer sleeve 17 together, and securing the pedicle 2 in an

elongated position (with widened circumferential cut 11) to provide an expanded spinal canal (Fig. 14).

An identical procedure is followed for the pedicles of both the right and the left side of the vertebra 1. To assist with pedicle healing at the circumferential cut 11,
5 the expandable flanges 21 could be made of, or include, an osteogenic material to promote bone healing across the site of the pedicle 2 elongation.

These and other advantages of the present invention will be apparent to those skilled in the art from the foregoing specification. Accordingly, it will be recognized by those skilled in the art that changes or modifications may be made to the
10 above-described embodiments without departing from the broad inventive concepts of the invention. It should therefore be understood that this invention is not limited to the particular embodiments described herein, but is intended to include all changes and modifications that are within the scope and spirit of the invention.

Claims

What is claimed is:

1. A method for expanding a spinal canal, comprising:
cutting a vertebra through to the spinal canal in at least one location;
widening each vertebral cut to expand the spinal canal; and
securing each separated vertebral cut to allow the vertebra to heal with the spinal canal expanded.
2. An implant for expanding a spinal canal, comprising:
an outer sleeve;
an inner bolt in communication with the outer sleeve, wherein movement of the inner bolt in relation to the outer sleeve widens a vertebral cut to expand the spinal canal.

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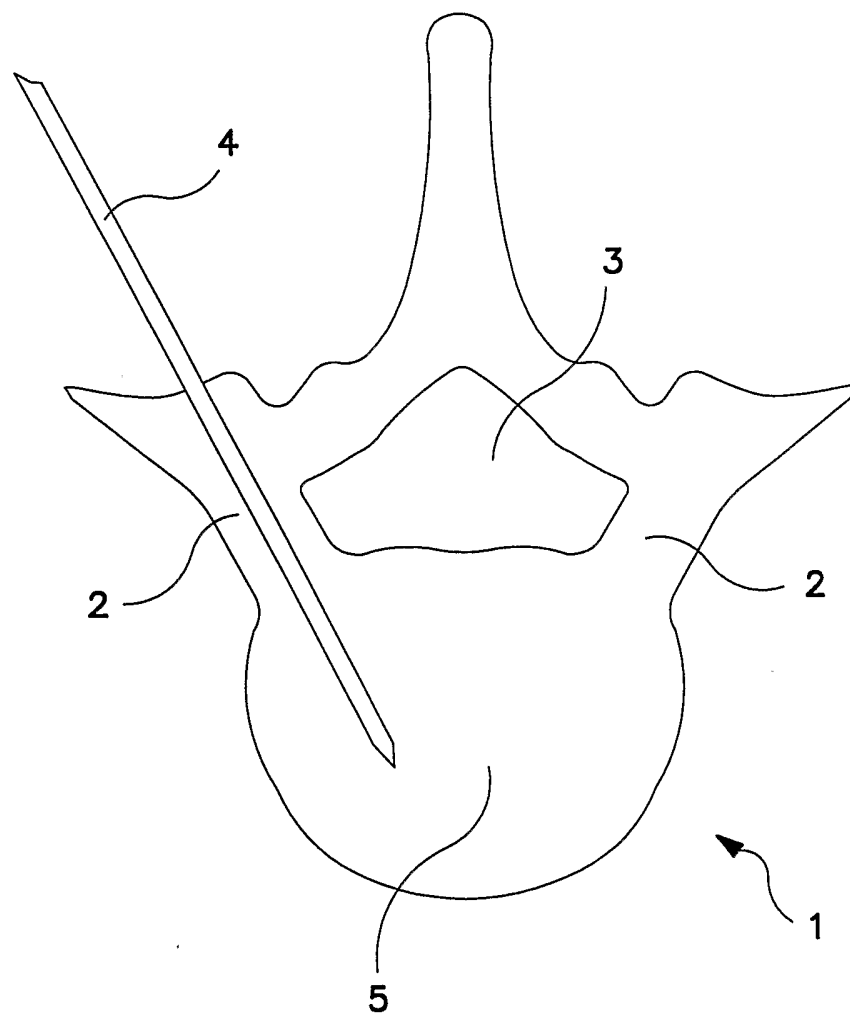


