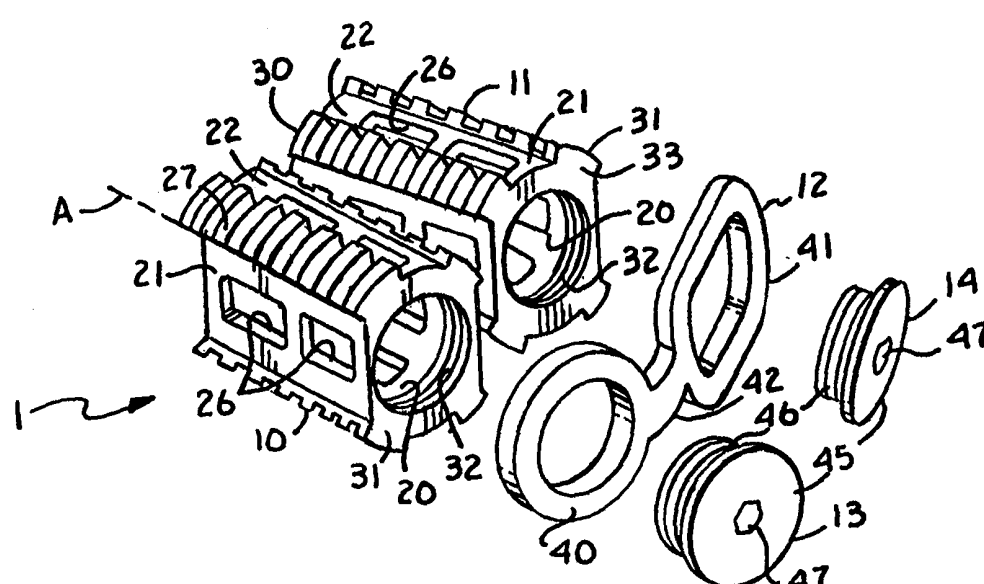


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(54) Title: SPINAL FUSION APPARATUS AND METHOD  (57) Abstract An apparatus (1) for stabilizing, promoting fusion between adjacent vertebrae includes at least a pair of implants (10, 11) to promote bone growth, and to fuse with vertebral bone. The implants (10, 11) are joined by a connector (42). Preferably the implants (10, 11) are inserted into receiving bores in a non-parallel configuration, and/or the connector (42) joins the implants so as to bias the implants to a non-parallel configuration. A pair of connection members (40, 41) also preferably secure the implants to each of the adjacent vertebrae. A method of using the apparatus (1) provides for stabilizing between vertebrae where the original cushioning disc has deteriorated or becomes damaged.		

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1 SPINAL FUSION APPARATUS AND METHOD

3 Background of the Invention

5 The present application is directed to an apparatus and
6 method of stabilizing the spine by placement of implants
7 between effected vertebrae which result in fusion of the
8 vertebrae. In particular, the present application is
9 directed to an apparatus and method of improving the
10 stabilization of the implants during the fusion process by
11 linking the implants that are positioned between the same
12 vertebrae together in pairs and also linking the implants to
13 adjacent vertebrae. Still further the apparatus and method
14 provides some pre-loading or twisting of the implants such
15 that the axes of the implants are not parallel, so that the
16 implants are further stabilized relative to their position
17 between the vertebrae and more difficult to inadvertently
18 dislodge.

19 Many millions of people in the United States alone
20 suffer from some type of spinal injury or disease that
21 effects the spine and especially the discs that are located
22 between adjacent vertebrae of the spine. These discs are
23 necessary to properly position and cushion the vertebrae
24 during the movement. Degeneration, injury or other damage
25 to the disc results in improper alignment of and dysfunction
26 of the vertebrae which often also results in severe pain,

1 the inability to move correctly or to perform certain
2 functions, paralysis and other physical problems which may
3 leave the patient totally incapacitated. Approximately ten
4 percent of the persons who have degeneration or herniation
5 of discs are candidates for surgery to correct the problem.
6 Many different systems have been developed to provide relief
7 to persons having defective discs some of which have been
8 effective and some of which have been relatively
9 ineffective. One of the methods of correcting disc defects
10 has been to properly position the adjacent vertebrae
11 relative to each other and then fuse them together in the
12 proper position or alignment.

13 Fusing often is best in situations where the discs
14 between the adjacent vertebrae have been either damaged or
15 diseased to such an extent that one or more of the discs no
16 longer functions properly and cannot be preserved by simple
17 procedures such as removal of herniated material and the
18 like.

19 One particular type of fusion device which requires
20 insertion of an implant having live bone between the
21 vertebrae has grown in substantial popularity in recent
22 years. In this type of implant, two such devices are often
23 inserted in spaced relationship relative to one another
24 between two adjacent vertebrae in the region normally
25 occupied by the defective disc. In order to accomplish
26 this, at least part of the disc is removed or the entire

1 disc is removed (discectomy) and the intervertebral implant
2 devices, often referred to as cages, are inserted in
3 receiving bores. Such implants have exterior walls which
4 are fenestrated, porous or windowed so as to provide
5 multiple openings therethrough. The interior of each of the
6 implants is filled with live bone harvested from another
7 part of the persons body, such as the hip and after
8 implantation, the bone of the vertebrae grows into and joins
9 with the live bone in the implants such that the two
10 adjacent vertebrae and the implant bone grow into a single
11 mass causing a fusion of the two vertebrae so as to hold
12 them in a desired position. While this procedure reduces
13 flexibility of the vertebrae, it significantly reduces pain
14 and/or nerve damage due to collapse, missing or defective
15 discs and, therefore, the benefits outweigh the lost
16 flexibility. This is especially true where the patient would
17 otherwise be immobile.

18 Applicant, as a spinal surgeon, has found that it is
19 desirable to further stabilize the implants, especially
20 during the period between implantation and the time when
21 stabilizing fusion occurs. Consequently, applicant has
22 developed an apparatus and method of joining a pair of
23 implants that are located between two vertebrae in such a
24 manner as to further stabilize the pair such that they are
25 not as likely to become dislodged at some time before the
26 fusion process is complete or afterward. In addition

1 applicant has found it is desirable to secure implants to
2 vertebrae on opposite sides of the implant and to other
3 implants so as to further improve the stability of those
4 implants.

5 Finally, applicant has found that it is desirable to
6 position the implants such that the central axis of the
7 implants are not parallel to one another prior to joining
8 such that it is more difficult to accidentally remove the
9 implants from bores that receive the implants prior to
10 completion of the fusion process. Yet further applicant has
11 found it desirable to place a slight torque on the implants
12 such that they are biased against the sides of the bore in
13 opposite directions so as to yet further assist in
14 maintaining the implants between the vertebrae during the
15 fusion process.

16 17 18 Summary of the Invention 19

20 The present invention is directed to implants utilized
21 to stabilize vertebrae wherein the pad or disc between
22 adjacent vertebrae has deteriorated or been damaged and no
23 longer properly spaces and cushions the vertebrae. Implants
24 of the type of the present invention have been previously
25 used to both separate and support adjacent vertebrae while
26 functioning as a promoter for encouraging bone fusion to

1 occur between the vertebrae. The present invention further
2 stabilizes such implants to allow the implants to form a
3 quicker and stronger fusion platform and, very importantly,
4 reduce the risk that the implants will become unseated and
5 either require surgery to repair or that the implants will
6 impinge on a nerve, blood vessel, or other structure and
7 produce serious injury either directly or indirectly due to
8 instability of the vertebrae supported by the implants.

9 In particular the apparatus of the invention includes a
10 pair of implants shaped and sized to be received in a bore
11 or alternatively to be driven by tapping between the
12 vertebrae, each having an axis of insertion and each being
13 placed between two adjacent vertebrae. The implants include
14 a central chamber that receives bone for fusion or material
15 to function as a matrix promoting bone growth and has a
16 plurality of radially located apertures between the chamber
17 and the exterior that allow bone from the vertebrae to grow
18 into and fuse with the bone in the chamber. Alternatively,
19 other types of implants may be used including carbon fiber,
20 porous tantalum or any structure compatible with
21 implantation in the human body and adapted to support bone
22 growth so as to join adjacent vertebrae together through
23 promotion of bone growth and fusion. The implants that are
24 secured into bores preferably include an external rough
25 thread that is sized and shaped to be received in a similar
26 thread in the implant receiving bores to assist in securing

1 the implants in the implant receiving bores.

2 The implants are joined by a connector. In one
3 embodiment the connector element is an elongate and
4 generally rigid bar of rectangular cross-section that is
5 received in recesses in the front of each implant and
6 secured thereto by fasteners. Preferably, the connector is
7 not aligned to be perpendicular to the central axis is
8 slightly bowed at an angle preferably between about 2° to
9 10°. This allows the implants to be biased relative to each
10 other such that the implants are non-parallel after
11 completion of the implantation. This urges the implants
12 into the sidewalls of the implant receiving bores, which may
13 also be non-parallel, and makes it more difficult for the
14 implants to be unintentionally disturbed while in the
15 implant receiving bores or pulled entirely from the bores.

16 In a second embodiment the connecting element is a
17 relatively thin plate connecting the implants and also
18 preferably designed to allow the implants to be aligned to
19 be non-parallel. The plate also includes at least one
20 elongate slot so that upon installation, a set screw can
21 slide along the plate during tightening while effectively
22 biasing the implants against the wall of the implant
23 receiving bores.

24 In a third embodiment a connecting plate joins two tap-
25 in type intervertebral implants. To gain additional
26 stability a pair of L-shaped connecting plates are secured

1 to the implants near one end thereof and to the adjacent
2 vertebrae. Also the implants between different vertebrae
3 are joinable by a connecting strip.
4

5 Objects and Advantages of the Invention
6

7 Therefore, the objects of the present invention are: to
8 provide a spinal stabilizing system having an apparatus
9 including implants that are positioned in bores between
10 vertebrae having a degenerated or damaged disc wherein the
11 implants include live bone or are constructed of bone growth
12 enhancing material for generating fusion between the
13 vertebrae and wherein the implants are joined for greater
14 stabilization during the fusion process; to provide such an
15 apparatus that provides for proper spacing and alignment
16 between the vertebrae thereby relieving pressure on nerves,
17 restoring strength to the spinal column and correcting other
18 problems associated with vertebrae misaligned due to disc
19 failure or related damage; to provide such an apparatus
20 including structure to further join implants to adjacent
21 vertebrae above and below the implants and other implants so
22 as to additionally improve stabilization of the implant
23 during the fusion process; to provide such an apparatus
24 wherein the implants are joined in such a manner that the
25 axes thereof are nonparallel so as to substantially reduce
26 the likelihood of accidental dislodgement of the implants

1 from the bores in which they are seated or their correct
2 position between the vertebrae; to provide such an apparatus
3 where the implants are biased against the interior walls of
4 the bores so as to further reduce the likelihood of
5 inadvertent removal of the implants from the bores during
6 the fusion process; to provide a method that utilizes the
7 implants in such a manner as to provide an extremely stable
8 implant construction during the fusion process to reduce the
9 likelihood of disturbance of the implants or of accidental
10 removal of the implants from the bores and to speed the
11 fusion process so as to quickly stabilize the patient's
12 spine; and to provide such an apparatus and method which are
13 relatively simple to use, economical to produce and utilize
14 and that are especially well adapted for the intended usage
15 thereof.

16 Other objects and advantages of this invention will
17 become apparent from the following description taken in
18 conjunction with the accompanying drawings wherein are set
19 forth, by way of illustration and example, certain
20 embodiments of this invention.

21 The drawings constitute a part of this specification
22 and include exemplary embodiments of the present invention
23 and illustrate various objects and features thereof.
24
25

26 Brief Description of the Drawings

1 Figure 1 is a fragmentary perspective view of a
2 patient's spine showing implants in accordance with the
3 present invention inserted in a region normally occupied by
4 a disc between two vertebrae wherein the implants are joined
5 to each other by a stabilizing structure or apparatus
6 according to the present invention.

7 Figure 2 is a perspective view of the patients spine
8 prior to insertion of the implants illustrating the
9 insertion of a non-circular spacer between the vertebrae.

10 Figure 3 is a front view of the vertebrae of the
11 patients spine showing the spacer in phantom lines as the
12 spacer was inserted and showing the vertebrae in phantom
13 lines at the time of first insertion of the spacer and also
14 showing the spacer in solid lines as the spacer is rotated
15 to space the vertebrae that are shown in solid lines, when
16 spaced.

17 Figure 4 is a perspective view of the patients spine
18 illustrating the pair of vertebrae in spaced relationship to
19 one another and illustrating a bore being produced by use of
20 a drill and drill guide.

21 Figure 5 is a fragmentary cross-sectional view of the
22 spine illustrating an implant receiving bore being drilled,
23 taken along line 5-5 of Fig. 4.

24 Figure 6 is a fragmentary cross-sectional view of the
25 spine illustrating a top threading the implant receiving
26 bore, taken along line 5-5 of Fig. 4.

1 Figure 7 is a front view of the patient's spine
2 subsequent to the production of an implant receiving bore by
3 the steps of Figs. 2 through 6.

4 Figure 8 is a front view of the patient's spine showing
5 an implant positioned in the bore formed in steps of Figs. 2
6 through 7.

7 Figure 9 is a schematic top plan view of a pair of
8 implants prior to joining of the implants.

9 Figure 10 is a schematic top plan view of the pair of
10 implants subsequent to joining of the implants.

11 Figure 11 is an exploded and enlarged perspective view
12 of the implants and a connecting element prior to joining of
13 the implants.