FIG. I

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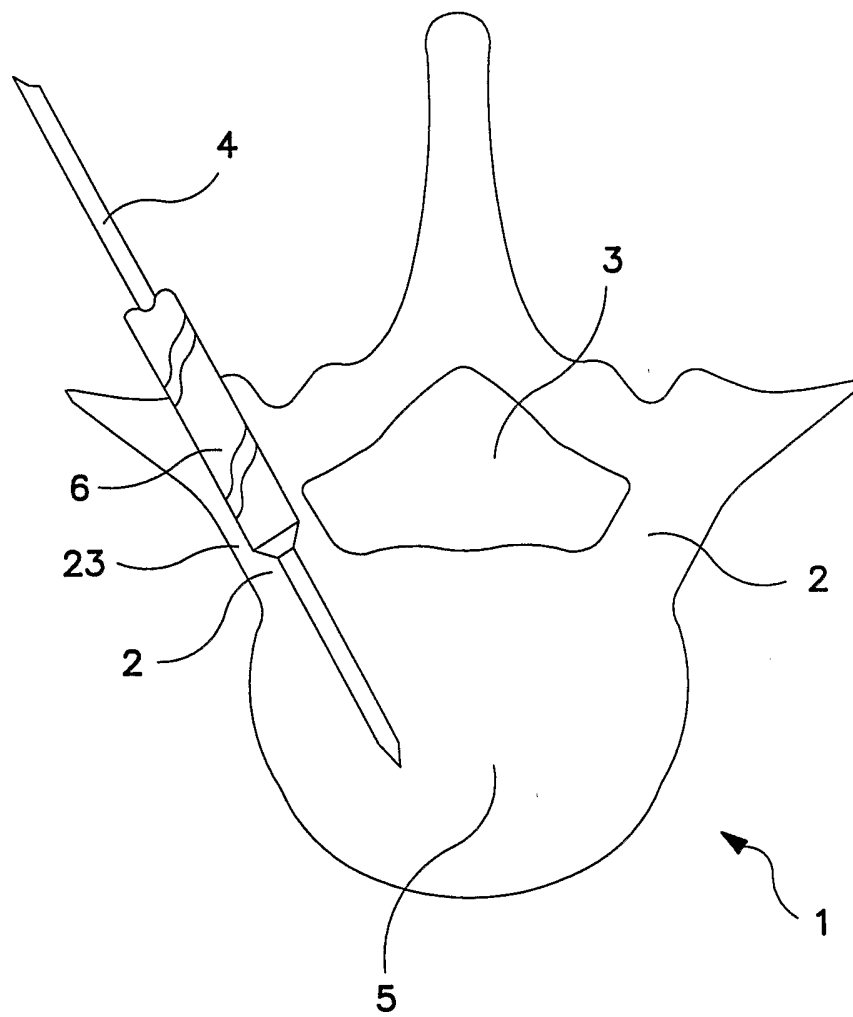


FIG. 2

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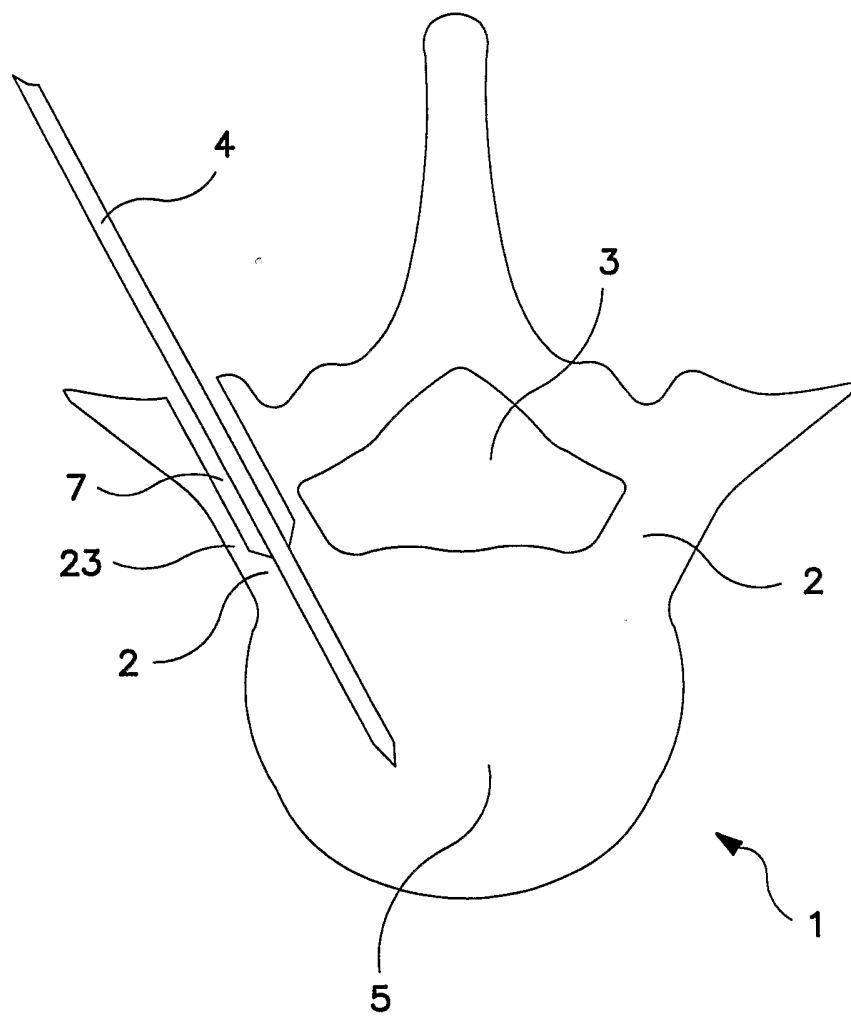