14 Figure 12 is a perspective view of a portion of a first
15 modified implant system showing an implant, a rod for
16 connecting the implants and a pair of links for connecting
17 the implants to adjacent vertebrae.

18 Figure 13 is a fragmentary perspective view of the
19 first modified implant system positioned in a patients spine
20 between two vertebrae and inter-connecting the vertebrae to
21 the system.

22 Figure 14 is a front elevational view of a second
23 modified implant system showing two pairs of top-in implants
24 with connectors and a strip joining the connectors.

25 Figure 15 is a side elevational view of the upper pair
26 of implants of Fig. 14, taken along viewing line 15-15.

1 Figure 16 is a side elevational view of the lower pair
2 of implants of Fig. 14, taken along viewing line 16-16.
3

1 Detailed Description of the Invention

2

3 As required, detailed embodiments of the present
4 invention are disclosed herein; however, it is to be
5 understood that the disclosed embodiments are merely
6 exemplary of the invention, which may be embodied in various
7 forms. Therefore, specific structural and functional
8 details disclosed herein are not to be interpreted as
9 limiting, but merely as a basis for the claims and as a
10 representative basis for teaching one skilled in the art to
11 variously employ the present invention in virtually any
12 appropriately detailed structure.

13 The reference numeral 1 generally represents a first
14 embodiment of a spinal stabilization and fusion enhancing
15 apparatus or system 1 in accordance with the present
16 invention shown in Figures 1 and 8 through 11 and showing
17 installation of the apparatus 1 in Figures 1 through 10 in
18 the spine 2 of a patient.

19 The fusion enhancing apparatus 1 includes a pair of
20 bone receiving cages or implants 10 and 11 that are joined
21 to a connecting plate 12 by a pair of set screws 13 and 14.

22 The implants 10 and 11 are designed to be received in a
23 circular bore, but have a somewhat rectangular cross-section
24 with arcing at four opposite corners. Implants of the type
25 illustrated are sold in the marketplace by Spine-Tech Inc.
26 and other manufacturers of spinal fusion type implants. In

1 accordance with the invention pairs of implants of a wide
2 range of shapes and constructed of a wide range of materials
3 may be utilized in the invention, provided that the implants
4 are positionable between adjacent vertebrae, that is,
5 intervertebral implants; are compatible with use in the
6 human body; promote, encourage or enhance bone growth into
7 the implant or between the vertebrae and are connectible.

8 Each of implants 10 and 11 (best seen in Fig. 11) are
9 elongate and have a central axis A. Each of the implants 10
10 and 11 also are somewhat annular in shape having a central
11 chamber 20, surrounded by a wall 21 having an outer surface
12 22. The wall 22 is penetrated by a plurality of ports or
13 windows 26 that are radially positioned and open into the
14 central chamber 20. The outer surface 22 also includes
15 partial threads 27 interspaced at opposite corners with the
16 windows 26.

17 Each implant 10 and 11 has an enclosed rear end 30 and
18 a front end 31. The front end 31 has a threaded bore 32
19 that is generally aligned with the axis A and an outer
20 generally planar surface 33. When installed, bone chips 35,
21 normally harvested from another part of the body such as the
22 hip, are inserted in the chamber 20 (see Fig. 8).

23 The plate 12 is relatively rigid, but has a slight
24 amount of resiliency. The plate 12 has two spaced loops 40
25 and 41 joined by a connector 42. The loops 40 and 41 are
26 sized and shaped to generally sit on the front end surface

1 33 of each of the implants 10 and 11. One of the loops 40
2 is circular and the other loop 41 is oblong. The general
3 reason for the difference in shape is that the loop 40 is
4 joined to an implant 10 or 11 first and, thereafter, the
5 loop 41 to the opposite implant. The oblong nature of the
6 loop 41 is necessary to allow for various spacing of the
7 implants 10 and 11 and more importantly to allow the second
8 of the set screws 13 or 14 to be started into the associated
9 bore 32.

10 In particular, the plate 12 is bowed or bent from top
11 to bottom across the connector 42. Normally, the angle of
12 the bend will be in the range of 2° to 10° and, in the
13 illustration the angle is about 7° and the bend can be seen
14 in Figures 9 and 10.

15 The plate 12 is relatively rigid to hold the implants
16 10 and 11 in a non-parallel relationship to each other as
17 seen in Fig. 10 to make the implants 10 and 11 harder to
18 disturb once implanted and to also provide a slight loading
19 or bias to the implants 10 and 11 in some instances to
20 further stabilize the apparatus 1.

21 The set screws 13 and 14 are sized and shaped to be
22 received through the connector 42 loops 40 and 41
23 respectively with a cap 45 abutting on and snugged against
24 each respective loop 40 and 41. Each set screw includes a
25 threaded surface 46 below the cap 45 that is operably
26 received in a respective implant matingly threaded bore 32.

1 Each cap 45 also includes an opening 47 sized and shaped to
2 receive a driving tool such as an allen wrench, screwdriver
3 or the like (not shown).

4 In use, the patient's spine 2 is exposed and a pair of
5 vertebrae 50 and 51 are exposed, normally by entry from the
6 front. Although rear entry is possible, front entry is
7 normally considered to be preferred to rear entry.

8 The vertebrae 50 and 51 to be stabilized and fused are
9 first separated, since proper spacing has usually been
10 compromised by a defective intervertebral disc or vertebrae
11 damage. To space the vertebrae 50 and 51 a nonsymmetrical
12 spacer having a rotating lug 61 is inserted between the
13 vertebrae 50 and 51 on the left or right side (see Fig. 2).

14 The spacer 60 is then rotated (as seen in Fig. 3) and
15 the vertebrae 50 and 51 are further spaced as illustrated by
16 the difference between phantom lines (not spaced) and solid
17 lines (spaced) in Fig. 3. Normally the vertebrae 50 and 51
18 are spaced approximately to the limits of ligaments (not
19 shown) holding the vertebrae 50 and 51 together.

20 A guide tool 63 is then positioned opposite the spacer
21 60, as seen in Figs. 4 and 5. The guide tool 63 includes a
22 tube 64 with pins 65 at one end to provide better gripping
23 of the bone. The guide tool 63 aligns the location of a
24 bore 68 to receive one of the implants 10 or 11. A drill
25 bit 70 is inserted in the guide tool sleeve 64 and the bore
26 68 is drilled. The drill bit 70 is then removed and a

1 threading tool 71 is inserted to form a coarse thread 72 on
2 the interior of the bore 68 that mates with the thread 27 of
3 implants 10 and 11.

4 The threading tool 71 is removed from the bore 68 and
5 an implant 10 (see Fig. 8) is inserted. The spacer 60 is
6 then removed and the drilling and threading procedure is
7 repeated on the opposite side creating a second bore 74.
8 The second implant 11 is then inserted in the second bore
9 74, as seen in Fig. 1.