FIG. 3

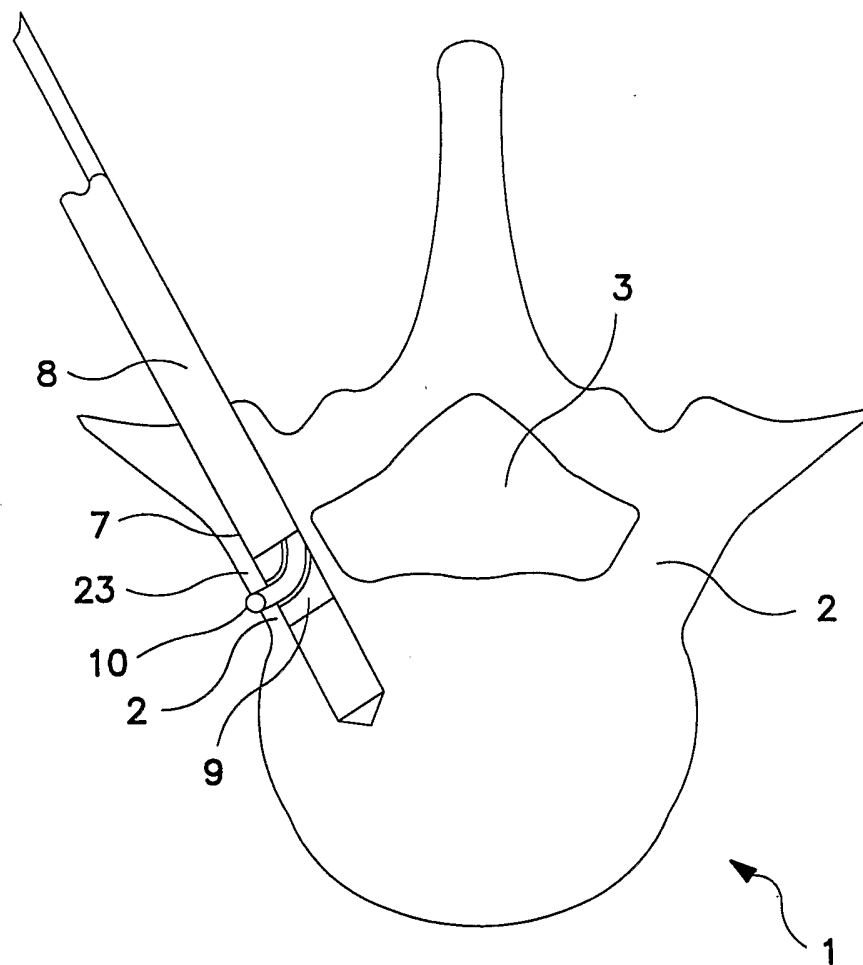


FIG. 4

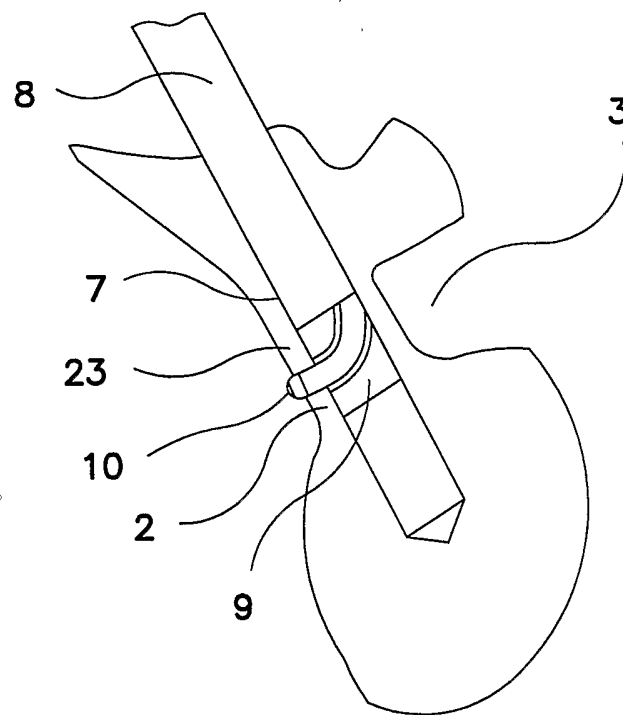


FIG. 5

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