10 The connecting plate 12 is then attached to the
11 implants 10 and 11 using the set screws 13 and 14. The
12 implants 10 and 11 may originally be parallel as shown in
13 Fig. 9 or the bores 68 and 74 may be drilled to be non-
14 parallel. In either case, when the plate 12 is secured to
15 the implants 10 and 11 (shown schematically in Fig. 10), the
16 implants 10 and 11 are urged into a non-parallel alignment
17 due to the angle of the bores 68 and 74, the loading of the
18 plate 12 or both.

19 In particular, the set screw 13 is first placed to
20 extend through the loop 40 into the bore 32 of implant 10
21 and tightened. The second set screw 14 is likewise
22 positioned with respect to implant 11. As the set screw 14
23 is tightened the bend in the plate 12 biases the implants 11
24 and 12 to a non-parallel alignment.

25 It is noted that the bores 68 and 74 may also be skewed
26 (not in the same horizontal plane) to give the implants

1 greater gripping and purchase with respect to the vertebrae
2 50 and 51, such that the implants 10 and 11 are more likely
3 to resist forces that try to displace the implants 10 and 11
4 during use.

5 The reference numeral 101 generally represents a
6 modified stabilization apparatus or system that is
7 illustrated in Figures 12 and 13. The system 101 which is
8 seen installed in a spinal column 103 of a patient in
9 association with and at least partly between a pair of
10 vertebrae 104 and 105.

11 Individual elements of the stabilization system 101 are
12 illustrated in Figure 12. The system 101 includes a pair of
13 bone receiving and engaging cages or implants 109 and 110, a
14 connecting element or bar 111 and a pair of connecting
15 members 112 and 113.

16 Each of the implants 109 and 110 is cylindrical in
17 shape having an annular wall 120. Each wall 120 is porous
18 or heavily fenestrated and includes a plurality of pass
19 through bores or apertures 121 that are generally radially
20 aligned. The exterior of each of the walls 120 also
21 includes a rough helical thread 122 that is aligned with a
22 central axis of each respective implant 109 and 110 and
23 which is designed to help secure each respective implant 109
24 and 110 in a desired position thereof.

25 Each of the implants 109 and 110 includes a rear end
26 124 for closing the rear end and has a front end 125 that

1 opens into an interior bore 126. An interior chamber 127 is
2 thus formed between the annular wall 120 and the end cap 125
3 that is not entirely enclosed as it opens outwardly through
4 the various apertures 121.

5 The chamber 127 receives bone fragments 128 that are
6 harvested from another part of the patient's body, such as
7 the patient's hip. The front end 125 of each implant 109
8 and 110 includes a rectangularly shaped recess sized and
9 shaped to receive the connecting element, plate or bar 111.
10 The recess 131 has a partial rear wall surface 132. The bar
11 111 is not linear but has a bend or curve in the range of 2°
12 to 10°, preferably about 5°. This same feature may be
13 created by a continuous curve or arc located between the
14 implants 10 and 11. In this manner, when the connecting bar
15 111 is placed in the recess 131 and abuts against the
16 surface 132, the two implants 109 and 110 are urged to align
17 in a slightly nonparallel relationship to one another,
18 preferably so as to toe in or converge at the rear ends 124
19 of the implants 109 and 110 opposite the bar 111.

20 It is foreseen that the axial deviation of the two
21 implants 109 and 110 could also be spread further apart in
22 the rear thereof as opposed to where the implants 109 and
23 110 join the bar 111, that is diverge or toeout. On the
24 other hand, the implants 109 and 110 may be aligned to also
25 be skewed relative to one another and/or divergent or
26 convergent.

1 The connecting bar 111 is bent on one outer wing 135
2 thereof to conform to the curvature of the vertebrae 104 and
3 105, as shown in Fig. 12. The wing 135 extends outwardly
4 further than the opposite side of the bar 111 and is
5 normally located on the left hand side of the patient. The
6 wing 135 is so located, as surgeons normally enter from the
7 front, but on the left side, so that the patient left hand
8 location allows the surgeon better access.

9 Located in the wing 135 is a threaded bore 136 that
10 receives a mating screw 137. The screw 137 is also received
11 through one of a series of apertures 139 and 140 in each of
12 the connecting members 112 and 113.

13 The connecting member 112 and 113 are L-shaped and each
14 have a second set of threaded apertures 142 and 143 spaced
15 from the wing 135 and positioned opposite the bones 104 and
16 105 respectfully as shown in Figure 13. The bone screws 145
17 and 146 are of the type having a thread 147 on the body for
18 taping into bone and a second thread 148 on the head that is
19 mated with the bores 142 and 143 respectfully.

20 The modified apparatus 101 is installed and functions
21 in a similar manner to the apparatus 1 of the previous
22 embodiment with the principal exception that the connecting
23 members 112 and 113 are secured to the adjacent vertebrae
24 104 and 105 so as to secure the apparatus 101 directly to
25 the vertebrae 104 and 105.

26 Illustrated in Figures 14, 15 and 16 is a second

1 modified embodiment of a spinal stabilization apparatus in
2 accordance with the invention, generally identified by the
3 reference numeral 201 and used in conjunction with a spine
4 202.

5 The apparatus 201 includes a first pair of implants 205
6 and 206 joined by a first connecting member 207 and a second
7 pair of implants 208 and 209 joined by a second connecting
8 member 210. The implants 205, 206, 208 and 209 are similar
9 to the implants of the previous embodiments in that each
10 contains bone and has windows 212 or similar openings
11 extending between an interior chamber holding the bone and
12 an exterior.

13 The implants 205, 206, 208 and 209 are different in
14 comparison to those of the previous embodiment in the shape
15 and method of implantation thereof. The implants 205, 206,
16 208 and 209 illustrate implant types that are placed between
17 bones 220, 221 and 222 by striking or pushing, sometimes
18 referred to as tap-in type herein, as opposed to being
19 secured by screwing into previously formed bores.
20 Consequently, the implants 205, 206, 208 and 209 have a
21 rectangular cross section as opposed to circular or near
22 circular cross section.

23 The implants 205, 206, 208 and 209 illustrate several
24 different types. In particular the implants 205 and 206 are
25 each generally rectangular when viewed from the side (see
26 Fig. 15), but have different heights with implant 205 being

1 larger than implant 206. The implants 205 and 206 are used
2 to support opposite sides of a bone 221 that has
3 deteriorated or been damaged on the side requiring the
4 larger implant 205 to level the opposite sides of the bone
5 221.

6 The implants 208 and 209 have a trapezoidal
7 configuration when viewed from the side (see Fig. 16) to
8 operably space the front of the bones 222 and 223 more than
9 the rear thereof.

10 The connector plates 207 and 210 are similar to the
11 connector plate 12 of the first embodiment and join the
12 implants 205 and 206 as well as the implants 208 and 209
13 respectively with the one difference being that the plates
14 207 and 210 each include a centrally located threaded bore
15 230 that receives a threaded screw 231. Each of the
16 connector plates 207 and 210 are joined to respective
17 implants 205, 206, 208 and 209 by set screws 238.

18 An elongate strip 241 operably extends vertically along
19 the front of the spine 202 and joins the connecting plates
20 207 and 210. The strip 241 has a series of oval shaped
21 apertures 244 that receive screws 231 so as to secure the
22 strip 241 to each plate 207 and 210 and so as to further
23 stabilize the apparatus 201 and spine 202.

24 The apparatus 201 is installed in a somewhat different
25 manner than that of the previous embodiments. Instead of
26 forming bores to receive the implants, any pad between bones

1 221, 222 and 223 is removed and the implants 205, 206, 208
2 and 209 are driven into place by tapping or the like. The
3 connecting plates 207 and 210 are then joined to respective
4 implants 205, 206, 208 and 209 by set screws 238, as in the
5 previous embodiments, with the plates 207 and 210 bent to a
6 selected angle. The strip 241 is then joined to each
7 connecting plate 207 and 210 by screws 231.

8 While the implants have mainly been described as cages
9 for receiving bone to enhance bone growth into the cages and
10 to fuse the vertebrae, it is foreseen that other types of
11 implants may be used for this purpose. For example, carbon
12 fiber implants, implants of porous tantalum and other
13 structures of stainless steel, tungsten and other body
14 friendly materials, either coated with bone growth enhancing
15 medium or simply porous so as to support and encourage bone
16 growth into and through the implants, may be utilized in
17 accordance with the invention.

18 It is to be understood that while certain forms of the
19 present invention have been illustrated and described
20 herein, it is not to be limited to the specific forms or
21 arrangement of parts described and shown.
22

C L A I M S

What is claimed and desired to be secured by Letters Patent is as follows:

1. An apparatus for stabilizing between adjacent vertebrae of a spine by promotion of bone fusion between the adjacent vertebrae; said apparatus comprising:

- a) a pair of implants adapted to be received between adjacent vertebrae; each of said implants adapted to promote bone growth between the adjacent vertebrae;
- b) a connector joined to each of said implants; and
- c) fasteners securing said connector to each of said implants.

2. The apparatus according to Claim 1 wherein:

- a) said connector is a substantially rigid elongate bar.

3. The apparatus according to Claim 2 wherein:

- a) each of said implants has a recess located at said front end thereof; said bar being received in both of said recesses.

4. The apparatus according to Claim 3 wherein:
 - a) said bar is bent at an angle between 2° and 10° , such that when said bar is received in said recess, said implants are biased so that the central axes thereof are nonparallel.
5. The apparatus according to Claim 1 wherein:
 - a) said connector is a plate operably joined to the front end of each of said implants.
6. The apparatus according to Claim 5 wherein:
 - a) said plate is bent intermedially and is secured to said implants such that said implants are biased in such a manner that central axes associated with said implants are nonparallel when assembled.
7. The apparatus according to Claim 1 wherein:
 - a) each implant has a front end that has a pass through bore that is threaded; and
 - b) said fasteners comprise set screws operably joining said connector to said implants and being received in said threaded bore.

8. The apparatus according to Claim 1 including:
 - a) a vertebral connecting member; said connecting member being connected at a first portion location therealong to said implants and having a second spaced portion whereat said connecting member is adapted to be secured to one of the two adjacent vertebrae.
9. The apparatus according to Claim 8 wherein:
 - a) said connecting member is a first member; and including
 - b) a second connecting member operably secured to said implants and adapted to be secured to a second of the two adjacent vertebrae.
10. The apparatus according to Claim 9 wherein:
 - a) said first and second members are L-shaped and include apertures therealong to receive a series of bone screws to secure said members to said vertebrae.

11. An apparatus for stabilizing intervertebrally by promotion of bone fusion between two adjacent vertebrae of a spine; said apparatus comprising:

- a) a pair of implants adapted to be received between the adjacent vertebrae; each of said implants having an interior chamber for receiving bone fragments; and each of said implants having a plurality of radially positioned and wall penetrating apertures adapted to allow bone fragments in said bores to join and fuse with bone in the adjacent vertebrae;
- b) a connecting member operably joined to each of said implants;
- c) fasteners operably securing said connecting member to each of said implants.

12. A method of stabilizing and promoting bone fusion between two adjacent vertebrae comprising the steps of:

- a) selecting a pair of implants with each implant adapted to promote bone growth;
- b) forming a pair of implant receiving bores between the two adjacent vertebrae

- with each of the implant receiving bores sized to snugly receive a respective one of said implants;
- c) placing said implants in respective bores; and
 - d) joining a front end of each implant with a connector.
13. The method according to Claim 12 including the step of:
- a) prior to the step of forming said implant receiving bores, biasing apart said two adjacent vertebrae to the extent allowed by connecting ligaments.
14. The method according to Claim 13 wherein said biasing is performed by:
- a) inserting a non-circular plug between said vertebrae in a first alignment and then rotating said plug to space said vertebrae.
15. The method according to Claim 12 including:
- a) forming said implant receiving bores such that the central axes thereof are non-parallel.

16. The method according to Claim 15 wherein:
- a) said implant receiving bores diverge from front to rear.
17. The method according to Claim 12 including the step of:
- a) joining said implants to said connector in such a manner that central axes of each of said implants is in a non-parallel configuration relative to each other and held in such configuration by said connector.
18. The method according to Claim 12 including the step of:
- a) selecting a connecting member and securing said member to said implants and to one of said adjacent vertebrae by a fastener.

19. The method according to Claim 18 wherein:

- a) said member is a first member and including the step of selecting a second member and then securing said second member to said implants and to the second of said adjacent vertebrae.

20. In an apparatus for promoting fusion between adjacent vertebrae including a pair of intervertebral implants; the improvement comprising:

- a) joining said implants with a connecting member.

21. The apparatus according to Claim 20 wherein:

- a) said connecting member is bent such that said implants are urged to a non parallel alignment relative to each other.

Fig. 1.

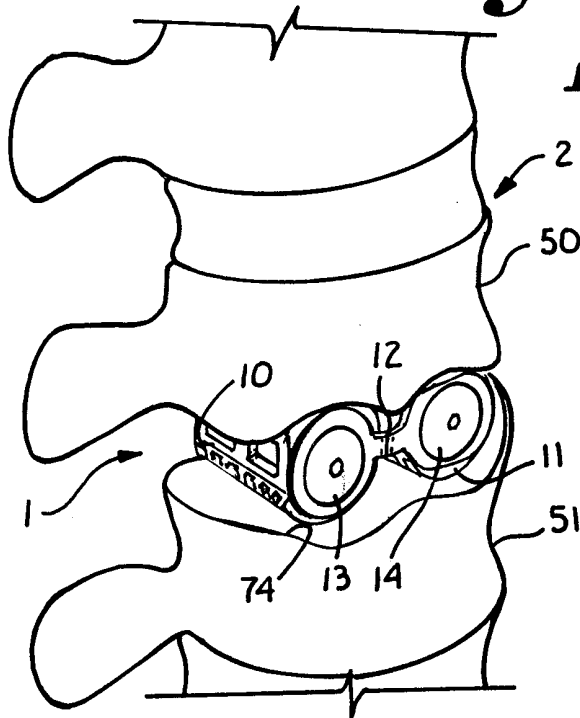


Fig. 7.