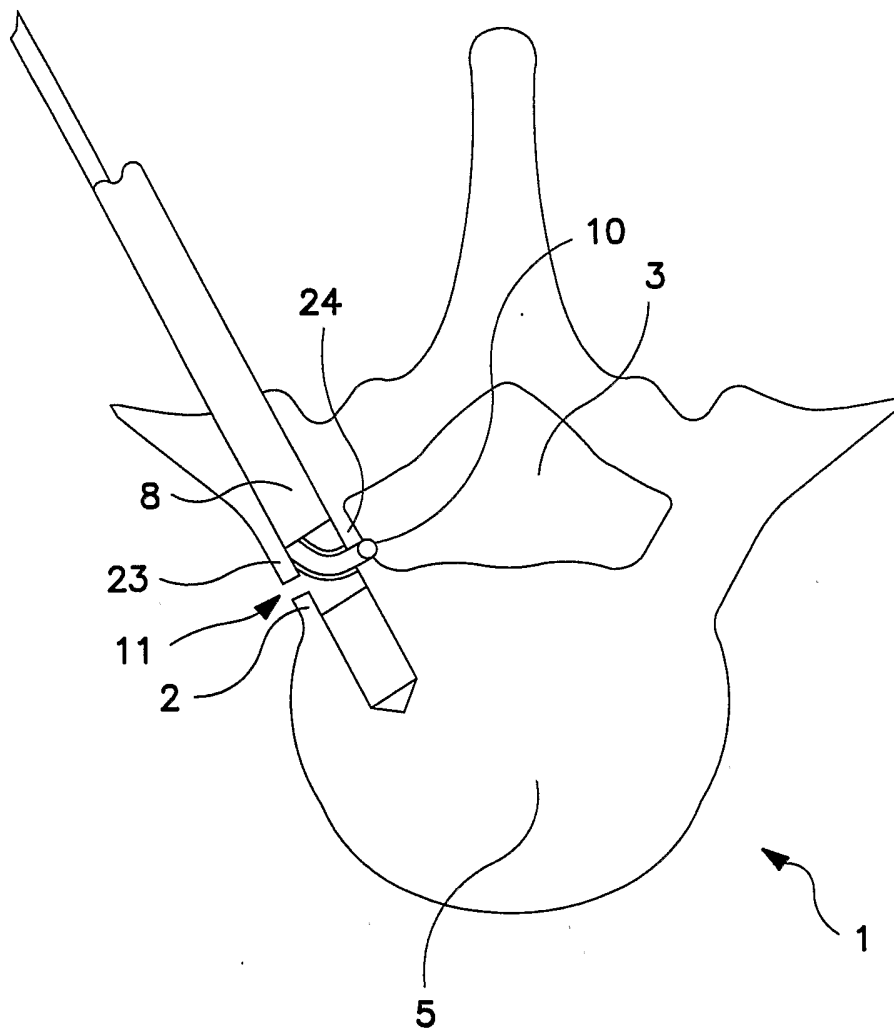


FIG. 6

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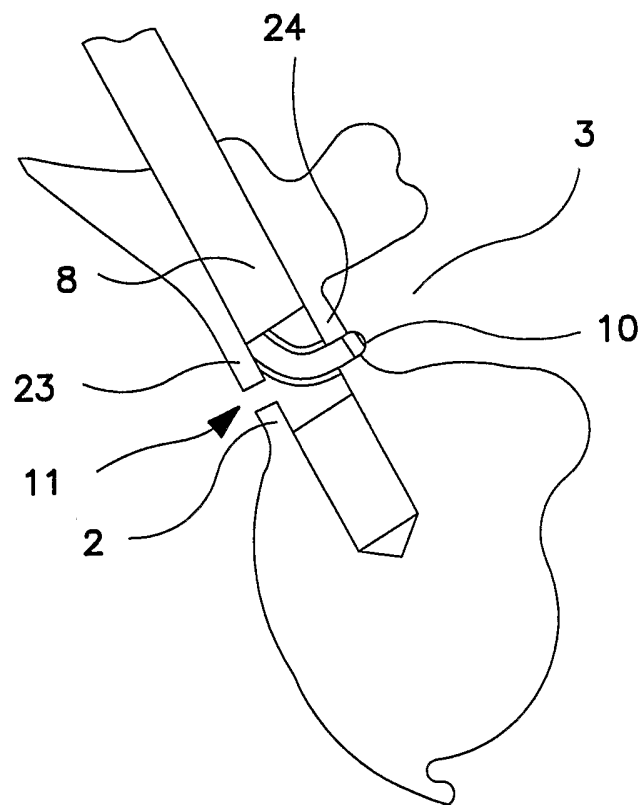