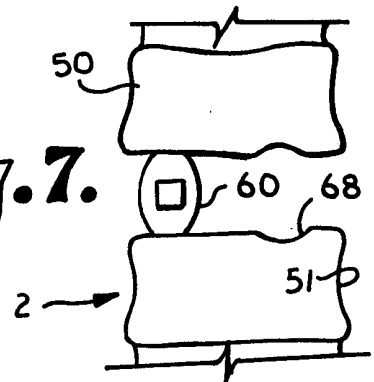


Fig. 8.

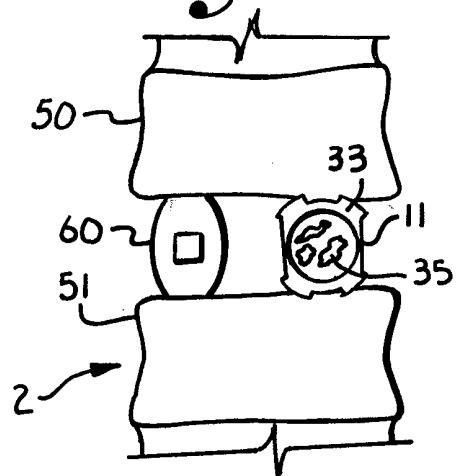


Fig. 9.

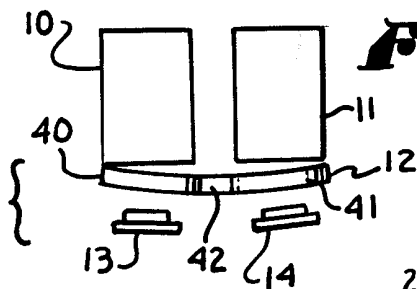


Fig. 10.

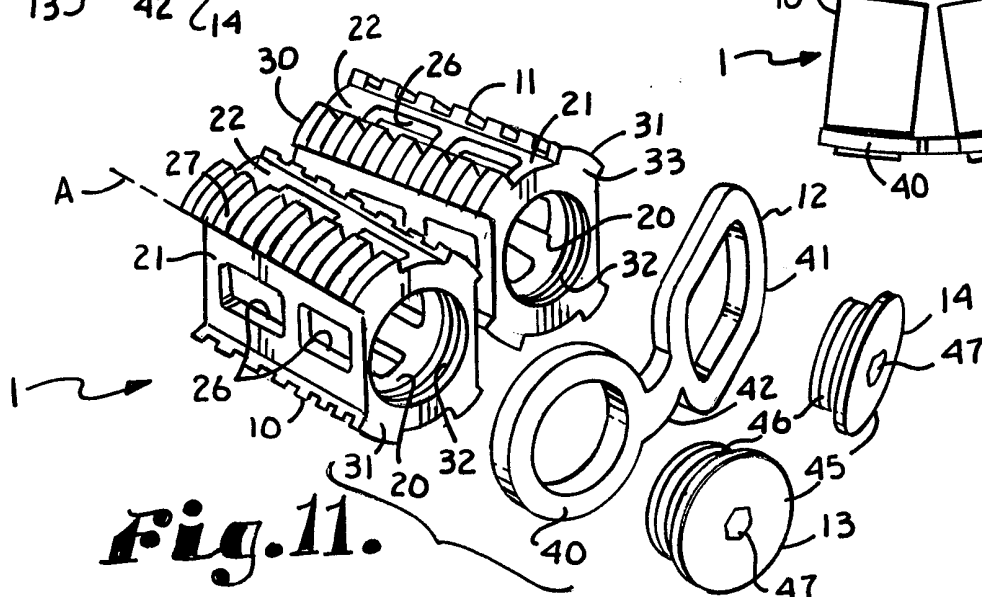
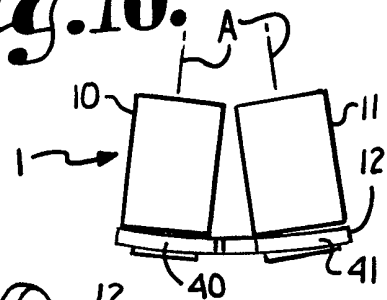


Fig. 11.

Fig. 2.

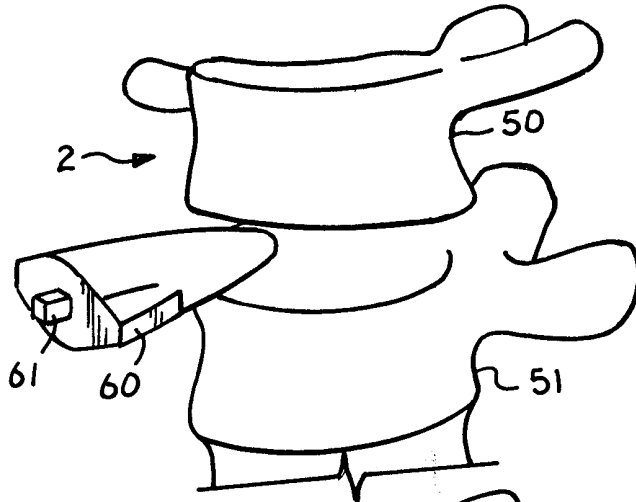


Fig. 3.

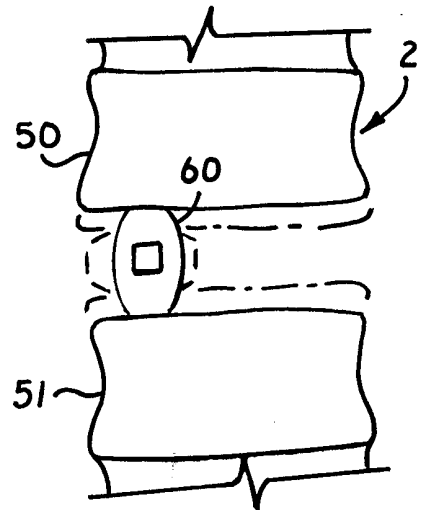


Fig. 4.

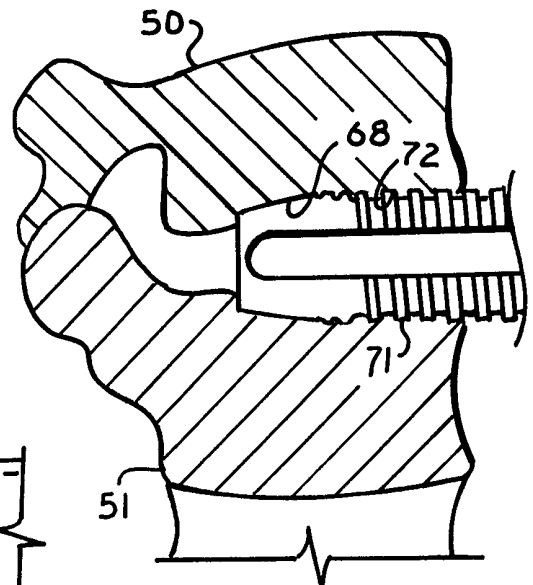
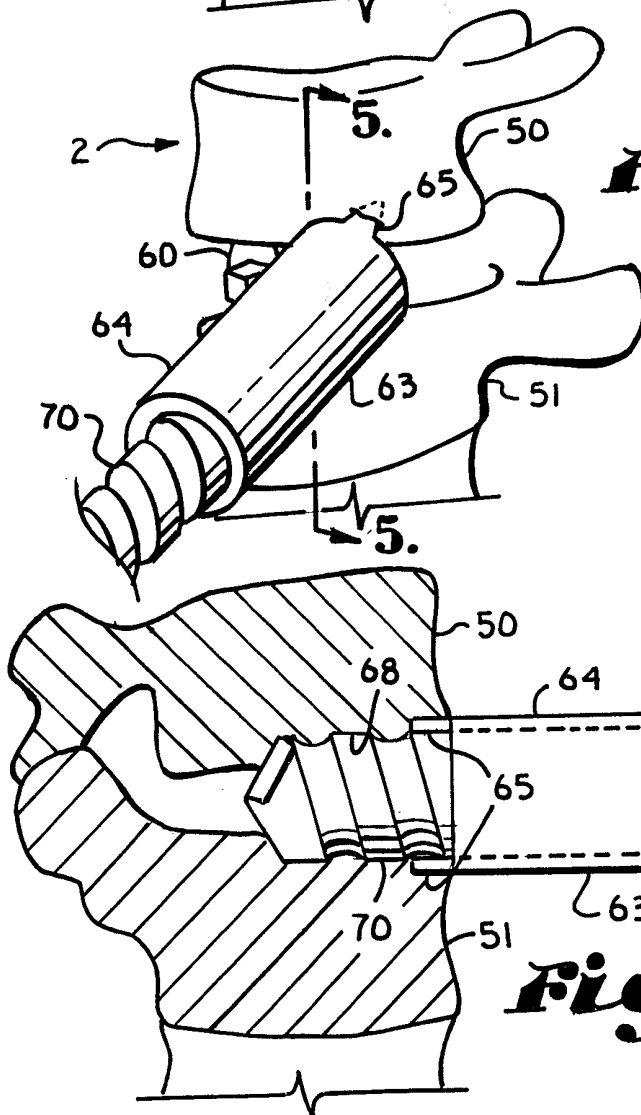
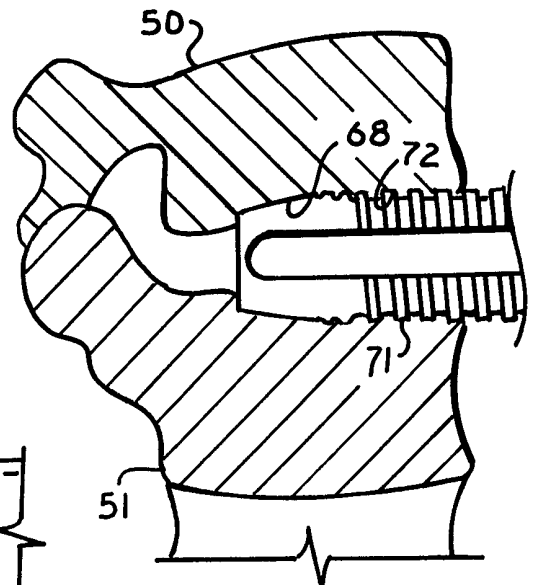


Fig. 5.

Fig. 6.



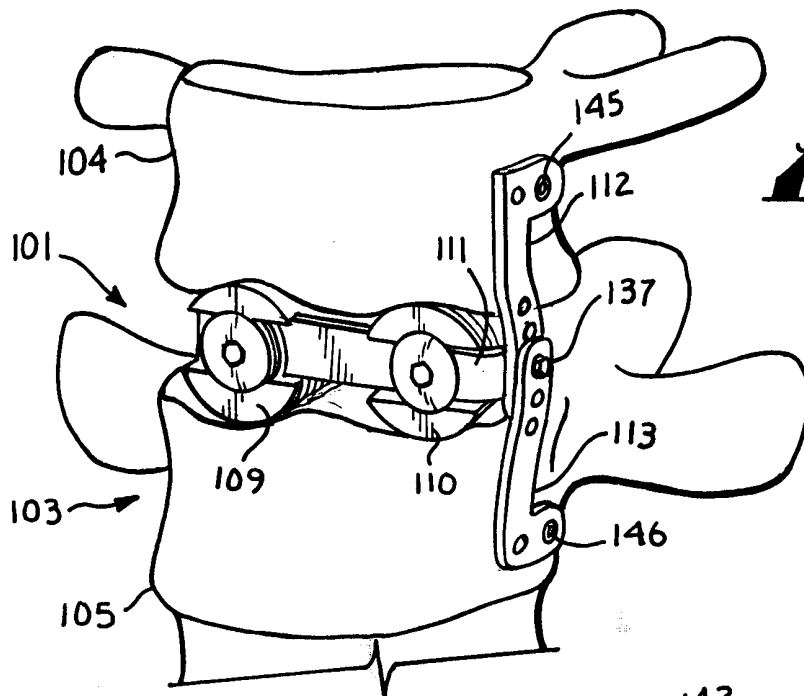


Fig. 13.