FIG. 7

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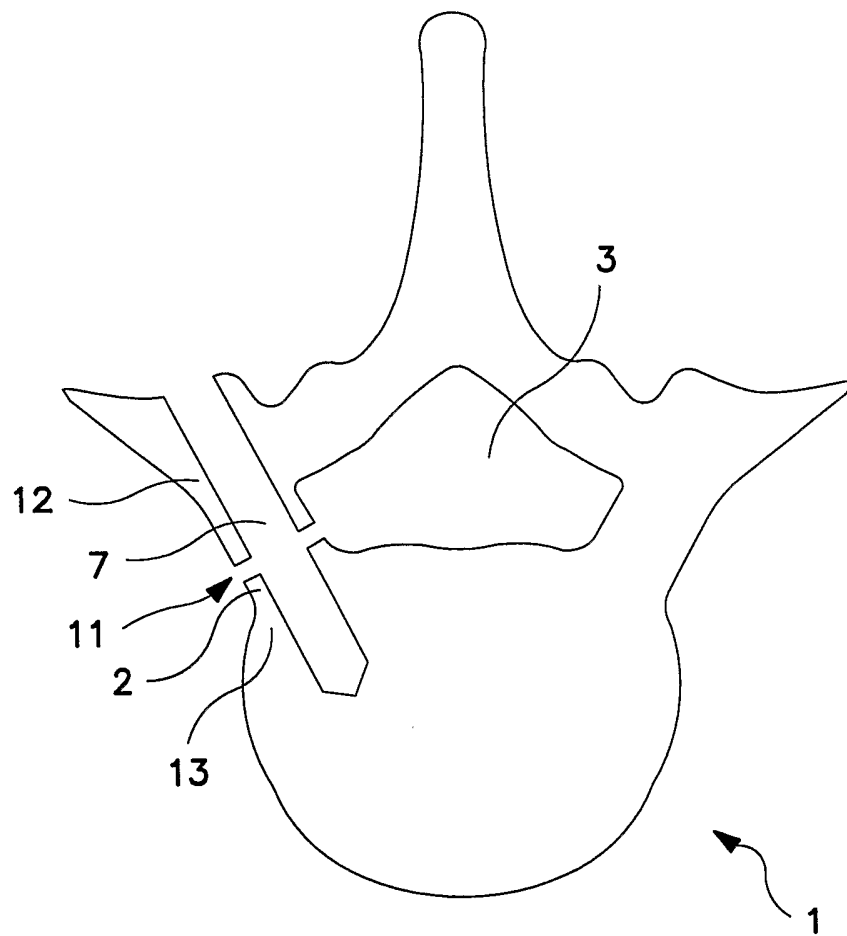


FIG. 8

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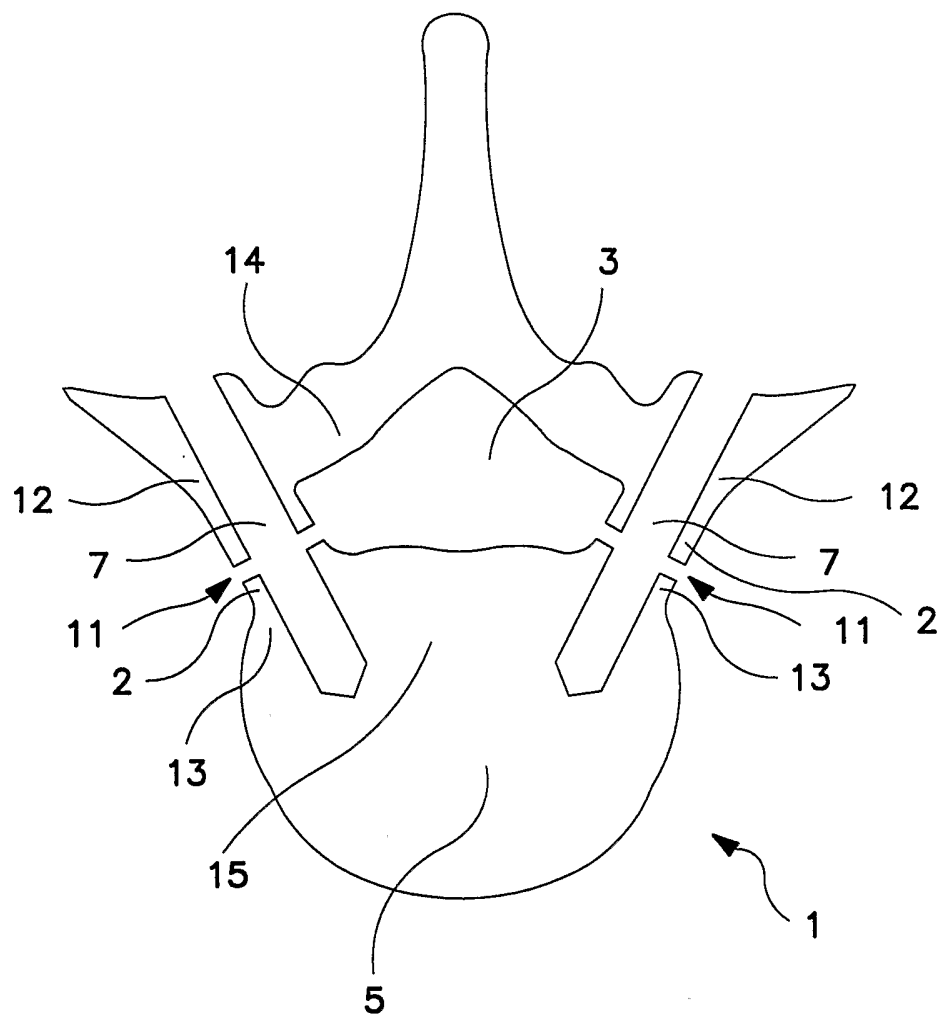


FIG. 9

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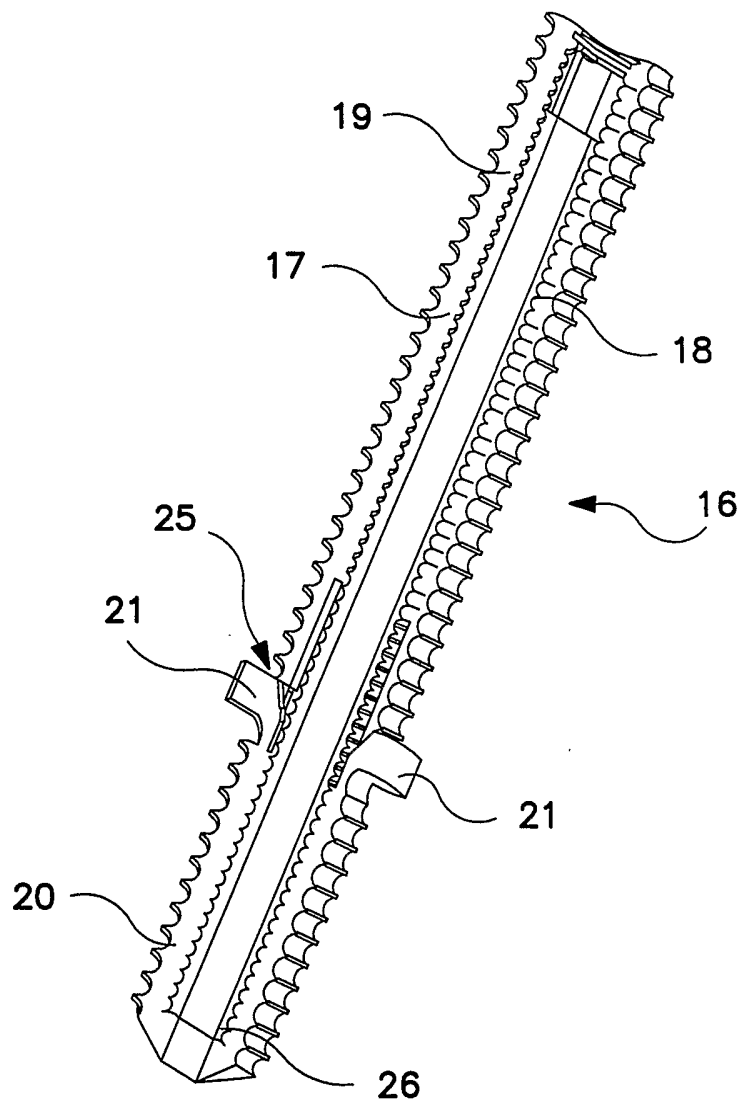