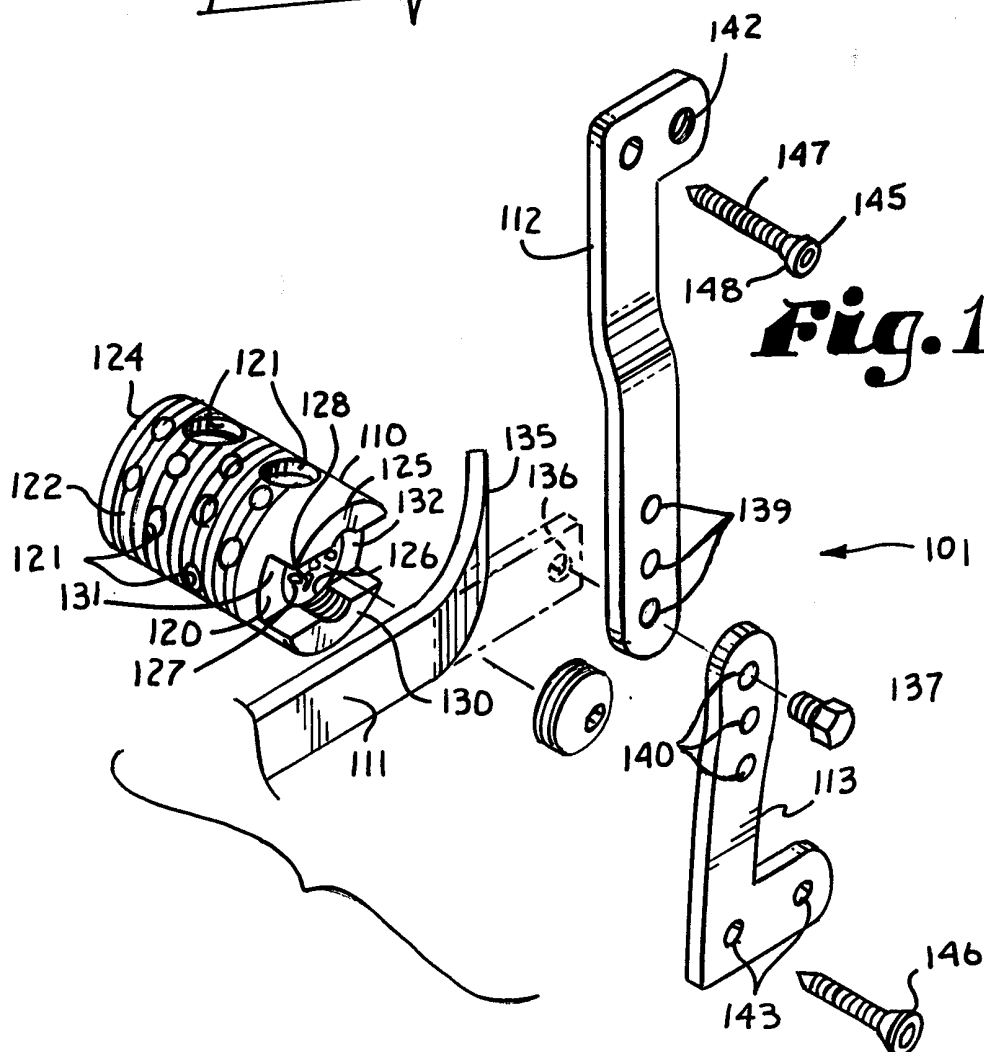


Fig. 12.

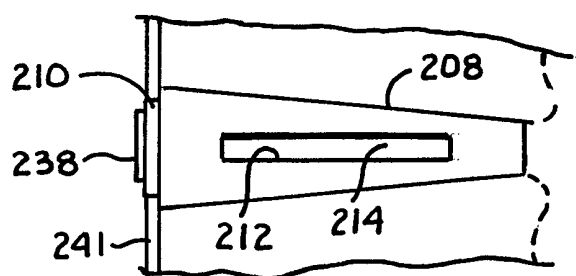
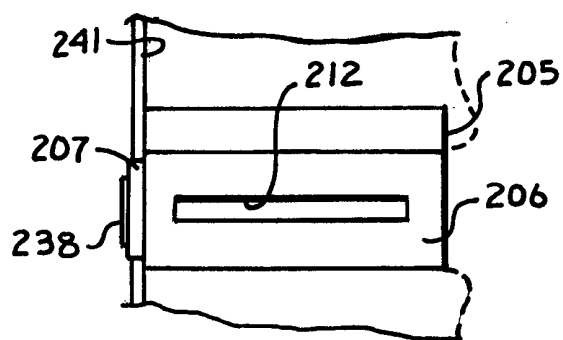
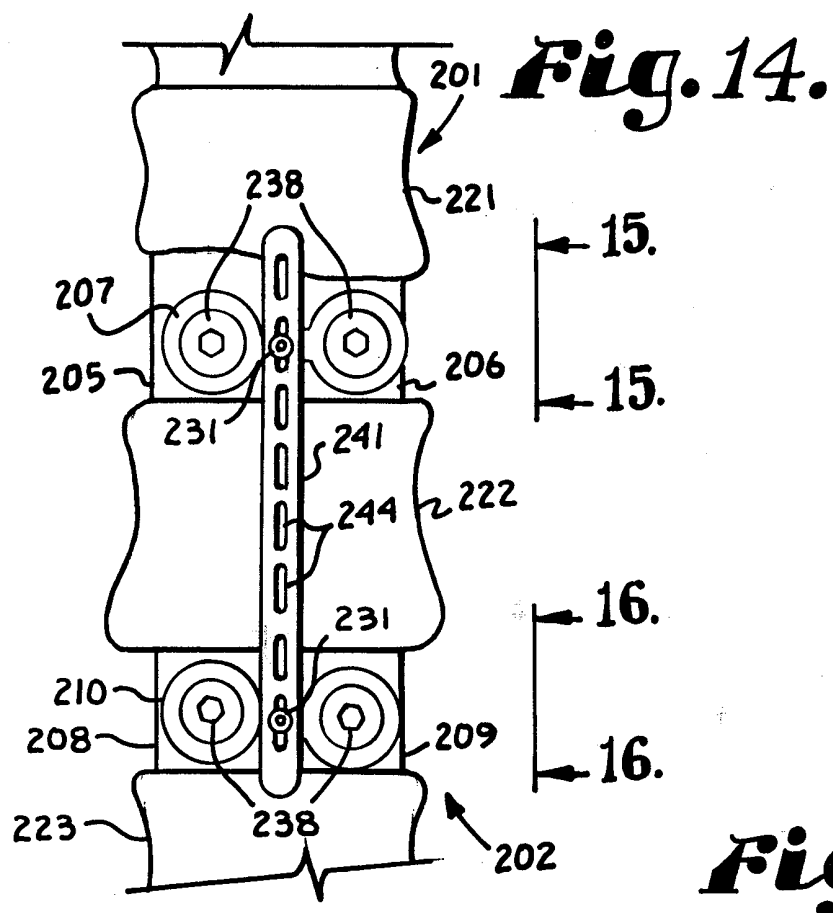


Fig. 16.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/15714

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61B 17/56

US CL :606/61

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. : 606/61, 60, 72, 73; 623/17

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)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,489,308 A (KUSLICH et al.) 06 February 1996, Figs. 1, 26, and 28.	1-3, 5, 7, 11-14
X	US 5,055,104 A (RAY) 08 October 1992, Fig. 7.	1-3, 7, 11-14
X	US 5,683,391 A (BOYD) 04 November 1997, Fig. 3.	1-4, 7, 11-13, 15-21
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Y		5, 6, 14

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"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

19 AUGUST 1999

Date of mailing of the international search report

21 OCT. 1999

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