FIG. 11

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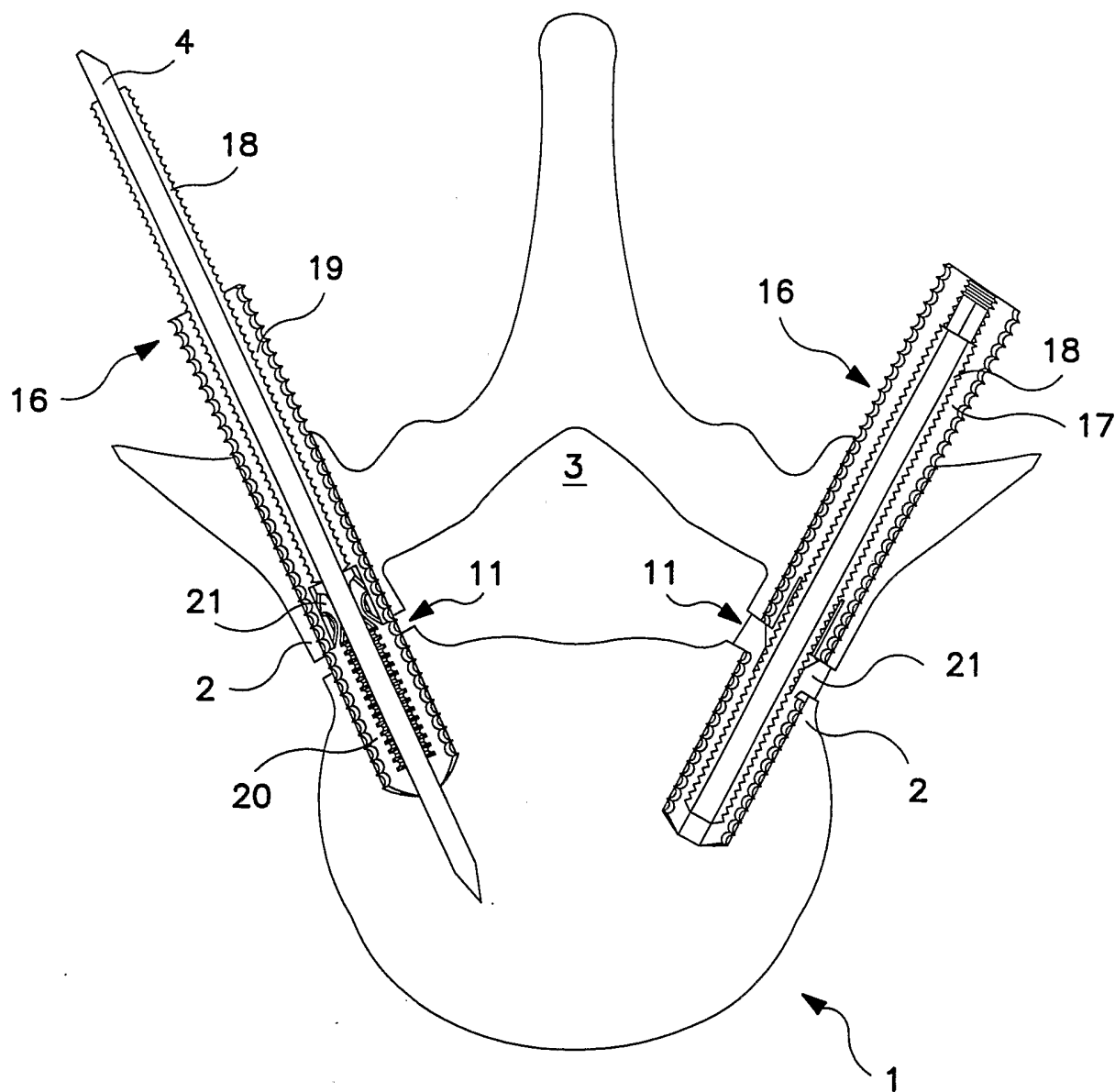


FIG. 12

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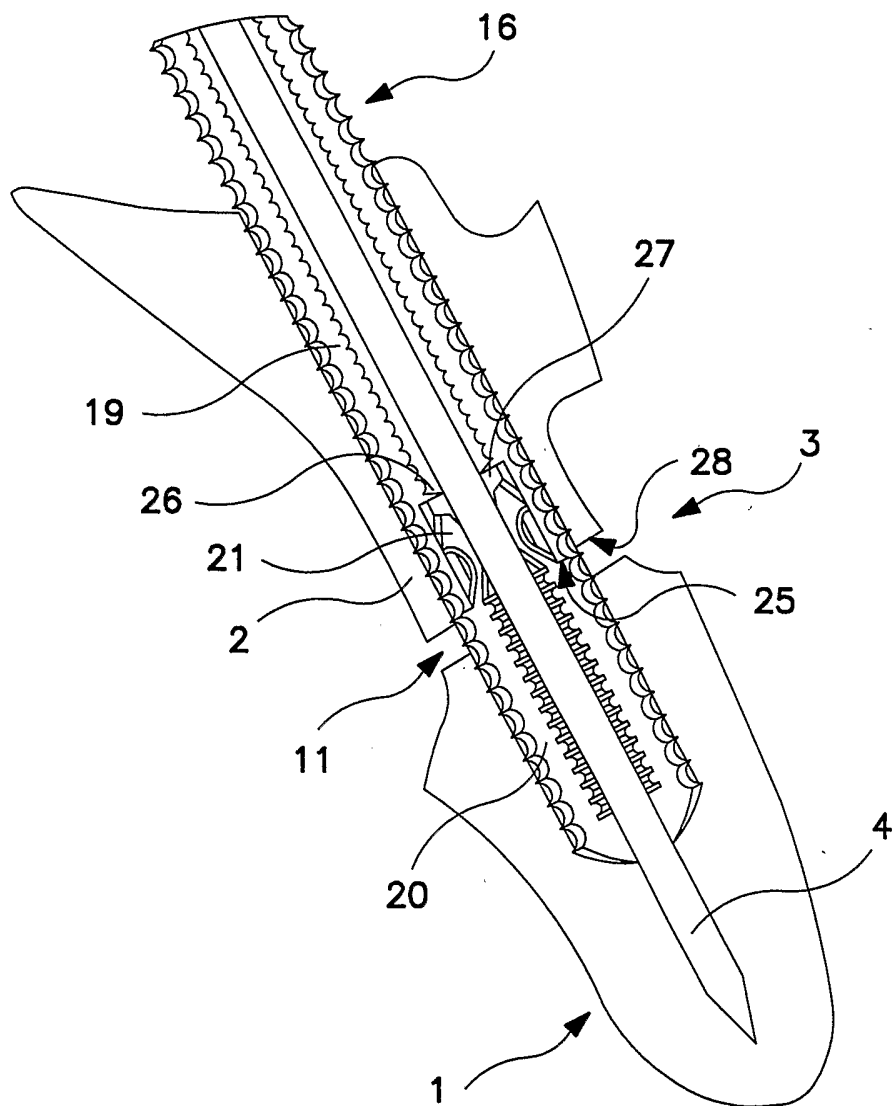


FIG. 13

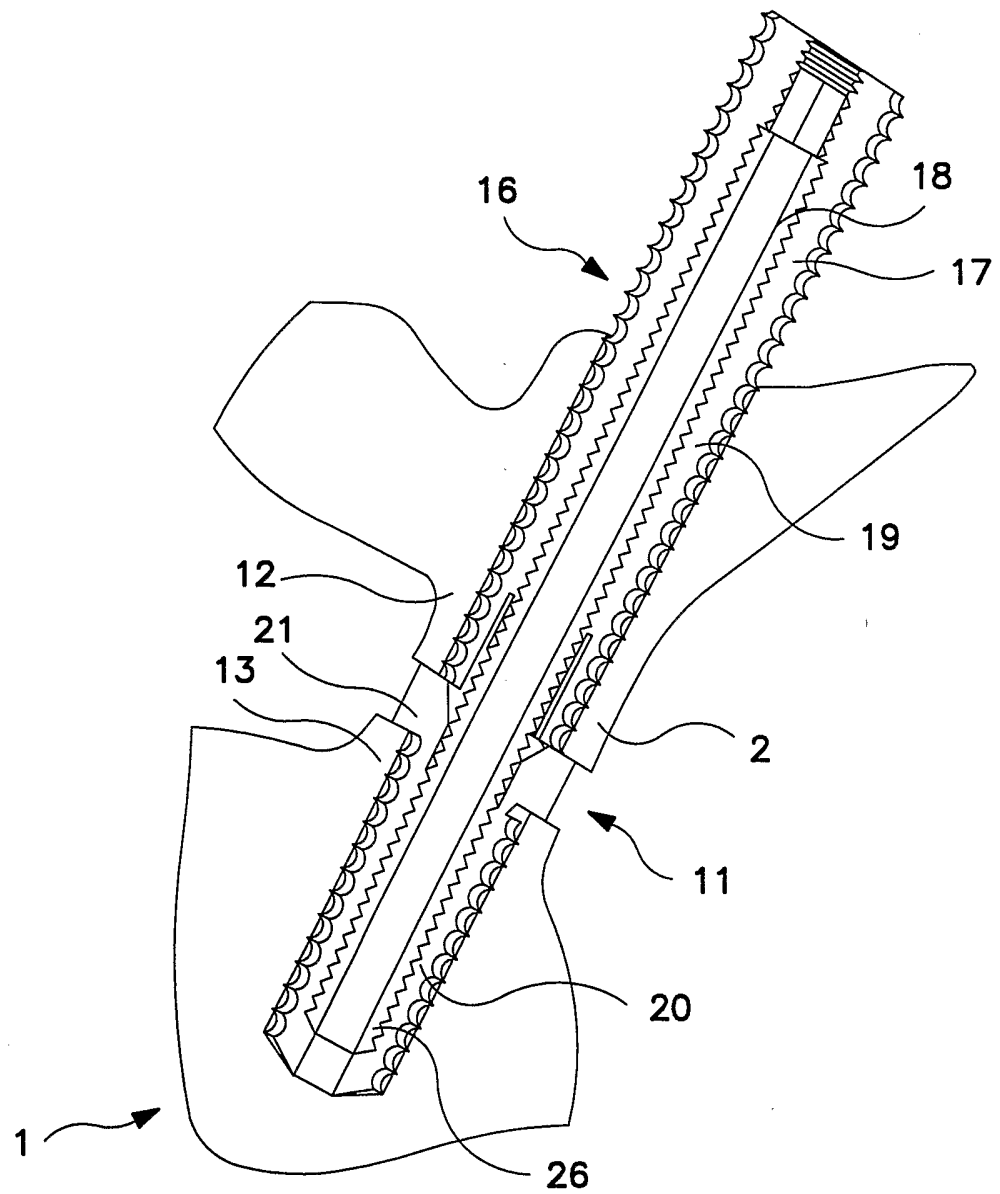


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/08565

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61B 17/70
US CL : 606/63

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)
U.S. : 606/63, 61, 73, 84, 96, 105; 623/17.11, 17.16; 411/55, 71, 80.1, 80.6

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 practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,034,011 A (HOWLAND) 23 July 1991 (23.07.1991), column 1, lines 54-56 and 64-68.	1
X	US 5,827,285 A (BRAMLET) 27 October 1998 (27.10.1998), Figures 7 and 8 and column 7, lines 26-29.	2

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

☐ See patent family annex.

Special categories of cited documents:	
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"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

01 June 2003 (01.06.2003)

Date of mailing of the international search report

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